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**Ready - Reckoner
for**

Protective Shade

Nets Structures

for

Horticultural

Applications

About SASMIRA

The Synthetic & Art Silk Mills' Research Association (SASMIRA) is a co-operative venture set up by the man-made textile industry of India after independence as a multi-functional institute to serve its scientific and technological needs. SASMIRA was established on 12th January, 1950 after due recognition by the Council of Scientific and Industrial Research under the Ministry of Science and Technology, Government of India. Later it was linked to the Ministry of Textiles. Since then, SASMIRA is engaged in multifarious activities with the prime objective of rendering scientific & technical assistance to the textile industry, thereby assisting its growth and development.

SASMIRA is engaged in various research and development projects in man-made textiles for apparel, industrial and defence applications. Considering the importance of this field SASMIRA had altered its focus towards technical textiles for the past ten years. Various products and processes have been developed viz. Geotextiles, Agrotextiles, Defence textiles, Sport textiles, etc. a few of which have been patented also. Seminars, conferences and workshops are also conducted regularly, both national and international level, to cater awareness in emerging areas of technical textiles. SASMIRA has fully equipped laboratories to carry out testing, evaluation and investigation of a variety of textile and allied materials, with specialised services for technical textiles. SASMIRA laboratories are recognised by International Bureau for Standardisation of Man-made Fibres (BISFA), Bureau of Indian Standards (BIS) and several Government agencies. The laboratory is accredited by nationally by NABL, New Delhi and internationally by AZLA, USA for testing Chemical, Mechanical & Microbiological Parameter of textiles and allied substrates.

SASMIRA's education programme conduct diploma and certificate courses in various disciplines of textiles e.g. knitting, fashion, apparel merchandising and management. In addition to the regular courses on textile technology, processing, knitting technology etc.

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1. What is Shade net?

Light and temperature plays a vital role in vegetative and productive phase of all crops. Shade net regulates the quality and quantity of light and temperature which is required to control growing conditions. It manipulates growth pattern and protect crops from excess sun rays and wind. By providing the right balance with the correct grade of shade net, the optimum climatic conditions are created under which the plant's productivity is maximized. Under these optimum conditions, photosynthesis is enhanced and extremes of air and soil temperatures are reduced and moderated. Even more importantly, plant leaf temperatures are lowered to the same level as surrounding air temperature and it is this mechanism which accounts for the improved productivity of the plant.

In order to protect fields and greenhouses from the intense solar radiation for healthy plant growth and good harvest, Shade nets with open mesh construction are used to control sunshine and amount of shade required. These shade nets are open mesh structure textiles used to cover the shade houses for regulating the sunlight exposure of plants inside. The mesh size of the nets is variable decides the shading percentage provided. Functionally, these net fabrics allow the air to flow freely so that the excess heat does not built up under the screen. The selection of shade net depends upon the percentage of shading required for the crop being cultivated.

2. Advantages & Applications

- a) It enhances photosynthesis by manipulating the amount and quality of light by means of various densities of netting and hence growth and yield.
- b) It improves productivity by moderating extremes of temperatures. Prevents sun burn and frost damage. The special knitted construction "breathes", allowing hot air to escape.
- c) It restricts air movement thus reducing wind damage to the crop and evaporation of soil moisture
- d) Air beneath the shade cloth stays humid which is of further benefit to the plant.
- e) It provides a physical barrier against hail and heavy rain and keeps many birds and insects off the crop

f) It saves water to a great extent by reducing evaporation, reduces fertilizers and insecticides costs. (Fungicide still necessary).

g) It reduces wind, hail, bird and insect damage to crops.

Shade nets are generally used in agriculture and horticulture for applications like:

- a) Floriculture
- b) Horticulture
- c) Indoor plants, fruit plants nursery;
- d) Tea, coffee, cardamom, pepper and other spices, vegetables growing;
- e) Cattle sheds, fish ponds, poultry farming etc.;
- f) General purpose shading;
- g) Vermi-composting;

3. Technology of Manufacturing

They are generally made of PP or HDPE in knitted and woven form. In India, the standard sizes of net available are in widths of 2, 3, 4, & 8 metres and in length of 50 & 100 metres. These are extremely useful in horticulture, also in floriculture and sericulture.

A. Materials

The shade nets are generally manufactured from PE tape yarns in the width 1.5 mm to 3.5 mm. The tape denier may range from 400 D to 650 D depending upon the application. In some cases where strength is important, monofilament of PE is also used. The stability of the material to outdoor exposure is the most important, hence the dope is mixed with UV stabilizer. It is important to note the following 'Polymers used in the manufacture of shade net fabrics shall consist of long chain/staple fibers of synthetic polymers, composed of at least 95 percent by weight of polyolefins (polypropylene, high density polyethylene). It shall be formed into a stable network by heat setting such that the ribs, filaments or yarns retain their dimensional stability relative to each other, including selvages and no curling takes place. Polyolefin material shall be made resistant to ultraviolet light by adding a minimum of 3 percent carbon black.'

B. Process flow

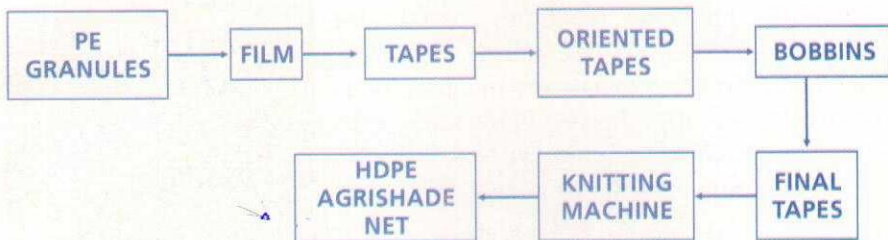


Fig.1: Process Flow Chart for Shade net Manufacturing

In this process as shown in Fig.1, the polymer melt from the extruder is passed through a flat die with a slit. The film emerging from the die is then quenched in a water tank. This film is then passed through a slitter. Here the film is slit into tapes of specific width according to the end use requirement. The slit tapes are then oriented, by drawing through a hot air oven or by passing them over a hot plate. The stretching of the tapes is done by passing them over two sets of rollers, called goddet rollers, placed on either side of the hot air oven/hot plate, operating at different speeds. The drawn tapes are annealed immediately after stretching operation, so as to minimize the tape shrinkage. Annealing is done by heating (melting point between 100-110°C) the stretched tapes while they are passing over from second set of goddet rollers to third goddet rollers which are maintained at a slightly lower speed (5% less). The tapes emerging from third goddet rollers are wound individually on bobbins with the help of winders.

The tapes are then knitted into fabrics of different textures on a Raschel knitting system. They can create very high quality fabrics of different texture and do so with high rate of uniformity throughout the fabric.

Alternative Method

In this process, the polymer is processed from the extruder and converted to film rolls. This is fed in the slitter machine and these rolls get cut into tapes. The slitting and the knitting is done together. After slitting the tapes come to the knitting machine and it gets knitted into fabric of different textures on a High Speed Raschel Knitting system. They can create very high quality fabrics of different types.

C. Machinery Suppliers

The raschel knitting machines used for manufacturing shade-nets are mostly imported. The key raschel knitting machinery manufacturers in the world are Karl Mayer (Germany), LIBA Maschinenfabrik GmbH (Germany) and Brückner Technology Holding GmbH (Germany).

The machinery costs around ₹ 2-2.5 crore and has a capacity of 60-150 linear metre / hour. The cost of the machine depends on whether the raw material is in monofilament form or in tape form.

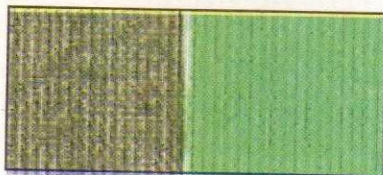


4. Important Functional Requirements

The shade nets are expected to bear the impact of weather and varying sunlight continuously for years together. This demands stability of the structure to outdoor exposure. The important functional requirements of a shade net may hence be listed as below:

- i. Weight per square meter - This implies the minimum textile material that should be present to make a sustainable and stable structure.
- ii. Thickness - This is yet another physical dimension of the shade net for quantification of material.
- iii. Tensile strength - This is the minimum strength of the fabric in the longitudinal manner to quantify its serviceable life, when assembled in a shade net house.
- iv. Bursting strength - This implies the maximum impact of the falling darts like hailstones, stones, or any other droppings that the erected shade net would be able to bear.
- v. Light shading percentage - This indicates the amount of light that is being transmitted through the shade nets and quantifies the shade from the sunlight that the nets provide.
- vi. Colour fastness - The nets have varying colours like green, blue, white, black, red. Light spectrum of light available to the plants affects their growth. Hence it is important that the colour of shade nets lasts their serviceable life. Hence colour fastness to light is important.

- vii. Stability to outdoor exposure - This is an indicator of the severe weathering conditions that the shade nets would be able to survive. This is measured in terms of accelerated UV exposure test to evaluate the serviceable life of shade nets.



5. Classification of Shade nets

Shade nets can be technically classified based on their shading percentage. The three major varieties have been listed and tabulated along with their minimum desirable functional characteristics in Table1.

Table 1: Functional Characteristics of Different Types of Shade nets

Sr. No	Characteristic(s)	Type I 50 % Shading	Type II 75 % Shading	Type Ili 90 % Shading	Methods of Tests
1.	Weight/square meter g	Minimum 90	Minimum 120	Minimum 150	IS 1964,
2.	Tensile Strength N	250 - 350	350 - 450	Min. 500	IS 1969
3.	Bursting strength, kg/cm	Minimum 5.5	Minimum 6.0	Minimum 8.0	IS 1966
4.	UV Accelerated exposure testing	Less than 2 %	Less than 2 %	Less than 2 %	IS 7903
5.	Light shading percentage	50 - 56	70 - 80	87 - 93	ASTM D1003
6.	Colour fastness to light	Minimum 4	Minimum 4	Minimum 4	IS 2454

6. Suitability of shade nets for Floriculture/ Horticulture

The choice of percentage shading of net varies regionally, and according to prevailing climatic conditions in each region. However, depending upon the type of crop, its light and photosynthesis needs, the following guidelines may be useful for use of shade nets in agricultural and horticultural applications:

- a) 30% and 40% shade cloth provide ideal conditions for germination of seeds and development of seedlings at this highly vulnerable stage of a plant's lifecycle.
- b) 50% and 55% shade cloth are for flower cultivation and are recommended for general nursery stock.
- c) The geographical situation of the site as well as the local climatic conditions can also play a roll in determining the ideal shade requirement.
- d) White shade nets provides protection form the ultra-violet rays, but allows more light to reach the plant, thus speeding up it's growth rate.
- e) Roses, strawberries, gooseberries, tomatoes, cucumber and fruit bearing plants can thrive well under 25% shade netting.
- f) For plants that grow under partial light like general pot and foliage plants and cut greens, orchids, anthuriums, ginger and other flowering pot plants use of 50% shade net is recommended.
- g) For plants that grow under extreme low light like indoor plants, certain orchids, plantation crops, tea, coffee, cardamom, use of 75% shade nets is recommended. It is also useful in summer to reduce the light level of some general purpose crops in certain geographic regions.
- h) The 90% shade nets are recommended for usage in cattle sheds poultry houses, construction scaffolding and vehicular shed.



7. Shade net houses - Types and Characteristics

There are mainly two criteria for shade net house orientation, viz., the uniformity of light intensity in the shade net house and wind direction. Single span structure may be oriented either in east-west or north-south direction but multispan structure should be oriented in north-south direction. A shade net house structure is composed of two basic components i.e. frame and cladding material. The shade net house frame provides support for cladding material and designed to protect against wind, rain and crop load. The shade net house mild steel angle frame lasts upto 20 to 25 years, if anti rust treatment is done at regular interval, whereas bamboo structure can last upto 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 net 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. A comparison of various shade net houses is summarised in Table 2.



Table 2: Comparison of Performance of Different Types of Shade net Houses

Sr. No.	Type of Shade net House	Low Cost Shade net House	Medium Cost Shade net House	High Cost Shade net House
1	Material of Construction	Bamboo, Shade nets, plastic wires and jute twines	GI/PVC Pipes, Shade nets, UV stabilized film, plastic wires	Metallic (MS) frame, Shade net, UV stabilized film
2	Type of Ventilation & Controls	Natural	Fan - pad system	Controlled temperature system, fogging controls

Sr. No.	Type of Shade net House	Low Cost Shade net House	Medium Cost Shade net House	High Cost Shade net House
3	Wind speed sustained (km/hr)	80	100	120
4	Cost of Construction per sq.m (₹)	100 - 120	450 - 500	1500 - 2000
5	Recurring Cost	Low	Moderate	High
6	Cost of Construction of 100 sq.m. (₹)	12,500	50,000	2,00,000
7	Cost of Cladding Shade net (₹) for the 100 sq.m @ ₹ 22 per sq.m	3,300	3,300	3,300
8	Expected life of Structure	3 - 5 years	20 - 25 years	20 - 25 years
9	Replacement Cost (₹)	12,500 (entire structure)	4,125 (cladding material & fabrication)	4,125 (cladding material & fabrication)

Assistance available:

The National Horticulture Mission provides a grant from the Govt. of up to 50% of the cost of shade-nets @ ₹ 14 / sq. m. limited to 2 hectare per beneficiary. The market price of shade-nets is around ₹ 22 per sq. m. The cultivators can benefit by installing the Shade net structures with certified cladding materials for their performance.

Acknowledgment:

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