CHAPTER 3

METHODOLOGY

3.1   Introduction

The objectives of this research is to analyse the characteristics of the coloured shade nets, investigate the lights property under each shading colour and evaluate plant performance in terms of its performance. Shading nets plays an important role in carrying out this research. These are the general steps taken to accomplish this research which are, germination of seedlings, management of irrigation system, pest and disease control and crop quality checking.

3.2   Experimental Flowchart

        Below is the experimental flowchart that has been followed out while conducting
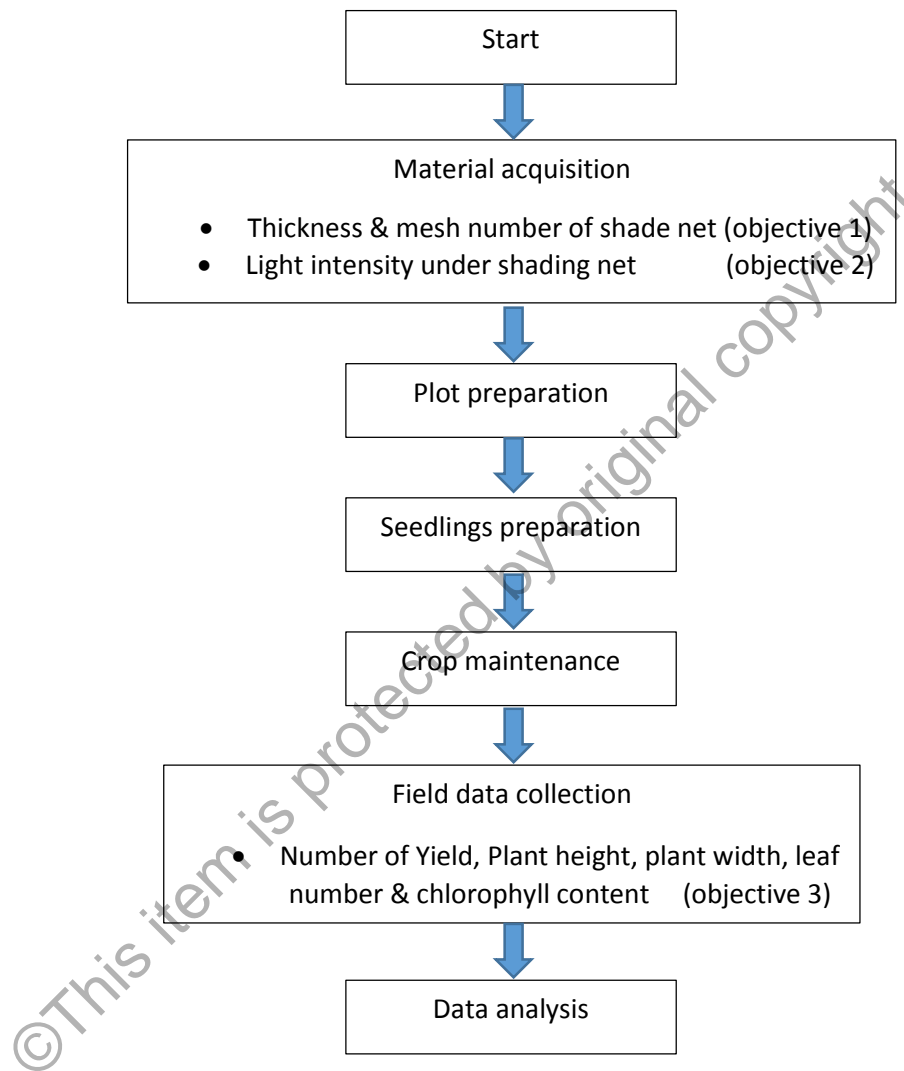this study. The general work taken in the study are shown in Figure 3.1.

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                            ┌─────────────────────┐
                            │        Start        │
                            └─────────────────────┘
                                      │
                                      ▼
        ┌─────────────────────────────────────────────────────┐
        │              Material acquisition                    │
        │                                                      │
        │   • Thickness & mesh number of shade net (objective 1)│
        │   • Light intensity under shading net     (objective 2)│
        └─────────────────────────────────────────────────────┘
                                      │
                                      ▼
                            ┌─────────────────────┐
                            │   Plot preparation  │
                            └─────────────────────┘
                                      │
                                      ▼
                            ┌─────────────────────┐
                            │ Seedlings preparation│
                            └─────────────────────┘
                                      │
                                      ▼
                            ┌─────────────────────┐
                            │  Crop maintenance   │
                            └─────────────────────┘
                                      │
                                      ▼
        ┌─────────────────────────────────────────────────────┐
        │              Field data collection                   │
        │                                                      │
        │   • Number of Yield, Plant height, plant width, leaf │
        │     number & chlorophyll content    (objective 3)   │
        └─────────────────────────────────────────────────────┘
                                      │
                                      ▼
                            ┌─────────────────────┐
                            │    Data analysis    │
                            └─────────────────────┘
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Figure 3.1: Flowchart and the Activity

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3.3   Study Area

Referring to Figure 3.2, the study was carried out in a greenhouse located at Institute of Sustainable Agrotechnology, INSAT which lies at latitude 6º 39' 9' N and longitude 100º 15' 39' E Padang Besar, Perlis with size of the greenhouse of 12m x 6m with 10m high. In Figure 3.3, represents the layout of the study area. The study was carried out during November 2016 to April 2017. Before and after cleaning the greenhouse is showed on Figure 1 Appendix B.
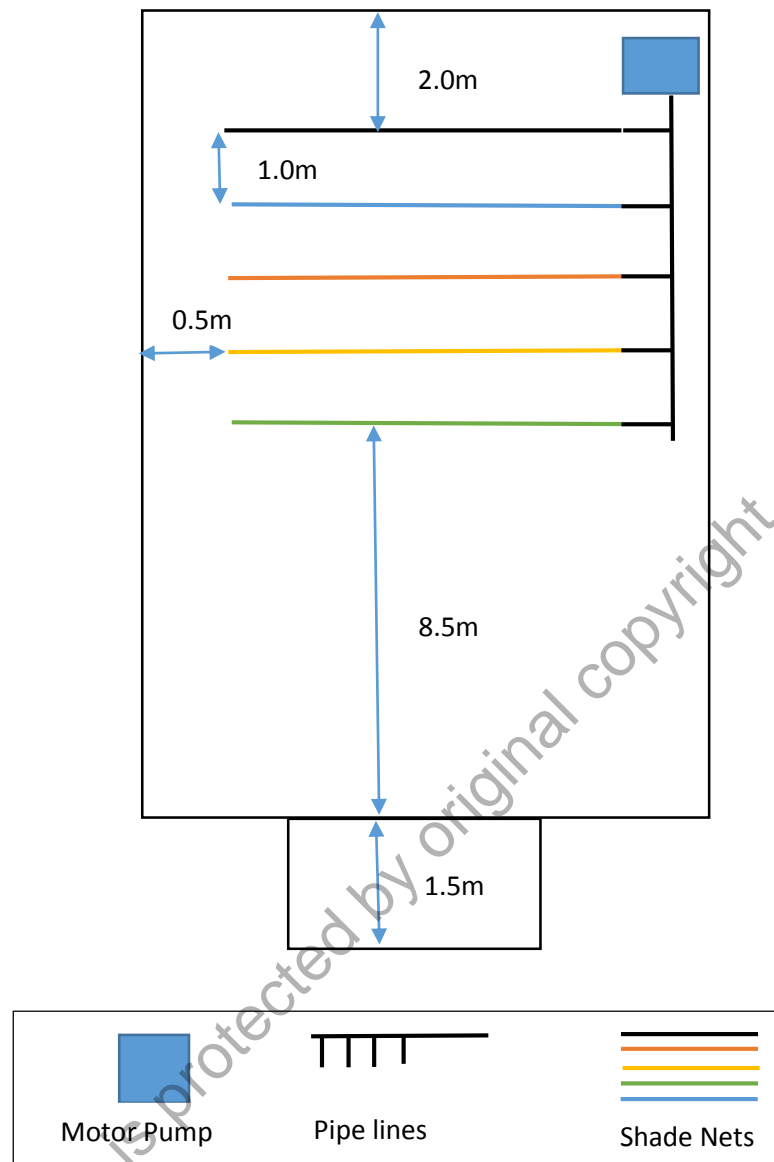

Figure 3.2: Greenhouse at INSAT

Figure 3.3: Layout of Study Area

3.4.   Experimental Design and Treatments

This study was carried out with three replication which consist of five treatments (red, yellow, blue, black shading nets and without net as control) with ten samples under each treatment colour. The treatments comprised of growing Pak Choy and Cabbage in the open as the control and under different colour net (red, yellow, blue and black). As in Figure 3.4, wooden plunks were used to make arches to support the nets. These arches

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are arranged in 5m long and 1m high, after being secured 0.2m into the ground. The yellow, red and blue shading nets with 70% shading factor were manufactured by Yize Wire Mesh Factory, China. Meanwhile, black net with 50% shading factor was purchased from a retailer in Kangar, Perlis. These nets were made from high-density polyethylene plastic, which makes them durable with a potential life span of up to 2 years. The process of fixing the wooden plunks and hanging the shading nets over the woods showed in Figure 3 Appendix B.

Figure 3.4: Coloured Shade Nets

3.4.1   Crop Germination

Pak Choy seedlings was germinated using germination tray with coco peat as the media. Bhardwaj (2013) revealed that coco peat have suitable physical properties and good water holding capacity that supports the germination of seedlings. In addition, it also have higher total pore space (TPS) and it is a good moisture-retentive material. Furthermore, the germination process was carried out in area which have less sunlight. Figure 3.5 shows the seeds and seedlings of the plant. Meanwhile in Figure 3.6 is Pak Choy plant undergoing germination.

Figure 3.5: Pak Choy Seeds and Cabbage Seedlings

Figure 3.6: Germination of Pak Choy after 4 days

3.4.2   Crop Transplanting

Transplanting is an economically and environmentally ideal alternative for seeding. Furthermore, this method also has greater climate control in terms of temperature, humidity and water management. According to Edi & Bobihoe (2010), after 21 days of germination or 3 - 4 leaves of Pak Choy and Cabbage shows up the plant can be transplanted to the polybags at the study area. Figure 3.7 shows the transplanting process.

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Figure 3.7: Transplanting Pak Choy and Cabbage

3.4.3   Fertilizer Management

As recommended by Department of Agricultural Penang (2016), before transplanting the media where the plants are going to be planted is prepared with NPK 15:15:15 fertilizer with the rate of 60 N kg/ha, 40-80 P kg/ha and 80-100 K kg/ha.

However, because of the NPK fertilizer is in solid state where it is hardly soluble, thus liquid fertilizer is used in order to fasten the absorption of fertilizer by the plants. In Figure 3.8 it indicates the fertilizer used in this study. This fertilizer was recommended by the Farmer Organization in Abi, Perlis. The amount of fertilizer used was 150 ml in every 16 L of water. Thus, it was made as 8.5ml in 900ml of water and sprayed twice a week.

Figure 3.8: Liquid Fertilizer

Thereafter, watering and weeding were carried out uniformly on need basis on all plots throughout the study. 45 ml/s of water was piped to each polybag twice a day by drip irrigation. The motor used and the fixing of pipelines is showed in Figure 2 Appendix B.

3.4.4   Pest Control

Insecticide was used in controlling the spread out of pest. The most common pest found in this area was Caterpillar. This insecticide was also recommended by the Farmers Organization in Abi, Perlis. As in Figure 3.9 caterpillar attacks the Pak Choy plant. Meanwhile, in Figure 3.10 is the insecticide used in this study. Insecticide was sprayed twice a week.

Figure 3.9: Caterpillar eats the plant before spraying insecticide

Figure 3.10: Insecticide from Joe Jalil Company

3.5   Mesh Number and Thickness of Shading Net

The thickness of shading net was measured using Digital Vernier Caliper 8"(0-200mm x 0.01/0-8" x 0.0005) manufactured by VERTEX. For mesh number, number of

holes in 1inch² of shading net was counted. Figure 3.11 shows the Digital Vernier Caliper used for measuring thickness of shading mesh.
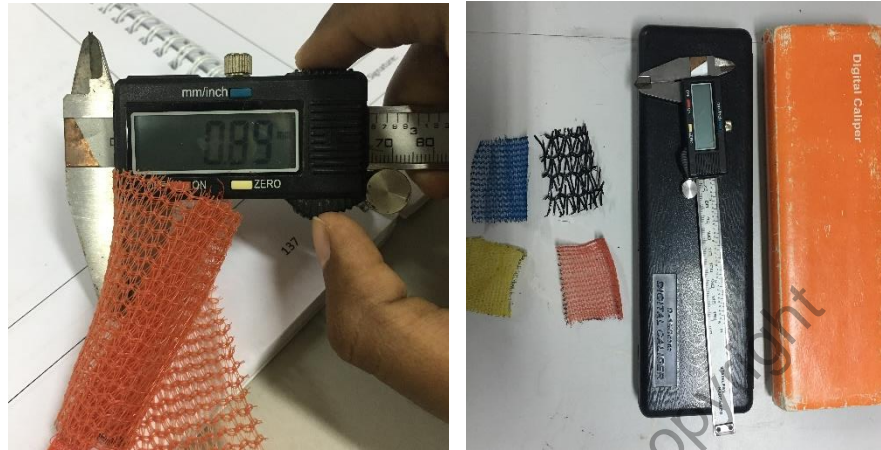

Figure 3.11: Digital Vernier Caliper

3.6 Light Intensity under Coloured Shading Net

Light Intensity was measured using Light Meter from EXTECH. This Light Meter measures light level up to 50,000 *lux* with a 5% accuracy. The light intensity was measured at 9am, 12pm and 4pm. It was measured four times along the study (December, January, February and March). The Light Meter was positioned 20 cm under the shading net and the light intensity was measured. Figure 3.12 indicates the Light Meter used in measuring the intensity of sunlight under each colour of shading net.

Figure 3.12: Light Meter under Direct Sunlight

3.7 Plant Performance under Coloured Shading Net

The plant performance was observed in terms of number of yield, number of leaves, plant width, plant height and chlorophyll content under each shading nets. Number of yield and leaves for each plant it was counted manually, their leaves numbers were counted in each shade net and the average of yield were calculated.

Meanwhile, plant width and height was measured by using ruler. The top opening of leaves indicated the crops width and the height was measured from the surface of coco peat up to the stalk of the crops. Figure 3.13 and Figure 3.14 shows the measuring of width and height of the Pak Choy and Cabbage.

Figure 3.13: Pak Choy Width and Height in Week 4

Figure 3.14: Width of Cabbage in Week 4

For chlorophyll content, referring to work by Riccardi et al.(2014), the fifth leave from the bottom of the plant was selected and taken off, immediately sealed in a plastic bag and transported to the lab for Chlorophyll extraction. Three disks of 1 cm² were cut from each leaf. The disks were put in a 90 % aqueous acetone solution and the tissues were ground using a mortar and pestle until Chlorophyll pigments were suspended in the solution. The resulting homogenate was transferred in a centrifuge tube and was centrifuged at 4,000 rpm for 12 min. Figure 3.15 shows process of chlorophyll extraction method using acetone.
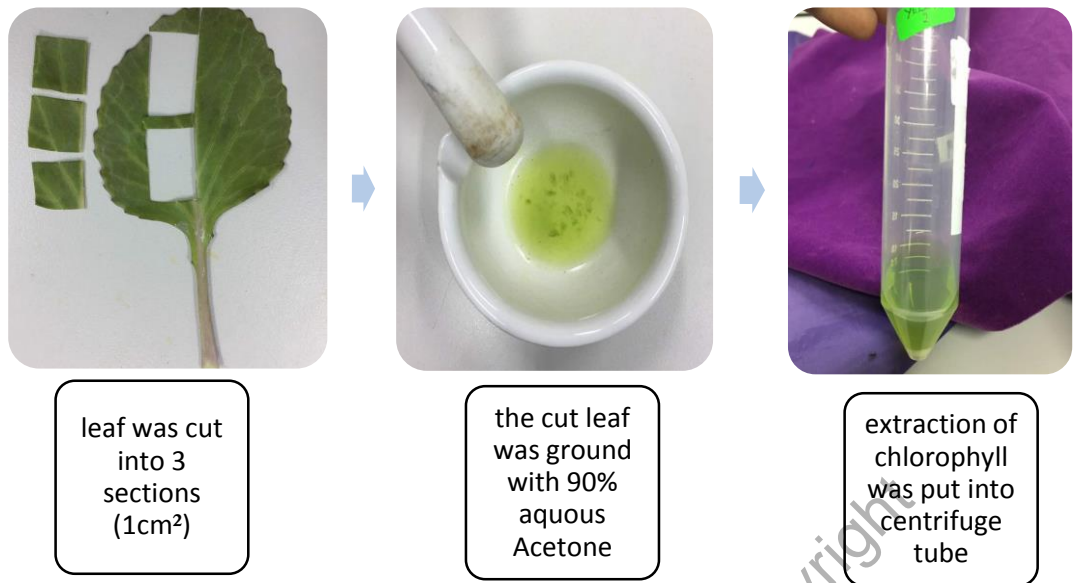
| leaf was cut into 3 sections (1cm²) | the cut leaf was ground with 90% aquous Acetone | extraction of chlorophyll was put into centrifuge tube |

Figure 3.15: Extraction of Chlorophyll

The extracted chlorophyll was then centrifuged using Thermo Scientific CL2 centrifuge and the absorbance value was read by using Shimadzu UV-1800 Spectrophotometer. Figure 3.16 shows the process of centrifuge and absorbance reading.
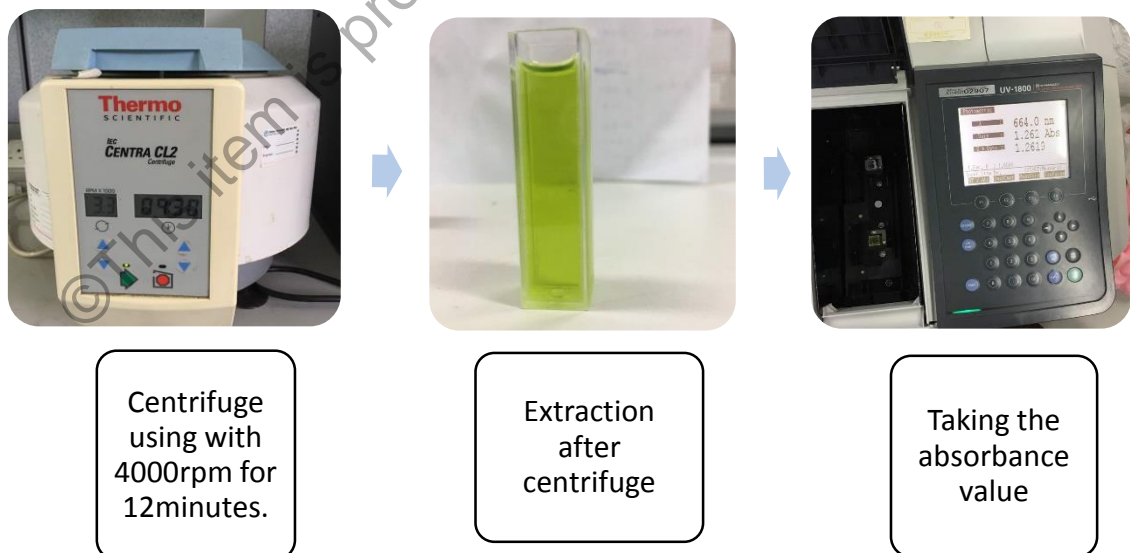

| Centrifuge using with 4000rpm for 12minutes. | Extraction after centrifuge | Taking the absorbance value |

Figure 3.16: Process of Centrifuge and Absorbance Reading

The absorbance value of the supernatant was read at a wavelength of 664 (A664) and 647 nm (A647) using Shimadzu UV-1800 Spectrophotometer. Total chlorophyll was calculated using the equations below described by Jeffrey and Humphrey (1975):

$$\text{Chl } a \text{ (µg ml}^{-1}) = 1.93 \text{ A}_{647} + 11.93 \text{ A}_{664} \tag{3.1}$$

$$\text{Chl } b \text{ (µg ml}^{-1}) = 20.36 \text{ A}_{647} - 5.50 \text{ A}_{664} \tag{3.2}$$

$$\text{Chl } tot \text{ (µg ml}^{-1}) \text{ Chl } a + \text{Chl } b \tag{3.3}$$

3.8   Data Collection and Analysis

The data obtained was then analysed by using ANOVA method. This method is used to observe if there is any differences between the coloured shading net used