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# Designing of Coir Mulch Needle Punched Non-Woven Fabric for Agro -Application

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**Abstract**
Agriculture is the most primal occupations of the humans, among others. Textile materials which are used for agriculture is called agro textiles. Mulch is an agro textile material that is a protective layer spread on top of exposed soil surrounding the plants. Mulch is by far the best way to preserve the water resource and soil composites and also helps in maintain the soil temperature.
Moreover plastic mulch sheets and mulch films are used in agricultural field exclusively, which also have some disadvantages in its side, as non-biodegradable, water resistance, etc. As natural fibers like coir, jute, sisal, etc., are also used for the purpose of mulching for its biodegradable nature. In this paper the usage of coir in agricultural field as mulch is experimentally explained.
Coir is having a very high potentiality in agro textile application. Its moisture retention capability and high wet strength has been excellent for its applications. At the end of its usage as mulch in agricultural field, coir with natural glue finish adds organic matters, nutrients, and turned as composite and improves soil fertility. The usage of organic coir mulch sheet on agricultural lands increases the quality and yield of crops in fastest way, as it is easily available, organic and eco-friendly.
Regards, the following experiment gives very good results on agricultural production, weed control, water retention and soil protection with a help of non-woven coir mulch sheet than the synthetic mulches.

**Keywords:** Mulch sheet, bio degradable, non-woven, moisture retention, natural glues

## 1. Introduction
Agriculture is the back bone of our country. A textile fabric has a long history of application in agriculture. The practice of textiles is also now widen to safeguard the agro products like plants, vegetables, and fruits from weather, weeds, birds, etc. agriculture gives us a multidimensional views and solution to the problems being faced by agro industry, from the textile sector [1].
Today, agriculture has realized the needs of future and opting the natural way with technologies to get higher overall yield, quality and tasty agro-products. The textile product, non-woven coir mulches serves great in ground covering, as the fastest plant growing medium [2]. Coir is a by-product obtained from the coconut husk (mesoderm of fruit) encasing the nut (endosperm).Coir fiber is having naturally occurring potassium, 60%water filled space and composite properties [3].
Mulching is the practice of placing some kind of material on the bare soil between plants [4]. Coir is used for this mulching purpose in agricultural fields as in the form of needle punched non-woven fabrics with some applied finishes, such as neem gum and babul gum finishes. These glues are applied for the fabric compression, stiffness and as anti- rodent matter.
Coir mulches permit the soil to take up and hold water. These natural mulches will be acted upon by soil organisms, causing them to decompose over time. This action ultimately enriches the soil with nutrients and improves the overall soil structure [5]. Its performance, as weed control, retention of water resources, prevention of UV radiation, air permeability, bio degradability, etc. serves to an extant range for plantations in agricultural field. Its stability in adverse weather condition, easy handling, soil conditioning are some of its promotions [6]. Thus mulching the agricultural field increases the production, in fastest way, gives organic healthy and tasty products and decreases the production cost for the farmers.

## 2. Methodology

This article explains about the materials used, methodology and procedures adopted for the development of agro textile product "the mulch sheet", through test methods.

### 2.1 Materials and Methods

#### 2.1.1 Selection of Raw Material

Brown coir fiber is obtained by harvesting fully mature coconuts. The fibrous layer of the fruit is separated from the hard shell by driving the fruit down on to a spike to split it. They are then beaten, to separate out the long coir fibers. These coir fibers having the characteristic of organic, biodegradable, retains more water and evaporates more slowly [3].

### 2.2 Fabric Formation

**Non-Woven:**

Nonwoven fabrics can be manufactured by various techniques such as needle punching, spun bonding, thermal bonding, spun lacing, etc. [9] Needle punching techniques are widely used for the production of nonwoven agro textiles. Non- woven coir fabric has lot of advantages, such as ventilation, filtration, Insulation, Water absorbent, Flexible, Low price, Can be mass- produced.

### 2.3 Needle Punching Technique

Needle punching techniques are mainly used due to its high and constant tensile strength and for having good tearing strength. The needle punching technology is an eco-friendly and low energy consumption process when compared to other bonding methods.

**Needle Punching Machine [8]**

#### 2.3.1 Machine Detail

- Brand Name: Yuelong
- Model Number: YLZCJ
- Stitching density: 4000-6000s/m
- Stitching frequency: 1000-1200n/min
- Stitching course: 30-50mm
- Fabric moving speed: 0.6-6m/min

#### 2.3.2 Specification

- Width: 2100-4500mm
- Needle density: 4000-6000 needles/liner meter
- Production capacity: 300-400kg/h
- Needle length: 9-10cm

### 2.4 Fabrication

Coir mulching is a unique textile product to serve several needs for agricultural field. In order to evaluate the performance of this mulch sheet, the following properties are taken to consideration. Intrinsic properties like thickness, GSM, width are measured.

The thickness of the fabric was measured according to ASTM D1777 standard with MAG thickness gauge as thickness is 4.1mm, GSM – 400 and width of the coir mulch sample is measured in diameter as 90cms.

### 2.5 Finishing's

Needle punched non-woven coir mulch is treated with the natural gums, compressed and dried for the experimental application. This glue finish binds the fibers and gives stiffness to the fabric. It protects the fabric from fungicides, moths and rodents. These gums also soluble slowly in rain or sprinkler water and adds as a manure for the soil plantation.

**Treatment of Natural Glue with Coir Mulch Sample**

**Fig.1:** Natural Gum

**Fig.2:** Dissolved Glue with Coir Sample

Figure 1 shows the solid form of neem and babul gum and Figure 2 shows the glues in semisolid form.

#### 2.5.1 Ingredients

Water for boiling – 400ml

Natural gums - Neem gum – 20gms and Babul gum – 20gms

#### 2.5.2 Process

1. The solid natural gum is treated with boiling water for 20 min.
2. The liquid gum is allowed to cool for 10 min.
3. The liquid gum is sprayed on the coir mulch sample using the spray can.
4. Then the coir sample is dried under sun for 2hrs.
5. Make a hole in the sample at the center according to the seed plantation.

### 2.6 Analysis

**Environmental Conditions**

Experiment was conducted at the, agro-ecological region in Tirupur district, Tamilnadu. Mean of the environmental conditions that prevailed during the last three months is recorded.

**Measurements**
Soil moisture content at 15cm and 30cm depths was measured at three weeks and six weeks after planting and at the harvesting stage.

**Plant growth parameters**
Namely D-leaf (Strong, longest and healthy plants) length and width, number of leaves per plant, stem length and girth were noted.

**2.7 Testing's**
Fenugreek seeds are taken for the experimental records for its fast growth parameters. Two pots of same size and structure with same type of soil is taken. Subsequent growth and quality parameters of the plants were recorded visually. Mulched pot plants and non-mulched pot plants where visualized and measured for its weed control, plant growth, water obtainability, etc. These are also observed under field study as subjective tests.
The coir mulch is tested for its decomposition property under three types. As three samples buried under soil with various conditions and observed for each four months and compared. Thus results were taken under soil burial test.

**3. Result and Discussion**
The non-mulched, synthetic mulched and coir mulched plantations are observed for their growth, weed control and water retention properties which shows good result in coir mulched plantation in the field test. Following are the subsequent growth study of fenugreek plant in several stages.

**3.1 Visual Analysis**
**3.1.1 Comparative Study of Soil Temperature and Weed Control Measures**

**Sowing Of Fenugreek Seeds**

**Fig: 3**

**Application of Coir Mulch on Soil Surface**

**Fig: 4**

Figure 3 shows the fenugreek seeds sowed in two equal soil, filled pots.
Figure 4 shows the application of coir mulch in one pot leaving only the seeded area barley for photosynthesis of plant seedlings and another pot is open without any mulch.

**Measure of Soil Temperature**

**Fig: 5**

Figure 5 shows the sprouted fenugreek plants over the soil in both the pots in which coir mulched pot has more plants compared to other.

**Measure of Weed Control**

**Fig: 5 (A)**

**Fig: 5 (B)**

Figure 5 (a) shows the growth of weeds along with fenugreek plants in non-mulched open soil.
And Figure5 (b) the coir mulched pot with no weeds.

### 3.1.2 Competition of Synthetic Mulch with Coir Mulch in the Growth of Fenugreek Plants for Water Conservation

Evaporation of soil water is a major component of the crop water balance. In order to reduce the evaporation of land water, ground covers as mulch sheets are used in the agricultural fields. In the following analysis the water balance in the plant growth, through mulches are shown.

**Measure of Water Retention**

**Fig: 6**

**Fig: 7**

Figure 6 shows that the synthetic mulched pot plantation consumes more water (90ml) than the coir mulched pot plantation (60ml) due to high water retention property of coir mulch and Figure 7 shows that the coir mulched pot plantation growth is high when compared to the synthetic mulched pot plantation due to air and water permissibility.

### 3.1.3 Comparative Growth Rate of Fenugreek Plant

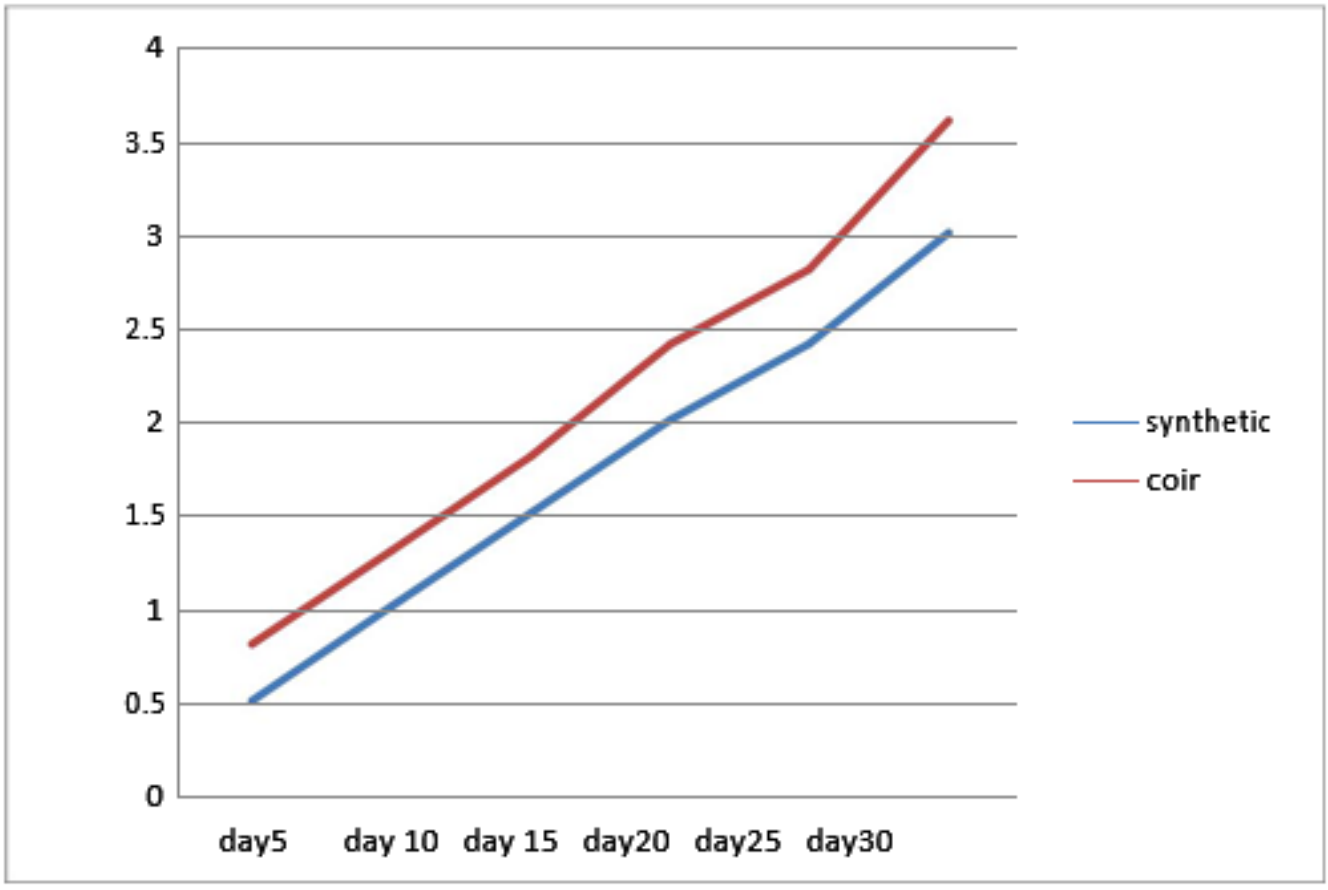



**Fig: 8**

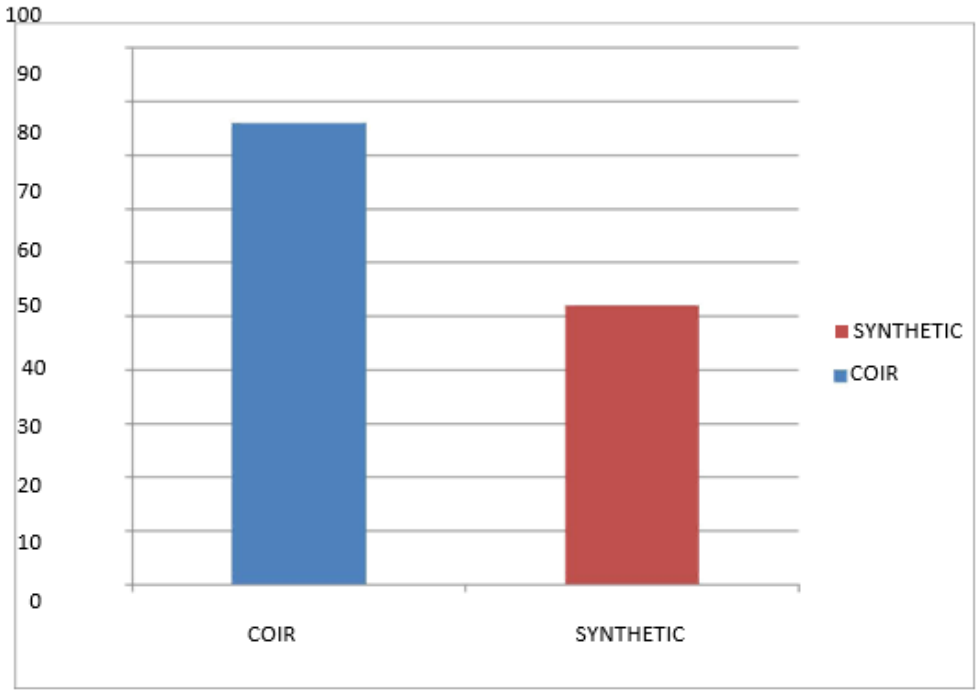
Figure 8 indicates the growth rate of fenugreek plant under coir mulch is greater, than the synthetic mulch.

**Table.1:** Comparative study of mulch sheets towards moisture retain and weed control

| S. No | Particulars | Total % | Obtained % |
|---|---|---|---|
| 1. | Coir | 100 | 86 |
| 2. | Synthetic | 100 | 52 |

The table no 3 indicates that coir mulches controls weeds and retain water resources higher than the synthetic mulches.

**Chart.1** Mulchees towards moisture retain and weed control




**Burrial testing**

In this the non-woven coir mulch samples are buried in the pit of 20*20cms with various soil composition, for its breakage and decomposing period analysis. As a result coir mulch decomposed and mixed with the soil as manure after a certain period.

**Testing for decomposing of coir mulch**

**Fig: 9**

**Fig: 9(a)**

**Fig: 9(b)**

Figure 9 shows the coir mulch sample buried in normal black soil.

Figure 9(a) shows the coir mulch sample buried with cow dung manure mixed soil.

Figure 9(b) shows the coir mulch sample buried with regular wetted soil.

**Coir mulch after decompose**

**Fig: 9**

**Fig: 9(a)**

**Fig: 9(b)**

Figure 9 shows the coir mulch sample turns black, decomposed and mixed with soil after a long period (say more than a year). Figure 9(a) shows the coir mulch sample broken down and decomposed soon (6-9 months) with

manure mixed soil. Figure 9(b) shows the coir mulch decomposed fully with continuous wetted land (which takes more than 10 months).

**Subjective evaluation test**

**3.3.1 A field survey on awareness, utility and usage of mulching**

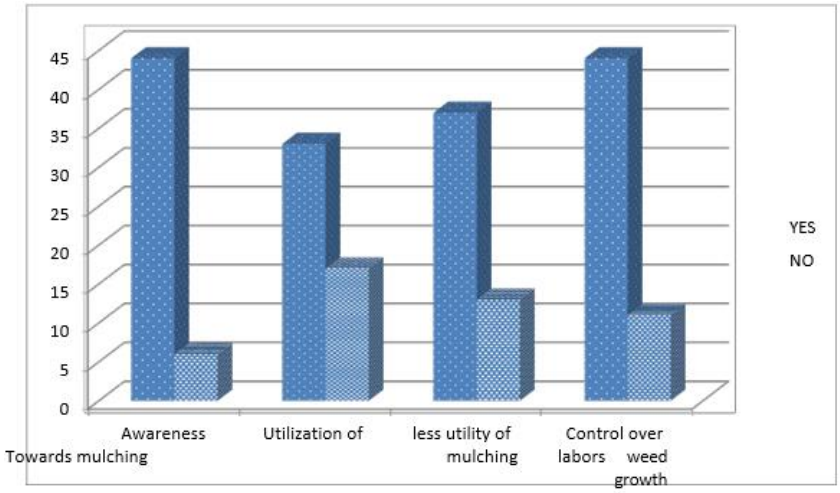
The subjective evaluation is mentioned under 10 questionnaires. The sample unit comprises of 50 different types of agriculturalists who are potential users of ground covers.

**Table: 2**

| S.no | Field tests | Yes | No |
|---|---|---|---|
| 1. | Awareness towards Mulching | 44 | 6 |
| 2. | Utilization of mulching | 33 | 17 |
| 3. | Less utility of labors | 37 | 13 |
| 4. | Control over weed Growth | 44 | 11 |

The table 2 indicates that majority of the respondents aware and accepts mulching on agricultural lands for its usage

**Chart. 2**



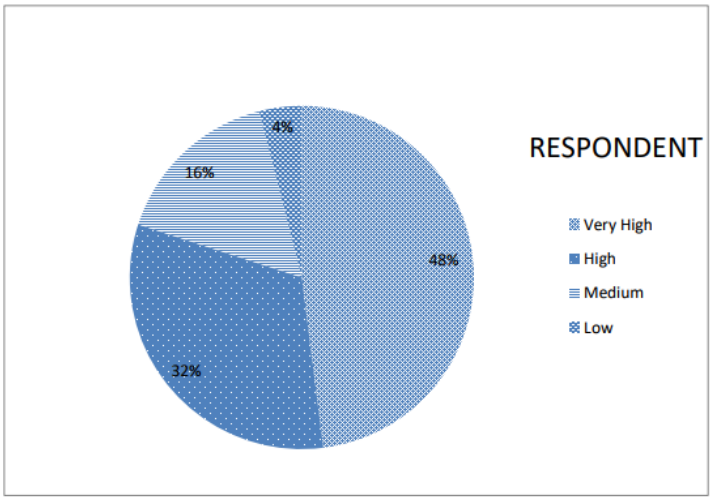

**3.3.2 Air and water permissibility of coir mulch**

**Table: 3**

| S.no | Particulars | No .of respondents | Obtained % |
|---|---|---|---|
| 1. | Very high | 24 | 48 |
| 2. | High | 16 | 32 |
| 3. | Medium | 8 | 16 |
| 4. | Low | 2 | 4 |

The table 4 indicates that 48% of the respondents says that the coir mulches air and water permissibility is very high, 32% of the respondents says its high, 16% of respondents says its medium and 4% of respondents says it is low. Majority of the respondents says that the coir mulches air and water permissibility in to the soil is very high.

**Chart .3:** Air and water permissibility of coir mulch



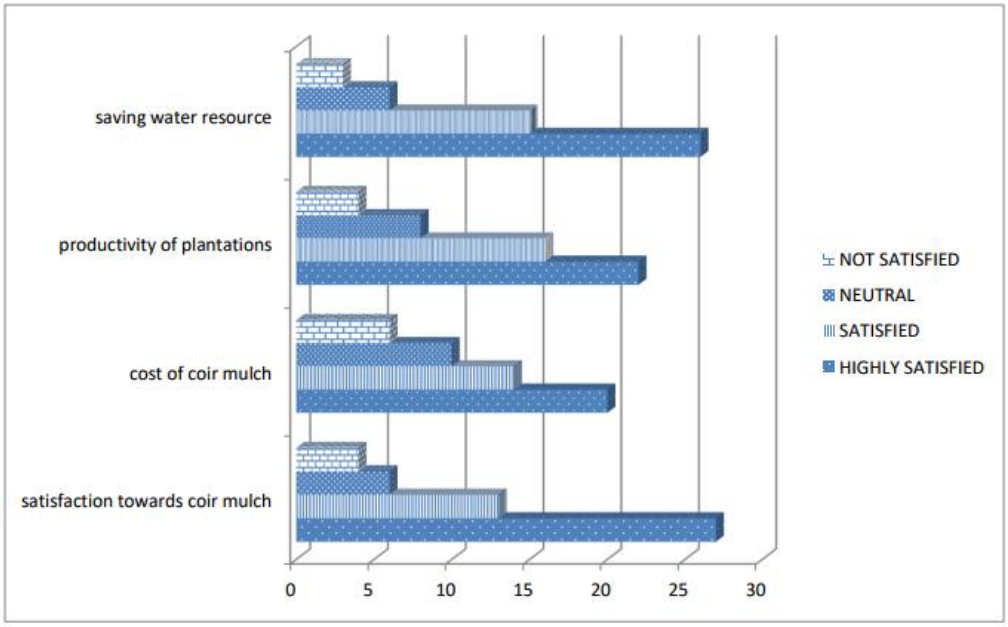
### 3.3.3 Level of satisfaction on coir mulch

**Table: 4**

| S.no | Field tests | Highly Satisfied | Satisfied | Neutral | Not Satisfied |
|---|---|---|---|---|---|
| 1. | Satisfaction towards Coir mulch | 27 | 13 | 6 | 4 |
| 2. | Cost of coir mulch | 20 | 14 | 10 | 6 |
| 3. | Productivity of Plantations | 22 | 16 | 8 | 4 |
| 4. | Saving water resource | 26 | 15 | 6 | 3 |

The table 5 indicates that majority of the respondents are highly satisfied with the cost, saving water resource and high productivity of plantations due to coir mulching. Thus they are satisfied with this natural mulch.

**Chart 4**




## Conclusion

Agriculture is the largest industry in the world. Crop production, water conservation and weed control are the major challenges faced by the farmers in the agriculture industry. From this paper it can conclude that the potential of the usage of natural fiber (coir) in agro textiles as mulches in open field is really helpful in various cultivations. Mulches contribute to weed management among crops by reducing weed seed germination, reduction in root damage, blocking weed growth, and favoring the crop by conserving soil moisture and sometime by moderating soil temperature.

Coir mulches also add organic matter as they break down, but synthetic mulch does not add organic matters to the soil. Generally coir mulches permits the rain water to reaches the soil and the root system, but in the case of non-porous synthetic mulches water runs off into alleys and may not reach the crop roots. Installation of row-drip irrigation lines are prior for mulched fields. Application of compost and solid fertilizers are in need of applying synthetic mulches. But 100% biodegradable and eco-friendly coir mulches acts as composite for soil after usage.

Thus in this paper a successful comparative study have been made between synthetic mulch and coir mulch. Whereas, the coir mulch can reduce weeds, enriches seed germination and conserving soil moisture for water conservation and helps in yielding of disease free quality products. This study reveals that coir mulch which is natural and easy obtaining fiber product, having the better performance and properties than the synthetic mulches as bio degradable and eco-friendly.

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