

Analysis of Plant Growth Using Textile Substrates

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Abstract — Mulch mat is a useful hairy mulching disc made from textile fibers which helps to suppress the weed growth and lower water loss from soil surface. The practice of growing crops in vertically stacked layers is known as vertical farming. Vertical farms tend to produce more than conventional farming method.. To decrease evaporation of water from pot and to control weeds mulch mats were very useful. As we all know that the backbone of our country is agriculture and now it faces land problem as most of the agricultural lands turn into building. By combining the technique of mulch mat and vertical farming one can produce more yield. The main objective of the project is analyzing the growth of plant and finding out in which textile substrate (coir/jute mulch mat) there will be a better vegetation.

Keywords: Vertical Farming, Mulch Mat, Jute, Coir, Agro Textiles

I. INTRODUCTION

With more and more people to feed in this difficult world, alternative agricultural techniques are necessary to provide enough food for everybody. In this case, using vertical farming we can overcome the current problem by increasing the food production in smaller areas especially in urban areas. Agro textiles help to keep sufficient level of soil humidity and increase the temperature of soil to protect from weeds during harvest. To suppress weed growth in horticulture applications mulch mat are used. They cover the soil around the plant or tree and help in blocking off light and preventing the competitive weed growth around seed links. With mulch mat we have the following uses like: It prevents the soil from constant run-off, there is a reduction in water evaporation and that helps in maintaining proper soil moisture, it prevents from insects and pests, the soil can gain maximum out of the water and fertilizer. By using different proportions of different textile substrates like coir mulch mat, jute mulch mat with soil we can find the growth in which the production yield will be high.

II. VERTICAL FARMING:

The practice of growing produce in vertically stacked layers is performed through vertical farming technique. This practice can use soil, hydroponic or aeroponic growing methods. The attempt of vertical farming is to produce food in this challenging environment, like where arable land is rare or unavailable. This method of farming is preferred for the following reasons.

- The main objective is to find the suitable textile substrates for the maximum yield.
- To enhance the terrace and alternative space gardening in buildings in urban areas.
- To help in retaining water.
- To increase production in smaller area.

III. TEXTILES IN FARMING:

Conventional agricultural techniques are not-sufficient or capable to cope up with the demands of ever-growing population. Urban expansion will-lead to loss of agricultural land. This is affecting on food production. Use of artificial fertilisers, pesticides, and herbicides, which indirectly impacted human health so some new techniques have been implemented through vertical farming. Due to inefficient irrigation almost 70% of the watered water is wasted. By increasing the yield, quality, and quantity agro-textile is helpful to reduce this stress. Weed in the field of plants creates problems to the growth of plant and the quality of the fruit or grain so to avoid the growth of weeds mulch mats are used them cover the ground. One of solution for water conservation was agro textile. The wetting property of agro-textiles is useful for water conservation. For automated irrigation which helps in reducing water wastage and water scarcity issues, agro mats were used. Hydroponics method is the fastest growing sector of agriculture, and this method could very well dominate food production in future. This method requires 90% less water than conventional farming. Using aeroponics system makes efficient use of water. Nearly 99% less water is consumed than conventional farming method. This method delivers nutrients directly to the plant roots, so this method results in faster growth of crops. Hydroponics and aeroponics method help to improve the quality and quantity of agricultural products, but it can't be commercially successful because they are too costly.

A. Scope of Natural Fibers in Agro Tech Sector:

Agro textiles can be used to keep sufficient level of soil humidity, increase the soil temperature, and protect the harvests of fruits against damage caused by the hail. Agro textiles requires important properties like strength, elongation, stiffness, resistance to sunlight and resistance to toxic environments. All these properties help in the growth and harvesting of crops and other foodstuffs. Agro textiles prevent the soil from drying out and thereby it helps to increase the crop yield. Woven and nonwoven are generally used structures for ground covers, mulch mats, shades.

- Ease of transport.
- Space saving storage.
- Long service life.
- Resistance to solar radiation.
- Resistance to ultraviolet radiation.
- Biodegradability.
- High potential to retain water.
- Protection property.

These are the properties required for agro textiles.

B. Substantial Role of Agro Textile in Agricultural Application:

Agro-textiles have been used in the agriculture sector for more than thousands of years and it has been an attractive tool for the protection of crops during their entire lifecycle time. Polyolefin or petrochemical-based agro-textiles are currently dominating the agro textile market currently. However, climate change and an increase in greenhouse gas emissions because it has raised concern about the future oil-based economy, and petroleum-based agro-textiles as it has become expensive and less desirable in this modern world. Natural fibers based agro textile product will degrade so fast in the environment but synthetic fibers based agro textile recovery from the field becomes difficult and unattractive even though by efficient recycling or combustion, and their lifetime is usually limited to minimum 1 or a maximum of 2 years. So, the development of bio-based agro-textiles will have a reduced impact on the environment and with extended durability is foreseen used to initiate the growth in the bio-based economy. In the current time the world is gradually preparing for the shift toward a bio-based economy, and research for sustainable bio-based alternatives has already been initiated for better green environment. To offer alternative solutions to the current agro-textile market, various agro-textiles used currently in agriculture and the research going on in the area of agro-textiles.

IV. MULCH MAT:

In horticulture applications Mulch mats are used to suppress weed growth. They cover the soil around the plant or tree and help in blocking off light and preventing the competitive weed growth around seed links. This also reduces the need of herbicides used in weed control. Plastic mulch films are popular and extensively used, and especially woven and non-woven and spun bonded agro textile mats structures are preferable for weed controlling application as they provide durability and better breathability. Types of mulch mats based on jute are also available which is biodegradable. In our country, straw, sawdust, asphalt paper, mulch film, etc. is conventionally used for mulching. Especially due to presence of cheaper mulch films adoption of technical textiles for mulching is yet to gain momentum. In horticulture applications Mulch mats are used to suppress weed growth. With bark chips, jute, or black plastic (polypropylene), which cover the soil, blocking out light and preventing the competitive weed growth around seedlings, weed control has been achieved traditionally. Wool, jute, and coir nonwoven fabrics are most effectively used material for mulch mats.

A. Use of Jute in Mulch Mat:

Jute agro textile is a kind of natural technical textile, which can be usually either in woven or nonwoven form, made from 100% natural eco-friendly bast fibre of jute plant used on soil. It is used to achieve higher agricultural productivity by improving the agronomical characteristics of soil and by reducing the growth of unwanted vegetation like weeds.

B. Use of Coir in Mulch Mat:

Coir have strong characteristics of retention of moisture is preferred for the agricultural applications. Coir fibre being naturally resistant to rot, moulds, and moisture. The coir fibre can be used for making a suitable product, which adapts the specific needs as it suits specific applications. Coir can be converted to any form such as coir yarn and then to wove mesh matting, which is used for mainly controlling soil erosion and conditioning the soil. Coir nonwoven is one more conversion of coir, which is also widely used for controlling erosion and conditioning the soil by more ground cover and soil retention. Nonwoven coir is used for making agro products like basket liners, mulching mats, grow sticks, cultivation mats for plants, roof green application, portable lawn, or instant lawn and for many more applications. The coir fibre can be used as coco logs and coco beds for shore protection and stream banks. Coir nonwoven or closely woven matting acts as a filter which allows the water to flow across its plane as well as separator. The mulch mat will protect the roots from the winter frosts as it suppresses the weeds growth and retain moisture in the soil.

C. Necessary Parameters for Successful Cultivation:

Textile substrates should have high porosity with a hairy surface to enable the penetration of roots into the fabric for successful plant growth. Furthermore, one can assume a correlation between the water absorption capacity and biomass growth. The best combination of good rooting properties, high germination rate, good water storage capacity, and high fresh and dry matter was shown in weft knitted plush. Considering water usage and sustainability, we will investigate these and other relatively thick, open-pore materials with different water-storage properties, and change the duration and frequency of irrigation to analyse and find if the amount of used water can be reduced by less frequent irrigation. Hence considerably water can be conserved.

D. Parameter Optimisation to Produce Needle Punched Non-Woven Mulch Mat:

Needle punching is a process for converting webs of fibres into coherent fabrics, normally by means of barbed needles, which produce mechanical bonds within the web. The nonwovens used as crop protection against frost can be manufactured from 100% natural fibres such as jute or from blends of natural fibres and man-made fibres such as jute and polypropylene. The jute-polypropylene blended needle-punched nonwovens are suitable for agricultural applications because jute ensures, on one hand, an elevation of the soil temperature by 2–4°C and, on the other hand, it ensures the needed moisture for easy vegetation. The polypropylene in the mixture is representing the strength bearing component. The required functional characteristics of needle punched nonwovens that can contribute to extending the plants growing period are weight, thickness and thermal capacity expressed through thermal conductivity. These characteristics are influenced by several process parameters such as punch density, needle gauge and depth of needle penetration. The present study is investigating the effect of two parameters, punch density and needle gauge, on the properties of jute-polypropylene nonwovens. The emphasis is on the optimization of the process parameters and

not on one particular nonwoven material. For this purpose, a central composite design for second model has been employed.

E. Procedure for Developing Needle Punched Mulch Mat:

Jute and coir fibres are sourced and carding process is done. The process of preparation is given below in Fig 1.

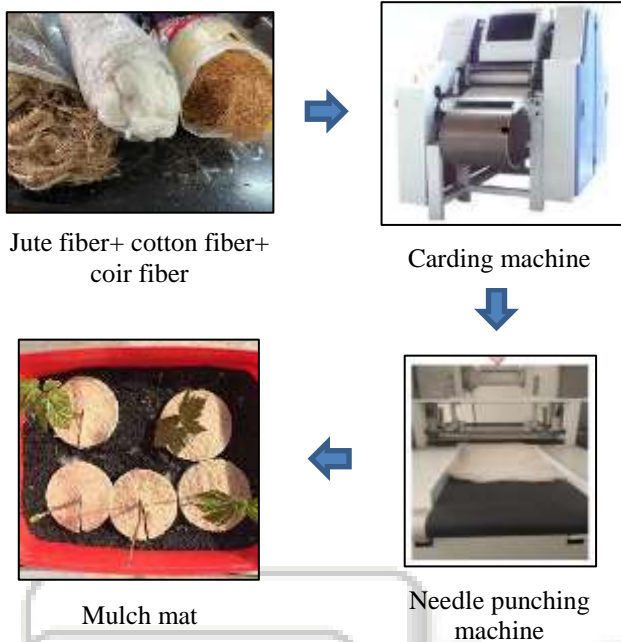


Fig. 1: Process of making mulch mat

F. Web formation process:

Fibres must be placed in a loose sheet structure called web forming. There are three web forming processes: dry laid, wet laid, and melt spun. Carding and air laying are the dry laid processes that are used to process staple fibres.

G. Needle punching process:

One of the methods used for making a nonwoven felt is needle punching process. This involves taking of loose fibres and needling them together using a needle loom that is full of barbed needles to force the fibre to push through and entangle itself.

V. PLANT GROWTH ANALYSIS:

The rate of plant growth can be assessed through the relative increase in leaf area over time, by substituting area of total plant leaf for total biomass in the conventional RGR equation. Where RGRA is relative leaf expansion rate, LA is total leaf area and t is time at two-time intervals, t1 and t2 individually, preferably 2-3 days apart.

A. Steps Involved In Plant Growth Analysis:

- 1) The height measurements of plant that have been taken and can be summarized in graph.
- 2) Summarize how to interpret and plot location on XY graph
- 3) X is taken as number of days and Y is taken as height of the plant in centimeter.
- 4) Collect the datum and draw the graphs for comparison.

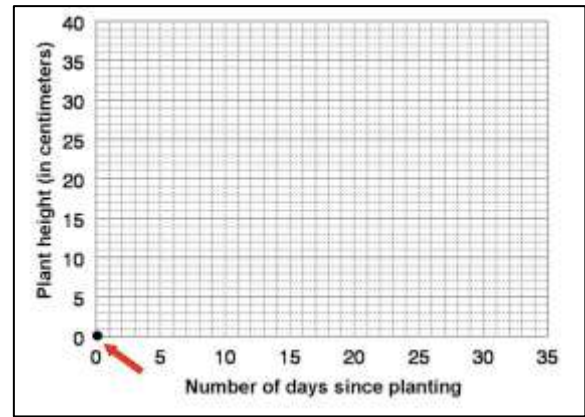


Fig. 2: Plant growth analysing graph

VI. CONCLUSION:

Therefore, the Agro-textile products are more frequently in usage all over the world, more importantly to secure the land, plants and reinforcement of the total cultivation area from damage, disturbances against sunlight, wind force, microbes and over-water, etc. The samples here we produce will help us to find the most growth and nutritious efficiency way to get a yield. As a result of this unique technology in the future helps to preserve moisture, eliminate weeds, and greatly increase soil health while producing more. This will also contribute significantly to the world's long-term food security. Hence, we can produce more yield by conserving water in a smaller areas.

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Links:

- [1] <https://textilelearner.net/agro-textiles-properties-manufacturing-and-applications/>

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