ABSTRACT

Green house shade nets are used in order to protect crops and plants from adverse weather conditions, animals and pests, besides providing suitable conditions for plant growth. The essential performance properties required to green house shade nets is the resistance to solar radiation and weathering. The intensity of the Photo synthetically Active Radiation (PAR) directly influences plant growth. Other non visible radiations are ultraviolet (UV), infrared (IR) and far infrared (FIR). Polypropylene and polyester are more resistant to UV radiation than polyethylene, which is resistant to radiations in the visible region. The use of green house shade nets in outdoor conditions also requires them to be resistant to abrasion. Good abrasion resistance is required for these, because there will be holes and patches, through which animals and pests can enter the structure and harm the crops. Lastly the tensile strength is a deciding factor due to its long term durability and service life. In the present study, an experiment has been conducted to find out the suitability of shade nets in terms of tensile strength calculation by means of an UTM (Tinius Olsen). Basing on the strength, it is found that the tensile strength of the insect net is maximum, so it can be safely used in the green house than other shade nets having white or green colour.

I. Introduction

A shade house is a structure enclosed by agro nets or any other woven material to allow required sunlight, moisture and air to pass through the gaps. It creates an appropriate micro climate conducive to the plant growth. It is also referred as shade net house or net house. Shade house can be used in cultivation of flower plants, foliage plants, medicinal plants, vegetables and spices. It is suitable for fruit and vegetable nurseries as well as for raising of forest species etc. It helps in quality drying of various agro products. It protects the crop from natural weather disturbances such as wind, rain, hail and frost. It can be used in production of graft saplings and reducing its mortality during hot summer days. It is very useful for hardening tissue culture plantlets.

The shade house structure should be planned taking into consideration the type of crop to be grown, locally available materials and local climatic conditions. The provision for future expansion should be there. A shade house should be located in such a way that it is well connected with market for input supplies and sale of its produces. This structure should be constructed away from buildings and trees, so also away from industrial or vehicular pollutants. The site should be free from drainage problem. There should be provision of electricity and good quality water. However, wind breakers may be located 30m away from the structure.

A shade house structure composed of two basic components i.e. frame and cladding material. The shade house frame provides support for cladding material and designed to protect against wind, rain and crop load. The shade house mild steel (ms) angle frame lasts up to 20 to 25 years, if anti rust treatment is done at regular interval, whereas bamboo structure can last up to 3 years. The agro shade
net lasts for 3 to 5 years depending on the climatic condition. Shade nets are available in different colours with wide range of shade percentages viz. 25%, 30%, 35%, 50%, 60%, 75% and 90%.

The design of shade house frames depends on the need and engineering skill. Structural frames of quonset, gable or gothic arch shape or with minor modification suitable to local condition are recommended in high rainfall areas. Shade nets are nets made of Polyethylene or Polypropylene thread with specialized UV treatment having different shade percentages. These nets provide a partially controlled environment by primarily reducing light intensity and effective heat during day time to crops grown under it. This enables lengthening of the cultivation seasons and well as off-season cultivation depending on the conditions and type of crop. Shade nets are typically used in structures known as shade net houses which are frame structures made of materials such as GI pipes, angle iron, wood or bamboo which are then covered with shade nets to provide the benefits listed above.

Singh et al, 2011 conducted a study at Central Institute of Post Harvest Engineering and Technology (CIPHET), Abohar (Punjab) during 2011-12 to determine the effect of three green shade nets (35, 50 and 75%) along with three height (2m, 2.5m and 3.5m) bamboo framed structures on yield and quality of tomato. Highest average plant yield of (3.49 kg/plant) was found in 35% shading net followed by open field (2.27 kg/plant). Lowest yield was observed (1.07 kg/plant) in 75% shading net.

Patel et al, (2014) Conducted a field experiment at Instructional farm of department of Irrigation and Drainage Engineering, Mahatma Phule Krishi Vidyapitha, Rahuri to study the yield response of cucumber grown under shade net house to 35%, 50% and 75% shading and in open field condition. Irrespective of nutrient sources applied, the performance of crop grown inside the shade net was comparatively better than open field condition. Pandey et al. (2015) studied the effects of growing environment on various growth, yield and fruit quality parameters of winter drawn strawberry under semi-arid conditions of Rajasthan. The results reveal that in naturally ventilated poly house, strawberry plants had higher crown height, plant spread and produced higher fruit yield (242.77g/plant) with maximum number of fruits/plant (29.00). Experiment was conducted at the Department of Horticulture, Agricultural College and Research Institute, Tamil Nadu to study about vegetables for under shade net house (35% shade) and open field for year round production of vegetables, tomato, egg plant, chilli, cucumber, cluster bean, radish, ladies finger and capsicum grown in summer and winter. The influence of environment variable like temperature, relative humidity and light intensity were studied the yield of production overall is more in shade net house compared to open field (Rajesekar et al, 2013). Leonardi et al (2004) conducted during summer months, a trial in wooden concrete green house to compare different shade nets and evaluate plant response in terms of growth, yield level, and fruit characteristics. The highest yields were observed in the green house with the insect net. Goren et al (2012) studied coloured shade nets (photo selective nets & chromatic nets) like pearl and yellow shade net are two cultivars of red sweet bell pepper Romans and Vegans. They found that peppers maintained better quality after 15 days storage at 7 degree for 3 days shelf life compared to traditional black shade net.

Ombodi et al (2015) studied the shading effect of external nets of different colours (white, green, yellow and red) on the yield of capsicum. Shading nets decreased incoming radiation by 23-39% and reduced PAR by 34-46%. The highest retention was obtained by yellow and green net in the range of 450-550nm and 550-67-nm respectively. So in green houses of less favourable climatic conditions red &white shading nets are required. Green house technology is a viable option for sustainable crop production in the regions of adverse climatic conditions. High summer temperature is a major setback for successful green house crop production throughout year. Naturally ventilated green house with larger ventilation areas (15-30%) provided at the ridge
and sides covered with insect proof nets of 20-40 mesh size with covering material properties
NIR (near infrared radiation ) reflection during day FIR (far infrared radiation) reflection
during night is suitable for green house production throughout year in tropical and sub tropical
regions. (Kumar et al, 2009). From all of the above reviews, it is clear that protected or surface
covered cultivation using shade nets/polyethylene sheets is more profitable than the open field
condition.

II. Materials and Methods

Shade nets are typically used in Shade Net Houses. Depending upon the costs involved in the
construction, these shade net houses are of three types – low cost, medium cost and high cost.

❖ The **low-cost shade net house** is made of a supporting structure of Bamboo and UV stabilized
shade net covering. It doesn't have any climate control system. Costing for low cost shade net
house including all the components is around Rs 150 per square metre.

❖ The **medium-cost shade net house** is made of G.I pipes, profile springs and wires, and a UV
stabilized shade net which has a high HDPE granule content percentage (up to 4-5 %) which in
turn increases the life of the net house. Costing for medium cost shade net house including all the
components is around Rs 180-250 per square metre.

❖ The **high-cost shade net house** is made of steel tubes and has many facilities like auto control
mechanism, heating, cooling and humidification system, drip irrigation system, etc. These have
the life span of around 8-10 years. Costing for high cost shade net house including all the
components is around Rs 300 per square metre

50% shade nets are suitable for plants that grow under partial light like pot and foliage plants,
orchids, anthuriums and ginger etc. 75% shade nets are suitable for plants that grow under extreme
low light like indoor plants, orchids, plantation crops, tea, coffee and useful in summer to reduce the
light level. Similarly 90% shade nets are useful in cattle sheds, poultry houses, construction of
scaffolding and vehicular shades.

Components of Shade Net Houses

- Depending on choice of shade net house, GI pipes, bamboo or steel for the structure along
  with nuts and bolts to hold structure in place at the joints
- Special aluminium locking profile to fix covering materials with structure
- Bears, hanging load 15- 25 Kg per Sq. Mt.
- UV stabilized covering materials like Insect Net or Shade Net
- Trellising system for vegetable
- If high cost shade net house is being installed, then Control System - Manual/Semi-
  Automatic/Automatic
- Planting material - soil less media like coco peat.

Shade Net Installation

- Measure out about 25 per cent more shade cloth than you will need to cover the entire
  structure. Unroll the shade cloth across the structure, leaving at least one foot of cloth
  overhanging on all sides. Pull the cloth into position, straightening as needed.
- Start with the longest side you will be covering and affix the cloth with staples every 12
  inches across the structure. Staple near the inner side of the board so they will not interfere
  when you later go to cut the edges off the fabric. Keep the fabric taut and the lines on the
  knitting straight as you work across the length of the structure.
- Begin stapling on the closest short side, keeping the shade cloth evenly lined up as you head
  in the direction away from the home. Always continue in the same clockwise or counter
clockwise motion you began in when attaching the cloth; never start stapling from an unattached side. When you finish the last edge, try to avoid any overlap in the fabric. Affix the cloth to rafters and centre supports of the structure as needed.

- Specification of shade nets as per established BIS (Bureau of Indian Standards) that should be adhered to while selected shade net is as follows:

![Fig.1. Pipe framed medium cost green house](image1)

![Fig.2. Shade nets of different colours and openings](image2)
Description of the UTM

A universal testing machine (UTM), also known as a universal tester, material testing machine or material test frame, is used to test the tensile strength and compressive strength of materials. The “universal” part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures.

Components:
- Load frame
- Load cell
- Cross head
- Means of measuring extension or deformation
- Output device

Use:
- The specimen is placed in the machine between the grips and extensometer if required can automatically record the change in gauge length during the test.
- If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held.
- Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen.

III. Results and Discussions

But from above characteristics only the tensile strength of shade net was measured by using universal testing machine of Tinius Olsen Company which is available in laboratory.

Testing of shade net:
- Universal testing machine, shade nets were taken.
- Gauge length should be maintained at 250mm and speed should be maintained 20mm/min.
- White and green colour shade nets were taken, also an insect net was taken and data was recorded.
- The shade nets are in Shreya Agro (Behrampur, Odisha) and placed both in horizontal and vertical manner.
Fig.4. Strength measurement in the UTM

Table No.1. Test report for the shade net

<table>
<thead>
<tr>
<th>Name</th>
<th>Batch reference</th>
<th>Breaking force (Newton)</th>
<th>Elongation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White shade net horizontal</td>
<td>19-1</td>
<td>306.00</td>
<td>56.5</td>
</tr>
<tr>
<td>White shade net vertical</td>
<td>19-2</td>
<td>790.00</td>
<td>51.3</td>
</tr>
<tr>
<td>Green shade net horizontal</td>
<td>20-1</td>
<td>900.00</td>
<td>55</td>
</tr>
<tr>
<td>Green shade net vertical</td>
<td>20-2</td>
<td>344.00</td>
<td>60.5</td>
</tr>
<tr>
<td>Insect net vertical</td>
<td>21-1</td>
<td>470.00</td>
<td>15.24</td>
</tr>
<tr>
<td>Insect net horizontal</td>
<td>21-2</td>
<td>906.00</td>
<td>23.55</td>
</tr>
</tbody>
</table>

From the shade net testing the following graphs are obtained.

Graph No.-1

![Graph](image)
From the universal testing machine only tensile strength and elongation can be measured. The tensile strength of shade nets can be a deciding factor of its long term durability and service life. Hence good tensile strength is necessary parameter for shade nets.

**Interpretation from the graph**
- In the above graphs in X-axis, extension has been taken and in Y-axis force has been taken.
- In graph-1, 19-1 represents transverse measurement and 19-2 represents longitudinal measurement. The maximum force occurs in 19-2 i.e. 790N. After that breaking will be occurred.
- In graph-2, 20-1 represents longitudinal measurement and 20-2 represents transverse measurement. The maximum force or ultimate force will be at 20-1 i.e. 900N. After that breaking will be started.
In graph-3, 21-1 represents longitudinal measurement and 21-2 represents transverse measurement. The maximum force or ultimate force will be at 21-2 i.e.906N. After that breaking will be started.

IV. Conclusion

From the above graphical studies, it is concluded that the tensile strength of the insect net is maximum, so it can be safely used in the greenhouse. The strength of the shade nets plays a vital role for selection and life period of the green houses. The farmers will accordingly select the shade nets for their green houses for protected cultivation.

Bibliography