EFFECT OF REDUCED LIGHT INTENSITIES ON GROWTH AND YIELD OF TWO CUCURBITS

BY

MD. HEADAYET ULLAH KABIR

REG. NO. : 03-01157

A Thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
AGRICULTURAL BOTANY

SEMESTER: JANUARY-JUNE, 2010

APPROVED BY:

Md. Moinul Haque
Associate Professor
Department of Agricultural Botany
SAU, Dhaka
Supervisor

Dr. Kamal Uddin Ahamed
Professor
Department of Agricultural Botany
SAU, Dhaka
Co-Supervisor

Prof. Asim Kumar Bhadra
Chairman
Examination Committee
Department of Agricultural Botany SAU, Dhaka

DEDICATED

TO

MY BELOVED PARENTS

DEPARTMENT OF AGRICULTURAL BOTANY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

Memo No: SAU/ Agricultural Botany /

CERTIFICATE

This is to certify that the thesis entitled **"Effect of Reduced Light Intensities on Growth and Yield of Two Cucurbits"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science in Agricultural Botany**, embodies the result of a piece of bonafide research work carried out by **Md. Headayet Ullah Kabir**, Registration number: **03-01157** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

Moinul

Md. Moinul Haque
Associate Professor
Department of Agricultural Botany
Sher-e-Bangla Agricultural University
Dhaka-1207

ACKNOWLEDGEMENTS

All praises to Almightly and Kindfull trust to the "Omnipotent Creator" for His never-ending blessing. The author deems it a great pleasure to express his profound thankfulness to his respected parents, who entiled much hardship inspiring for prosecuting his studies and receiving proper education.

The author likes to express his deepest sense of gratitude to his respected supervisor Md. Moinul Haque, Associate Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, for his scholastic guidance, support, encouragement and invaluable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing.

The author also expresses his gratefulness to respected Co-Supervisor, , Dr. Kamal Uddin Ahamed, Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, helpful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and in preparation of the thesis.

The author expresses his sincere gratitude towards the sincerity of the Chairman, Asim Kumar Bhadra, Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his valuable suggestions and cooperation during the study period. The author also expresses heartfelt thanks to all the teachers of the Department of Agricultural Botany, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the period of the study.

The author expresses his sincere appreciation to his brother, sisters, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study period.

The Author

EFFECT OF REDUCED LIGHT INTENSITIES ON GROWTH AND YIELD OF TWO CUCURBITS

ABSTRACT

The xperiments were carried out at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 to investigate the growth and yield performance of two cucurbits (viz. bottle gourd and ash gourd) under four different levels of light intensities (100, 75, 50 and 25% PAR).The experiments were laid out following Randomized Complete Block Design (RCBD) with three replications. After crop establishment, nylon nets of different sieve sizes were used to create treatments of different reduced light and light intensity was measured by a light meter. Morphological characters like internode length, and individual leaf area increased whereas number of leaves plant^{-1}, branches plant^{-1} and individual fruit weight were decreased due to the reduction of light levels in the vegetables. At 25% PAR level, the number of leaves plant^{-1} decreased markedly in cucurbits, bottle gourd and ash gourd. Main stem length, stem weight ratio remained almost unchanged in bottle gourd and ash gourd under different light levels. Leaf weight ratio (LWR) slightly reduced in both bottle gourd and ash gourd. Compared to 100% PAR the total dry matter (TDM) of bottle gourd and ash gourd did not affected by reduction of light levels up to 75% PAR. The highest dry matter yield plant^{-1} (634.53 g and 556.47 g) were achieved from 100% PAR level in bottle gourd and ash gourd, respectively. At 100% PAR level, the fruit yield were 42.40 t ha^{-1} in bottle gourd and 44.13 tha^{-1} in ash gourd. Significant fruit yield reduction was observed at 25% PAR in both ash gourd and bottle gourd. The bottle gourd provided significantly higher yield (52.42 t ha^{-1}) at 75% PAR level compared to full sunlight. The higher fruit yield was the product of higher fruit plant^{-1} and higher individual fruit weight. These results suggested that bottle gourd is more suitable as under storey crop compared to ash gourd.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Vegetables are one of the essential food components of our daily diet.The standard requirement of vegetables is 200 g per head per day (Haque, 2009). But people consume about 96 g per head per day in our country due to unconsciousness of the people and shortage of production. Hence, it is a prime need to increase the vegetables production in Bangladesh. Total production of vegetables in Bangladesh in 2008 was 1.93 million ton (BBS, 2010). Cucurbitaceous vegetables occupy about 36% of the lands under vegetables cultivation and contribute 14% of total vegetable production (Weinberger and Genova, 2005). Summer vegetables especially cucurbits are cultivated in surrounding the homestead areas beneath the fruit and timber trees. These areas are increasing due to construction of houses, factories and roads for ever growing population pressure. As many as 15 kinds of cucurbitaceous vegetables are grown in the country; some of them are cultivated round the year. Cucurbits meet the demand to a large extent in summer season when the supplies of other vegetables are scanty in our country.In order to meet up the shortage of vegetables in Bangladesh, more attention should be given on cucurbits and on the homestead areas where shade is unavoidable due to standing trees. However, there is a tremendous need to screen these vine type vegetables under low light environment for evaluating their degree of adaptability and yield potential. Research works on the partial shade tolerance of these vegetables are very scanty in our country.

Among the vine type vegetables, two cucurbits viz. bottle gourd (*Legenaria vulgaris* L.) and ash gourd (*Benincasa hispida* L.) are very important considering people demand and prices. Most of the cucurbits and leguminous vegetables exhibited better yield performance under shaded environment (Haque, 2009). Morphological parameters like main stem length, internode length and individual leaf area increased, whereas main stem diameter and numbers of leaves per plant decreased due to the reduced light intensity (Haque *et al.*, 2009). They also found that fruit yield of bottle gourd and cucumbers were sufficient even under reduced light condition. Photosynthetically active radiation is the major factor regulating photosynthesis, dry matter production and yield of crops (Rao and Mitra, 1998). Plants grown under shading, showed decreased photosynthesis which ultimately affect yield and fruit quality (Morgan *et al.*, 1985). Generally adaptive responses of plant to low irradiance result increased leaf area ratio, stem mass and stem length. On the other hand the adaptive responses also include decreased in leaf thickness and root growth relative to shoot growth (Boardman, 1977; Corre, 1983 and Fujita *et al.*, 1993). Therefore, this study was undertaken to furnish the following objectives -

1. To characterize the morphological changes and growth of the bottle gourd and ash gourd under reduced light levels.
2. To evaluate the yield and yield contributing characters of bottle gourd and ash gourd under reduced light condition.

CHAPTER II

REVIEW OF LITERATURE

Bottle gourd and ash gourd are the popular vegetables in Bangladesh. But the available recommended cultural practices of these crops are not suitable for optimum growth and yield performance in low light environment. During the cultivation of bottle gourd and ash gourd farmers of our country mainly depends on open space of field but it may will suited to the homestead areas and shaded environment. Very few research works related to growth, yield and development of bottle gourd and ash gourd due to light intensity in these relations have been carried out in our country. The research work so far done in Bangladesh is not adequate and conclusive. However, some of the important and informative works and research findings related to the light intensity of vegetables crops and also other crops, so far been done at home and abroad, have been reviewed in this chapter below-

Haque *et al.* (2009) conducted an experiment at the experimental farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Bottle gourd cv. High-green (hybrid) was grown to investigate the morpho-physiological changes and yield performance under four different levels of light (100, 75, 50 and 25% PAR). It was observed that some of the morphological characters like main stem length, internode length and individual leaf area increased, whereas main stem diameter and numbers of leaves per plant decreased due to the reduced light levels. At 50% PAR number of leaves per plant did not decrease significantly in bottle gourd.

Leaf weight ratio (LWR) remained more or less similar up to 50% reduction of PAR. SPAD value increased with the reduction of PAR level i.e. partial shading stimulated chlorophyll synthesis in leaves. Compared to 100% PAR the total dry matter did not reduce. Bottle gourd produced the highest yield (41.53 t ha^{1}) at 75% PAR level and it did not show significant fruit yield reduction at 25% PAR level compared to full sunlight. However, considering Total Dry Matter (TDM) and fruit yield of bottle gourd and cucumber were found suitable for reduced light condition (up to 50% PAR).

In order to improve the light composition in the solar greenhouse, Wang *et al.* (2007) supplied red, blue, UV-A and UV-B light, and the effects of the different light qualities on the growth characteristics of cucumber were investigated. When under UV-B light the stoma conduction, transpiration rate, and the CO_2 concentration between cells as well as the photosynthesis rate were decreased, at the same time the germination rate, fresh and dry weight, plant height and flower differentiation number were decreased; while the stoma density and thickness of cucumber leaf were increased greatly.

The possibility of intercropping cinnamon (*C. verum*) with rubber (*H. brasiliensis* clone RRIC 100) planted with the standard inter row spacing of 8.1 m was examined in Sri Lanka by Pathiratna and Perera (2005). PAR transmission from the rubber canopy into the middle of the inter row was reduced to 20.6% by the eighth year. Length per stick, weight and bark yield of cinnamon also declined. The reduction in bark yield of cinnamon per bush was 70.5% by the eighth year.

The dry matter content of bark was highest (9.36%) when the light level was approximately 60%. Adverse effects of poor light availability and competition from rubber on cinnamon at this spacing by the fifth year were evident.

A study was conducted by Wang *et al.* (2003) to investigate illumination effect and its influence on the growth of some medicinal plants in an intercropping system with *Populus tomentosa* at different row spacing. The daily average light intensity between rows decreased with decrease in row spacing. The height growth of *Glycyrrhiza uralensis*, *Platycodon grandiflorus* and *Pinellia pedatisecta* was different when intercropped with *Populus tomentosa*.

Field experiments were conducted by Shikata *et al.* (2003) in Japan in 1999 to analyze the effect of intercropping with maize on the growth and light environment of cowpea and to evaluate the canopy photosynthetic rate in relation to the leaf area index (LAI), light interception, and leaf net photosynthetic rate. Superior light interception obtained by intercropping with maize led to an increase of the LAI with a decrease of the light extinction coefficient and resulted in a high canopy photosynthetic rate.

In Nordic winter conditions with a shortage of natural light, it is very important to grow species and cultivars suited for low light and artificial lighting reported by Sevelius (2003). The present study was conducted to determine if leaf net CO_2 exchange, chlorophyll a fluorescence, oxygen evolution, chlorophyll a and b content, or leaf morphology would be useful in assessing gerbera (*Gerbera* *cantabrigensis*) growth in low light. Biomass accumulation as well as flower yield was lowest in Lynx.

A field experiment was conducted by Sharaiha and Battikhi (2002) in the summer season of 1999, at the Faculty of Agriculture Research Station, University of Mutah, South Jordan. Maize and potato yields were increased especially under the 2:2 intercropping row arrangements. The increase of potato yield might be related to the reduction in air heat units (by 210 and 28), soil heat units (by 80 and 88), and light interception (by 350 and 344 micro mol m^{-2} $second^{-1}$) for Frisia and Berca, respectively, compared to their sole crops. Moreover, the values of soil moisture storage and evapotranspiration for Frisia tended to decrease under intercropping compared to sole cropping.

Baumann *et al.* (2002) established an eco-physiological model was used to improve understanding of interplant competition based on physiological, morphological and phenological processes. Dry matter production of the species, particularly if grown in mixture, was highly sensitive to maximum plant height and radiation use efficiency.

Cucumber plants were grown by Peil and Lopez (2002) under greenhouse and shading screen-inducing conditions of diffuse light during summer in Southern Spain, with two intensities of fruit removal viz., one fruit remaining per leaf axil and two fruits remaining per three leaf axils. The effects of fruit removal on biomass production were greater in terms of vegetative rather than total fruit growth and of dry rather than fresh weight. Increasing fruit removal intensity increased dry matter allocation to the vegetative organs and the total aboveground dry matter production. Although dry matter production of the vegetative parts of the shoot strongly increased with increasing fruit removal intensity, the dry matter allocation between stems and leaves was not affected.

Light interception of a cucumber row crop was investigated by Peil *et al.*, (2002) under greenhouse conditions during two growth periods (spring and summer). Measurements of the photosynthetic active radiation (PAR) were performed throughout the growth periods at the top (PAR) and at the bottom (PAR) of the crop. Shading screen-inducing conditions of diffuse light was used in summer, leading to a reduction of the integral of the incoming PAR of 33% (1036 and 691 mol m^{-2} in spring and summer, respectively). To estimate the intercepted light by the crop, an existing model of canopy light interception (M_1) by a row crop was used along with a simple estimation approach based on the Lambert-Beer's law. Validation of the models was performed using experimental data, assuming that all PAR in summer was diffuse.

Intercropping provides an important means of raising not only productivity and land-use efficiency of smallholder rubber lands, but also income generation during the unproductive immature phase of the rubber tree reported by Rodrigo *et al.* (2001). Dry matter production in the rubber-based treatments was directly related to planting density, being least in the sole rubber and greatest in intercrop. Increased in dry matter across treatments was derived from an increase not only in light capture (270%) but also radiation-use efficiency (RUE, 230%). Neither R nor BR treatment, which is currently recommended for intercropping in Sri Lanka, achieved full ground cover with fractional interception remaining below 40 and 50%, respectively. Fractional interception was greatest in BBR treatment, and by the end of the measurement period, total intercepted radiation was 23 and 73% greater than that in the BBR and BR intercrops, respectively.

A field experiment was conducted by Roodagi, *et al.* (2001) in Karnataka, India, during 1997-98, to determine the effect of sowing methods and intercropping on leaf area index (LAI), light transmission ratio (LTR) and cane yield of sugarcane. Sowing methods consisted of normal sowing (ridge and furrow, 90 cm) and paired row methods (60-120-60 cm). The highest cane and sugar yields were in the cane+sunnhemp intercropping system, while the lowest were in cane+maize intercropping system

Gerbera jamesonii cv. Illusion, *Rosa hybrida* cv. Frisco, *Kalanchoe blossfeldiana* cv. Tenorio and *Ficus benjamina* cv. Exotica were grown under laboratory conditions by Buwalda *et al.* (2000) and exposed to 3 different patterns of temperature variation at 2 levels of average temperature (18 and 22^0C) and 2 light levels (2.5 and 5.5 mol PAR m^{-2} d^{-1}) over a growing period of 72 days. The experiments were carried out in 16 phytotrons of 15 m^2 each with light levels of 2.5 and 5.5 mol PAR m^{-2} d^{-1} and 4 temperature levels (14, 18, 22 and 26^0C). *F. benjamina* final fresh weight, shoot length and number of side shoots were superior at the higher light level.

Three experiments were conducted Bodson and Verhoyen (2000) between November and April during 1994-97 to investigate the effects of photoperiod, supplementary light intensity and daily supplementary light integral on gerbera (*Gerbera cantabrigensis* cultivars Estelle and Ximena) flowering in poor natural light conditions. The plants were subjected to different photoperiods (12, 18 and 24 h), light intensities (75, 112.5, 150 and 300 micro mol/m^2 s^{-1} PAR) and supplementary lighting periods (12, 18 and 24 h). In all experiments, the 12-h photoperiod produced the highest number of inflorescences if the same daily supplementary light integral was used. As the quantity of gerbera flower yield was strongly affected by supplementary lighting regimes, the grower must be aware of different distributions of the same light energy over one day, which may lead to a change of about 45% in number of inflorescences.

A greenhouse study was carried out by Labeke and Dambre (1999) in Belgium to investigate the effects of supplementary light on Gerbera cv. Tiffany (small flowers) and cv. Optima (large flowers). Gerbera was planted on 11 August 1998 on rockwool mats (6/m^2 for cv. Tiffany and 4/m^2 for cv. Optima). Supplementary light (approx. 3000 lux) was used when natural light reached 150 W/m^2. Data were collected weekly on the number of flowers/plant, stem length, weight and diameter of flowers. Supplementary light increased the number of flowers/m^2 of cv. Optima significantly (by Supplementary light increased flower production in cv. Tiffany slightly (by 6%). However, significant increases were measured for flower diameter (between October and December), stem length (between December and April), and stem weight (between October and May).

A field experiment was conducted by Ahmed and Jahan (1998) during rabi season 1992-93, in Gazipur, Bangladesh to evaluate the effect of intercropping wheat (cv. Sonalika) with potato (cv. Cardinal) on light interception, leaf area index and dry matter production. The treatments comprised 100% potato + 100% wheat in 1 or 2 rows, 100% potato + 50% wheat in 1 or 2 rows, and 100% potato + 25% wheat in 1 or 2 rows. Leaf area index (LAI) and dry matter production by the component crops were reduced due to intercropping.

In many crop models, light intercepted by a canopy (IPAR) is calculated by Flenet *et al.* (1996) from a Beer's Law equation: $IPAR = PAR \times (1 - \exp(-K \times LAI))$, where k is the extinction coefficient, PAR the photosynthetically active radiation, and LAI the leaf area index. The effect of row spacing on k was investigated for maize, sorghum, soybeans and sunflowers to provide information for modeling. It is recommended that modeling light interception for different row spacing should account for these effects.

CHAPTER III

MATERIALS AND METHODS

The experiments were conducted during the period from February to August, 2010 to investigate the effect of reduced light intensities on the growth and yield of two cucurbits. The details of the materials and methods followed to conduct the study have been presented below:

3.1 Description of the experimental site

3.1.1 Location

The present piece of research work was conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site was $23^{0}74'$ N latitude and $90^{0}35'$ E longitude with an elevation of 8.2 meter from sea level.

3.1.2 Soil

The soil belonged to "The Modhupur Tract", AEZ – 28 (FAO, 1988). Top soil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and had organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood level. The selected plot was medium high land. The details were presented in Appendix I.

3.1.3 Climate

The geographical location of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October. Details of the metrological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e-Bangla Nagar, presented in Appendix II.

3.2 Test crops

Seeds of bottle gourd cv. high green(*Legenaria vulgaris* L.) and ash gourd cv. BARI chal Kumra-2(*Benincasa hispida* L.) were used the experiment as test crops.

3.2.1 Bottle gourd

Bottle gourd cv. high green is a hybrid variety. Plants grow vigorously and are very high yielding one. Fruits around 45-50 cm long, cylindrical in shape, medium green in colour, very tender, retains green colour even after maturity, flesh white in colour.

3.2.2 Ash gourd

BARI Chal Kumra-2 was developed at the Bangladesh Agricultural Research Institute Olericulture Division, HRC, Gazipur in the year of 2006. Sowing and harvesting time of this variety is – April and April to September, respectively. The fruit of this variety is light green attractive fruit, fruit length 20-25 cm, average fruit weight1.0 to 1.2 kg (edible weight), number of fruits per plant 10-12 and life cycle is 120-135 days.

3.3 Experimental details

Two experiments were conducted to evaluate the effect of different light intensity on the growth parameters and yield of two selected cucurbits (bottle gourd and ash gourd).

3.3.1 Experiment - I: Effect of different light intensity on the growth parameters and yield of bottle gourd.

The experiment comprised of four 4 Photo-synthetically Active Radiation (PAR) levels, such as

T_1: 100% PAR (full sunlight)

T_2: 75% PAR

T_3: 50%PAR

T_4: 25% PAR

After crop establishment, nylon nets of different sieve sizes were used to create treatments of different reduced light and light intensity was measured by a light meter.

3.3.2 Experiment - II: Effect of different light intensity on the growth parameters and yield of ash gourd.

The experiment comprised of the same PAR as was maintained in Experiment –I.

3.4 Experimental design and layout

The experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing all of the treatments.

3.4.1 Experiment-1

The experiment consists of total 12 plots of size 3.0 m × 2.0 m in each of 3 replications. The 4 treatments of bottle gourd field of the experiment was assigned at random into 4 plots of each replication.

3.4.2 Experiment-2

Same as Experiment-II.

3.5 Growing of crops

3.5.1 Seed collection

The seeds of the test crops of these experiments were collected from local market and Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur.

3.5.2 Seedling raising

Seeds of bottle gourd and ash gourd seeds were sown in polythene bags for seedling raising to transplant in the main field.

3.5.3 Preparation of field

The plot selected for the experiment was opened in the third week of March 2010 with a power tiller, and was exposed to the sun for a week after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally a desirable tilth of transplanting seedlings of bottle gourd and ash gourd. Pits were made to transplant the seedlings at the age of 20 days old.

3.5.4 Transplanting of seedling and treatments establishment

The vegetables crops received full natural radiation without any barrier that constituted the 100% light level. The reduced light intensity of 75%, 50% and 25%, respectively were created by using nylon nets as compared to open field light (100% PAR) Single color of white color mosquito net was used to create 75% PAR, Single ply of blue colored mosquito net was used to create 50% PAR and double ply of blue colored mosquito net was used to create 25% PAR. The light levels were obtained by adjusting mesh size, number of color Sunflec Septometer (Accu PAR Version2.1.) was used to have the desired light intensity along with net quality.

When crop establishment were completed the nylon nets were hanged from six feet over with the support of bamboo pillars. No net was used in the 100% PAR level plot. After setting the nets, light (PAR) measured again outside and inside the nets to check the PAR calibration.

3.5.5 Application of fertilizers and manure

The fertilizers Urea, TSP, MP and Gypsum, respectively were applied to supply N, P, K and S in the plots, respectively. The entire amount of TSP, MP and Gypsum, 1/3rd of urea were applied during the final preparation of land. Rest of urea was top dressed followed by irrigation (BARI, 2006). The dose and method of application of fertilizer are shown in Table 1.

Table 3.1 Dose and method of application of fertilizers in the field

Fertilizers	Dose (ha)	Application (%)		
		Basal	1st installment	2nd installment
Urea	220 kg	33.33	33.33	33.33
TSP	180 kg	100	--	--
MP	50 kg	100	--	--
Gypsum	120 kg	100	--	--
Cowdung	10 ton	100	--	--

Source: Krishi Projukti Hatboi, BARI, Joydebpur, Gazipur, 2006

3.6 Intercultural operations

After the transplanting of seedlings, various intercultural operations such as irrigation and drainage, weeding, top dressing of fertilizer and plant protection measure were accomplished for better growth and development of the bottle gourd and ash gourd seedlings as per the recommendation of BRRI (2006).

3.6.1 Irrigation and drainage

Over-head irrigation was provided with a watering cane to the plots once immediately after transplanting in every alternate day in the evening up to 1st harvest in sunny condition. Further irrigation was done as and when needed. Stagnant water was effectively drained out at the time of excess rainfall.

3.6.2 Weeding

Weeding were done to keep the plots free from weeds which ultimately ensured better growth and development of bottle gourd and ash gourd seedlings. The newly emerged weeds were uprooted carefully before the application of 1st and 2nd installment of urea fertilizer at 45 and 75 DAT.

3.6.3 Plant protection

The crop was attacked by different kinds of insects during the growing period. Triel-20 ml was applied on 5 January and sumithion-40 ml/20 litre of water was applied as and when required.

3.7 Harvesting of fruits

The fruits were harvested manually from each plot based on the optimum time for consumption. After harvest data were collected to observe the effect of different light intensity on the yield

3.8 Data collection

3.8.1 Main stem length

The length of main stem was recorded in centimeter (cm) at 20, 40, 60, 80, 100 and 120 DAT (Days after transplanting). Data were recorded as the average of 3 plants selected at random from the inner rows of each plot. The length was measured from the ground level to the tip of the plant.

3.8.2 Leaves plant^{-1}

The total number of leaves plant^{-1} was counted at 20, 40, 60, 80, 100 and 120 DAT as the number of leaves from selected plants from each plot and average value was recorded.

3.8.3 Branches plant^{-1}

The total number of branches plant^{-1} was counted at 20, 40, 60, 80, 100 and 120 DAT as the number of branches from selected plants from each plot and average value was recorded.

3.8.4 Dry matter

3.8.4.1 Stem dry matter

Stem and it branches as a sample of near about 200 g from 3 sample plants from each plot were collected at 120 DAT and gently washed with tap water, thereafter soaked with paper towel. Then fresh weight of 100 g was taken immediately after soaking. After taking fresh weight, the sample was oven dried at 70^0C for 72 hours. Then oven-dried samples were transferred into a desiccator and allowed to cool down to room temperature, thereafter dry weight of stem was taken.

3.4.8.2Leaf dry matter

Dry weight of leaves as a sample of near about 200 g from 3 sample plants has taken and drying 10 leaves in over at 65^0c for 72hours and then the leaf dry weight was calculated from each plot. The leaf dry weight per plant was calculated multiplying the leaf number plant^{-1} and finally average leaf dry weight was obtained.

3.8.4.3 Fruit Dry matter

Fruit dry weight as a sample of near about 200 g from 3 sample fruits was taken using the same temperature and time for leaf dry weight. Finally total fruit dry weight plant^{-1} was calculated, the fruit matter plant^{-1} and individual fruit weight.

3.8.4.4 Total dry matter

It was estimated following formula,

TDM=SDM+LDM+FDM

Where,

TDM=Total dry matter

SDM=Stem dry matter

LDM=Leaf dry matter

FDM=Fruit dry matter

3.8.5 Stem weight ratio

Stem weight ratio was calculated using the following formula:

$$\text{Stem weight ratio} = \frac{\text{Stem weight (g)}}{\text{Total plant weight (g)}}$$

3.8.6 Leaf weight ratio

Leaf weight ratio was calculated using the following formula:

$$\text{Leaf weight ratio} = \frac{\text{Leaf weight (g)}}{\text{Total plant weight (g)}}$$

3.8.7 Internode length

The length of internode was recorded in centimeter (cm) by a measuring scale. Data were recorded as the average of 10 internode selected at random from the inner rows of each plot.

3.8.8 Individual leaf area

Individual leaf area was determined by using leaf area meter.

3.8.9 Male flowers plant^{-1}

The total number of male flower that blooms was counted as the number of male flowers from each plant and average value was recorded.

3.8.10 Female flowers plant^{-1}

The total number of female flower that blooms was counted as the number of female flowers from each plant and average value was recorded.

3.8.11 Fruits plant^{-1}

The number of fruit plant^{-1} was counted from the sample plants and the average number of fruits plant^{-1} was recorded.

3.8.12 Fruits length

The fruit length was measured with a meter scale from the neck of the fruit to the bottom of 5 selected marketable fruits from each plot and there average was taken in cm as the length fruit.

3.8.13 Fruit diameter

Fruit diameter was measured at the middle portion of 5 selected marketable fruit from each plot with a meter scale and there average was taken in cm.

3.8.14 Individual fruit weight

Among the total number of fruits during the period from first to final harvest was considered for determining the individual fruit weight by the following formula:

$$\text{Weight of individual fruit} = \frac{\text{Total weight of fruit (g)}}{\text{Total number of fruits (g)}}$$

3.8.15 Fruit yield plant^{-1}

Fruit yield obtained from each plant was weighed carefully and recorded as fruit yield plant^{-1}.

3.8.16 Fruit yield hectare^{-1}

Yield of plant^{-1} was recorded as the fruits per plant and yield per hectare of fruits was calculated by converting it into the plot yield and then into hectare and was expressed in ton.

3.9 Statistical Analysis

The data obtained for different characters were statistically analyzed with the help of computer by using MSTAT program. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatment means were compared by the Least Significant Difference (LSD) Test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The results have been shown and discussed and possible interpretations are given in experiment wise under the following headings:

Experiment - I: Effect of reduced light intensities on growth and yield of bottle gourd

4.1.1 Main stem length

Main stem length of bottle gourd at 20, 40, 60, 80, 100 and 120 days after transplanting (DAT) showed significant variation among different levels of light intensity (Table 1). At 20 DAT, the longest main stem (1.67 m) was recorded from 25% PAR which was statistically identical (1.63 m and 1.60 m) with 75% PAR and 100% PAR i.e. full sunlight, respectively, while the shortest stem (1.26 m) was recorded from 50% PAR. At 40 DAT, the longest main stem (3.83 m) was found from 25% PAR which was statistically identical (3.75 m) with 75% PAR and closely followed (3.20 m) by 100% PAR (full sunlight), whereas the shortest stem (2.65 m) was observed from 50% PAR. At 60 DAT, the longest main stem (5.09 m) was recorded from 25% PAR which was statistically identical (4.91 m) with 75% PAR and closely followed (4.58 m) by 100% PAR, again the shortest main stem (4.45 m) was obtained from 50% PAR. This longer main stem length under reduced light intensity is probably due to higher apical dominance.

Table 1. Effect of different levels of light intensity on main stem length at different days after transplanting (DAT) of bottle gourd

Light level	Main stem length (cm)					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	1.60 a	3.20 b	4.58 bc	6.51 bc	7.66 b	8.75 a
75% PAR	1.63 a	3.75 a	4.91 ab	6.91 ab	7.87 ab	8.63 a
50% PAR	1.26 b	2.65 c	4.45 c	6.11 c	7.08 c	7.90 b
25% PAR	1.67 a	3.83 a	5.09 a	7.30 a	8.23 a	9.02 a
$LSD_{(0.05)}$	0.155	0.374	0.419	0.683	0.424	0.562
CV(%)	6.88	5.55	7.39	5.09	8.75	7.28

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

At 80 DAT, the longest main stem (7.30 m) was recorded from 25% PAR which was statistically identical (6.91 m) with 75% PAR and closely followed (6.51 m) by 100% PAR (full sunlight), while the shortest main stem (6.11 m) was recorded from 50% PAR. At 100 DAT, the longest stem (8.23 m) was recorded from 25% PAR which was statistically identical (7.87 m) with 75% PAR and closely followed (7.66 m) by 100% PAR (full sunlight), whereas the shortest main stem (7.08 m) was found from 50% PAR. At 120 DAT, the longest stem (9.02 m) was recorded from 25% PAR which was statistically identical (8.75 m and 8.63 m) with 100% PAR (full sunlight) and by 75% PAR, respectively and the shortest stem (7.90 m) was observed from 50% PAR. Kubota and Hamid (1992) reported that under low light condition, plant expense more energy to structural development compare to the plant grown under full sunlight.

4.1.2 Leaves plant^{-1}

Different levels of light intensity exerted significant influence on the number of leaves plant^{-1} in bottle gourd (Table 2). At 20, 40, 60, 80, 100 and 120 DAT, the highest number of leaves plant^{-1} (45.0, 93.0, 141.0, 226.3, 254.0,313.0) was obtained from 50% PAR which was statistically identical (44.7, 90.3, 138.0, 224.3, 250.0 and 303.3) and (44.3, 85.0, 129.3 212.3, 236.7 and 290.3), with 75% PAR and 100% PAR respectively, while the minimum number (38.0, 73.3, 114.7, 183.7, 214.0 and 252.0) was from 25% PAR (Table 4.1.2). Haque *et al.* (2009) found that numbers of leaves plant $^{-1}$ decreased due to the reduced light levels.

38768

Table 2. Effect of different levels of light intensity on number of leaves plant^{-1} at different days after transplanting (DAT) of bottle gourd

Light level	Leaves plant^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	44.3 a	85.0 a	129.3 ab	212.3 a	236.7 a	290.3 a
75% PAR	44.7 a	90.3 a	138.0 a	224.3 a	250.0 a	303.3 a
50% PAR	45.0 a	93.0 a	141.0 a	226.3 a	254.0 a	313.0 a
25% PAR	38.0 b	73.3 b	114.7 b	183.7 b	214.0 b	252.0 b
$LSD_{(0.05)}$	3.2	9.5	17.1	21.7	22.7	35.8
CV(%)	6.8	5.6	6.6	5.1	7.8	6.2

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.1.3 Branches plant^{-1}

Number branches plant^{-1} varied significantly in bottle gourd for different levels of light intensity at 20, 40, 60, 80, 100 and 120 DAT (Table 3). At 20 DAT, the highest number of branches plant^{-1} (3.3) was recorded from 50% PAR which was statistically identical (3.2) with 100% PAR i.e. full sunlight and closely followed (2.9) by 75% PAR, while the minimum number (2.6) was found from 25% PAR. At 40 DAT, the highest number of branches plant^{-1} (6.8) was recorded from 50% PAR which was statistically identical (6.8 and 6.5) with 100% PAR (full sunlight) and 75% PAR, respectively, while the minimum number (6.8) was observed from 25% PAR. At 60 DAT, the highest number of branches plant^{-1} (8.8) was recorded from 50% PAR which was statistically identical (8.7) with 100% PAR and closely followed (7.7) by 75% PAR, whereas the minimum number (7.1) was recorded from 25% PAR. At 80 DAT, the highest number of branches plant^{-1} (9.4) was found from 50% PAR which was statistically identical (9.0) with 100% PAR and closely followed (8.2) by 75% PAR; again the minimum number (7.6) was recorded from 25% PAR. At 100 DAT, the highest number of branches plant^{-1} (14.6) was recorded from 50% PAR which was statistically identical (13.9) with 100% PAR and closely followed (12.3) by 75% PAR, while the minimum number (11.2) was recorded from 25% PAR. At 120 DAT, the highest number of branches plant^{-1} (17.7) was obtained from 50% PAR which was statistically identical (16.9) with 100% PAR and closely followed (15.3) by 75% PAR, whereas the minimum number (14.9) was recorded from 25% PAR

Table 3. Effect of different levels of light intensity on number of branches plant^{-1} at different days after transplanting (DAT) of bottle gourd

Light level	Branches plant^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	3.8 ab	6.8 a	8.7 ab	9.1 a	13.9 a	16.9 ab
75% PAR	2.9 bc	6.5 ab	7.7 bc	8.2 b	12.3 b	15.3 bc
50% PAR	3.3 a	6.8 a	8.8 a	9.4 a	14.6 a	17.7 a
25% PAR	2.6 c	5.9 b	7.1 c	7.6 b	11.2 c	14.9 c
$LSD_{(0.05)}$	0.8	0.7	1.1	0.7	0.8	1.9
CV(%)	6.4	5.1	6.6	8.2	7.1	5.9

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.1.4 Dry matter content

4.1.4.1 Stem

Significant variation was found in stem dry matter of bottle gourd under different levels of light intensity (Table 4). The highest dry matter content in stem (178.00 g) was observed from 100% PAR i.e. full sunlight which was statistically identical (170.67 g) with 50% PAR and closely followed (168.00 g) by 75% PAR, while the lowest (149.33 g) was found from 25% PAR. Rao and Mitra (1998) reported that photosynthetically active radiation is the major factor regulating photosynthesis, dry matter production.

4.1.4.2 Leaf

Dry matter content in leaf of bottle gourd showed statistically significant variations at different levels of light intensity (Table 4). The highest dry matter content in leaf (252.67 g) was obtained from 100% PAR i.e. full sunlight which was statistically identical (249.33 g and 236.00 g) with 50% PAR and 75% PAR, whereas the lowest (214.00 g) was recorded from 25% PAR. It might be happened due to change in dry matter partitioning under reduced light intensity.

4.1.4.3 Fruit

Fruit dry matter of bottle gourd varied significantly among different light levels (Table 4). The highest dry matter content in fruit (206.80 g) was recorded from 100% PAR i.e. full sunlight which was statistically identical (203.87 g and 194.33 g) with 50% PAR and 75% PAR. On the other hand, the lowest (180.40 g) was found from 25% PAR.

Table 4. Effect of different levels of light intensity on dry matter accumulation in the above ground parts of bottle gourd

Light level	Dry matter content (g)				Weight ratio	
	Stem	Leaf	Fruit	Total	Stem	Leaf
100% PAR	178.00 a	252.67 a	203.87 a	634.53 a	0.28	0.40
75% PAR	168.00 b	236.00 ab	194.33 ab	598.33 a	0.28	0.39
50% PAR	170.67 ab	249.33 a	206.80 a	626.80 a	0.27	0.40
25% PAR	149.33 c	214.00 b	180.40 b	543.73 b	0.27	0.39
$LSD_{(0.05)}$	8.606	22.68	16.97	40.52	--	--
CV(%)	6.59	7.77	9.33	5.38	8.83	6.27

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.1.4.4 Above ground parts

A significant variation was recorded for dry matter content in above ground parts of bottle gourd among different levels of light intensity (Table 4). The highest dry matter content in above ground parts (634.53 g) was observed from 100% PAR i.e. full sunlight which was statistically at par with 50% PAR and 75% PAR (626.80 g and 598.33 g) respectively, again the lowest (543.73 g) was recorded from 25% PAR.

4.1.5 Stem weight ratio

Stem weight ratio (SWR) in bottle gourd showed statistically non-significant variations among different levels of light intensity (Table 4). The highest SWR (0.28) was found from 100% PAR i.e. full sunlight and 75% PAR, whereas the lowest SWR (0.27) was recorded from 50% PAR and 25% PAR.

4.1.6 Leaf weight ratio

Different levels of light intensity did not influence the leaf weight ratio (LWR) of bottle gourd (Table 4). The highest LWR (0.40) was recorded from 100% PAR i.e. full sunlight and 50% PAR while the lowest LWR (0.39) was observed from 75% PAR and 25% PAR. Corre (1983) reported that adaptive responses of plant to low irradiance include an increase of leaf weight ratio.

4.1.7 Internode length

Significant variations were recorded for internode length of bottle gourd among different levels of light intensity (Figure 1). The longest internode (21.33 cm) was found from 75% PAR which was statistically identical (20.53 cm) with 50% PAR and closely followed (18.83 cm) by 25% PAR, again the lowest (16.80 cm) was recorded from 100% PAR (full sunlight). Hillman (1984) reported that upto 50% reduced sunlight, the concomitant increase in main stem length and internode length clearly explained the contributing of internode length to main stem length.

4.1.8 Individual leaf area

Individual leaf area of bottle gourd exhibited statistically significant variations among different levels of light intensity (Figure 2). The highest leaf area (325.13 cm^2) was recorded from 25% PAR which was statistically identical (320.13 cm^2 and 307.53 cm^2) with 75% PAR and by 50% PAR, whereas the lowest (270.27 cm^2) was attained from 100% PAR (full sunlight). Under partial light condition stimulation of cellular expansion and cell division in leaf could be one of the possible factors that contribute to the individual leaf area increase (schoch, 1982).

4.1.9 Male flowers plant^{-1}

Number of male flowers plant^{-1} in bottle gourd varied significantly for different levels of light intensity (Table 5). The maximum number of male flowers plant^{-1} (45.43) was attained from 75% PAR which was statistically identical (42.47) with 25% PAR and closely followed (37.07) by 100% PAR (full sunlight). On the other hand, the lowest (31.27) was recorded from 50% PAR.

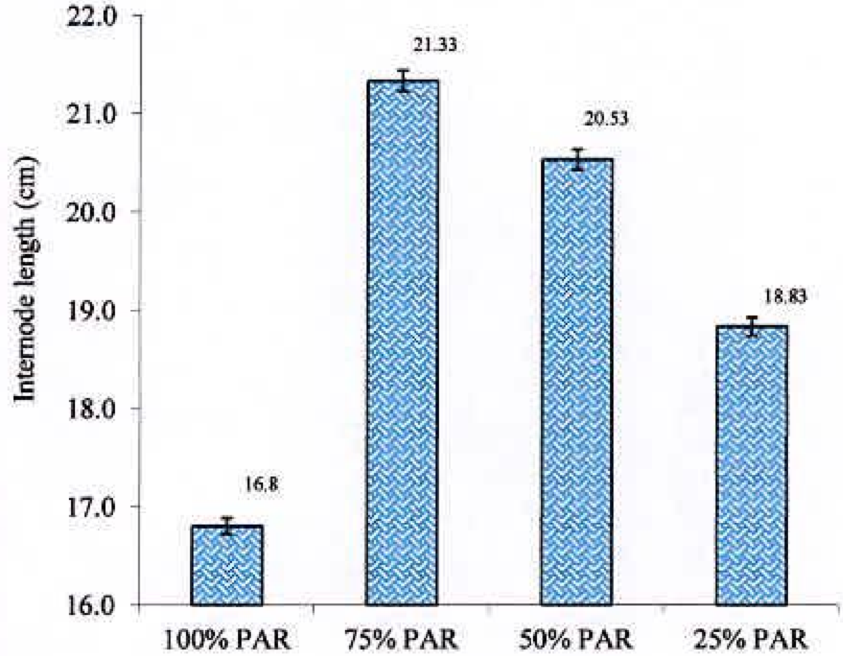

Figure 1. Effect of different levels of light intensity on internode length of bottle gourd

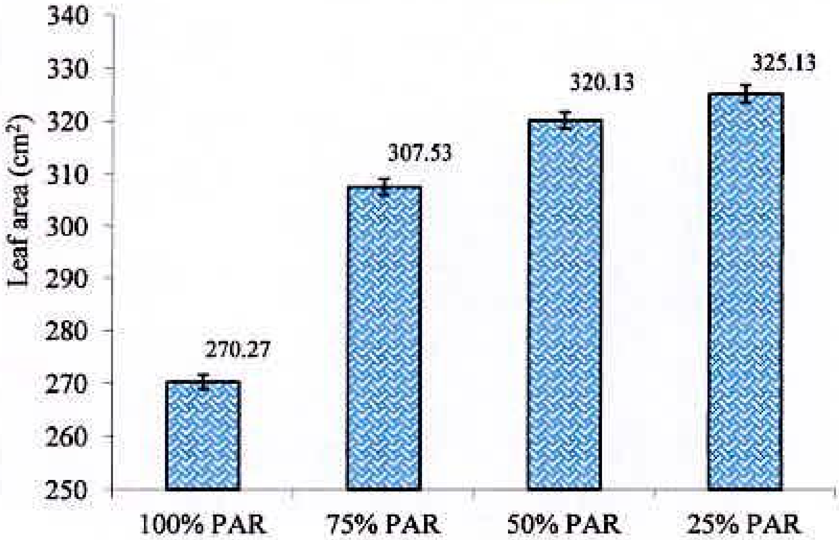

Figure 2 Effect of different levels of light intensity on individual leaf area of bottle gourd

Table 5. Effect of different levels of light intensity on yield contributing characters and yield of bottle gourd

Light level	Male flowers plant^{-1}	Female flowers plant^{-1}	Fruits plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Yield (t ha^{-1})
100% PAR	37.07 bc	18.07 b	7.25 b	44.13 a	20.07 ab	42.40 b
75% PAR	45.43 a	21.07 a	9.00 a	46.17 a	23.20 a	52.40 a
50% PAR	31.27 c	15.13 c	8.25 a	45.07 a	22.20 a	48.27 ab
25% PAR	42.47 ab	20.07 ab	6.25 c	39.13 b	18.13 b	26.00 c
$LSD_{(0.05)}$	7.175	2.828	0.866	4.361	3.467	6.225
CV(%)	9.20	7.62	5.63	5.00	8.30	7.29

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.1.10 Female flowers plant^{-1}

Number of female flowers plant^{-1} of bottle gourd showed statistically significant variations for different light intensity (Table 5). The maximum number of female flowers per plant (21.07) was observed from 75% PAR which was statistically identical (20.07) with 25% PAR and closely followed (18.07) by 100% PAR (full sunlight), whereas the lowest (15.13) was recorded from 50% PAR.

4.1.11 Fruits plant^{-1}

The number of fruits plant^{-1} in bottle gourd showed remarkable variation among different levels of light intensity (Table 5). The maximum number of fruits plant^{-1} (9.00) was found from 75% PAR which was statistically identical (8.25) with 50% PAR and closely followed (7.25) by 100% PAR (full sunlight), again the lowest (6.25) was recorded from 25% PAR.

4.1.12 Fruit length

Fruit length of bottle gourd showed statistically significant variations for different levels of light intensity (Table 5). The longest fruit (46.17 cm) was recorded from 75% PAR which was statistically identical (45.04 cm and 44.13 cm) with 50% PAR and 100% PAR (full sunlight), while the shortest (39.13 cm) was observed from 25% PAR.

4.1.13 Fruit diameter

Fruit diameter of bottle gourd showed statistically significant variations for different levels of light intensity (Table 5). The highest fruit diameter (23.20 cm) was recorded from 75% PAR which was statistically identical (22.20 cm and 20.07 cm) with 50% PAR and 100% PAR (full sunlight), whereas the lowest (18.13 cm) was found from 25% PAR.

4.1.14 Individual fruit weight

Different reduced light levels exerted considerable influence on individual fruit weight of bottle gourd (Figure 3). The highest weight of fruit (1.89 kg) was found from 75% PAR which was statistically identical (1.74 kg) with 50% PAR and closely followed (1.58 kg) by 100% PAR (full sunlight), again the lowest weight (1.25 kg) was observed from 25% PAR.

4.1.15 Yield plant^{-1}

Yield plant^{-1} of bottle gourd varied distinctly and differently among different levels of light intensity (Figure 4). The highest yield plant^{-1} (13.10 kg) was found from 75% PAR which was statistically identical (12.07 kg) with 50% PAR and closely followed (11.10 kg) by 100% PAR (full sunlight), while the lowest yield per plant (6.50 kg) was recorded from 25% PAR. Rao and Mitra (1998) reported that photosynthetically active radiation is the major factor regulating photosynthesis, dry matter production and yield of crops.

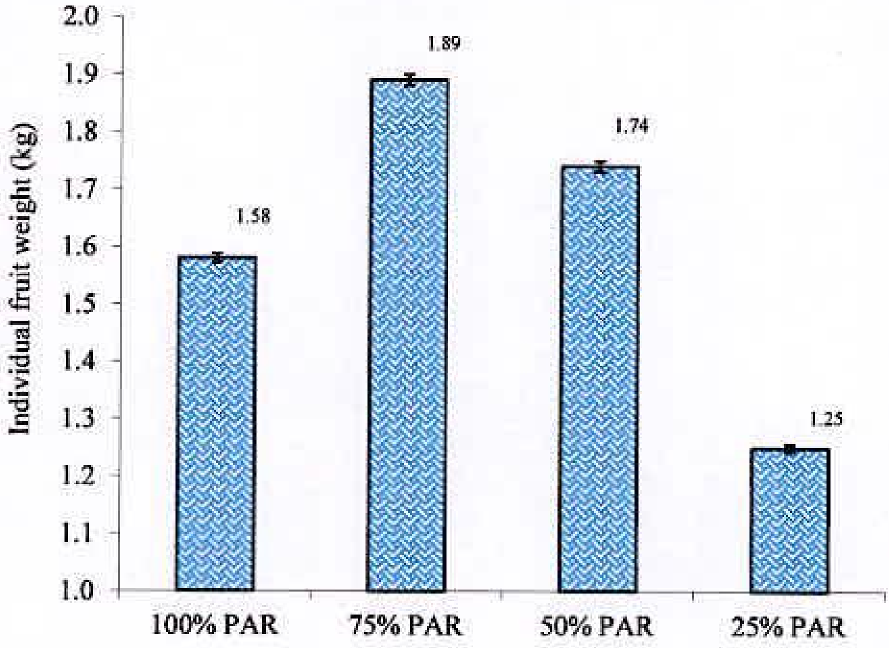

Figure 3. Effect of different levels of light intensity on individual fruit weight of bottle gourd

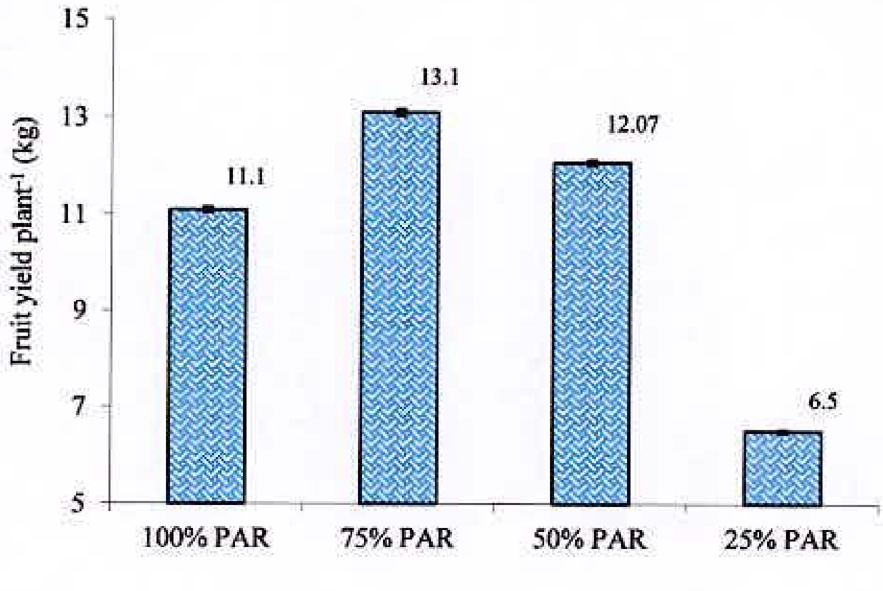

Figure 4. Effect of different levels of light intensity on fruit yield plant^{-1} of bottle gourd

4.1.16 Yield hectare^{-1}

Yield hectare^{-1} of bottle gourd showed considerable variations for different levels of light intensity (Table 5). The highest yield hectare^{-1} (52.40 ton) was obtained from 75% PAR which was statistically identical (48.27 ton) with 50% PAR and closely followed (44.40 ton) by 100% PAR (full sunlight), whereas the lowest yield hectare^{-1} (26.00 t) was recorded from 25% PAR.

Experiment - II: Effect of reduced light intensities on growth and yield of ash gourd

4.2.1 Main stem length

Main stem length of ash gourd differed significantly among different levels of light intensity at 20, 40, 60, 80, 100 and 120 DAT (Table 6). At 20 DAT, the longest main stem (1.61 m) was recorded from 25% PAR which was statistically identical (1.54 m and 1.53 m) with 75% PAR and 100% PAR i.e. full sunlight, respectively, again the shortest main stem (1.17 m) was found from 50% PAR. At 40 DAT, the longest main stem (3.03 m) was recorded from 25% PAR which was statistically identical (2.99 m and 2.47 m) with 75% PAR and 100% PAR (full sunlight), whereas the shortest main stem (1.91 m) was observed from 50% PAR. At 60 DAT, the longest main stem (4.22 m) was recorded from 25% PAR which was statistically identical (3.99 m) with 75% PAR and closely followed (3.69 m) by 100% PAR, whereas the shortest main stem (3.58 m) was recorded from 50% PAR. At 80 DAT, the longest main stem (6.22 m) was obtained from 25% PAR which was statistically identical (5.94 m) with 75% PAR and closely followed (5.46 m) by 100% PAR, whereas the shortest main stem (5.15 m) was found from 50% PAR. At 100 DAT, the longest main stem (7.01 m) was recorded from 25% PAR which was closely followed (6.71 m and 6.50 m) by 75% PAR and 100% PAR, respectively and they were statistically identical, again the shortest stem (5.93 m) was obtained from 50% PAR. At 120 DAT, the longest main stem (7.77 m) was recorded from 25% PAR which was statistically identical (7.41 m and 7.31 m) with 75% PAR and by 100% PAR, respectively and the shortest main stem (6.63 m) was recorded from 50% PAR.

Table 6. Effect of different levels of light intensity on main stem length at different days after transplanting (DAT) of ash gourd

Light level	Main stem length (cm)					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	1.53 a	2.47 ab	3.69 bc	5.46 bc	6.50 b	7.31 a
75% PAR	1.54 a	2.99 a	3.99 ab	5.94 ab	6.71 b	7.41 a
50% PAR	1.17 b	1.91 b	3.58 c	5.15 c	5.93 c	6.63 b
25% PAR	1.61 a	3.03 a	4.22 a	6.22 a	7.01 a	7.77 a
$LSD_{(0.05)}$	0.190	0.880	0.346	0.485	0.236	0.657
CV(%)	6.43	6.92	5.47	8.28	7.79	5.52

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2.2 Leaves plant^{-1}

Number of leaves plant^{-1} of ash gourd showed statistically significant variations for different levels of light intensity at 20, 40, 60, 80, 100 and 120 DAT (Table 7). At 20 DAT, the highest number of leaves plant^{-1} (40.7) was observed from 75% PAR which was statistically identical (40.0 and 38.3) with 50% PAR and 100% PAR (full sunlight) respectively, again the minimum number (34.3) was from 25% PAR. At 40 DAT, the highest number of leaves plant^{-1} (85.7) was found from 75% PAR which was statistically identical (83.3) with 50% PAR and closely followed (77.7) by 100% PAR, whereas the minimum number (66.0) was from 25% PAR. At 60 DAT, the highest number of leaves per plant (130.0) was recorded from 75% PAR which was statistically identical (128.3) with 50% PAR and closely followed (117.7) by 100% PAR, again the minimum number (103.3) was from 25% PAR. At 80 DAT, the highest number of leaves plant^{-1} (212.7) was recorded from 75% PAR which was statistically identical (209.7 and 198.3) with 50% PAR and 100% PAR, again the minimum number (169.0) was from 25% PAR. At 100 DAT, the highest number of leaves plant^{-1} (233.7) was obtained from 75% PAR which was statistically identical (229.7) with 50% PAR and closely followed (214.7) by 100% PAR, while the minimum number (193.0) was from 25% PAR. At 120 DAT, the highest number of leaves plant^{-1} (287.33) was obtained from 75% PAR which was statistically identical (280.3 and 267.3) with 50% PAR and 100% PAR, again the minimum number (228.0) was from 25% PAR. Haque *et al.* (2009) also found that numbers of leaves plant^{-1} decreased due to the reduced light levels. The earliest response of individual leaf area to decreasing light levels indicated that individual leaf area was the most important morphological parameter under shade stress.

Table 7. Effect of different levels of light intensity on number of leaves plant^{-1} at different days after transplanting (DAT) of ash gourd

Light level	Leaves plant^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	38.3 a	77.7 b	117.7 b	198.3 a	214.7 b	267.3 a
75% PAR	40.7 a	85.7 a	130.0 a	212.7 a	233.7 a	287.3 a
50% PAR	40.0 a	83.3 a	128.3 a	209.7 a	229.7 a	280.3 a
25% PAR	34.3 b	66.0 c	103.3 c	169.0 b	193.0 c	228.0 b
$LSD_{(0.05)}$	2.9	5.6	7.5	16.9	12.2	24.8
CV(%)	8.8	6.6	7.2	5.3	7.8	6.7

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2.3 Branches plant^{-1}

Different reduced light levels exerted significantly for number of branches plant^{-1} of ash gourd at 20, 40, 60, 80, 100 and 120 DAT (Table 8). At 20 DAT, the highest number of branches plant^{-1} (3.0) was recorded from 75% PAR which was statistically identical (2.8) with 100% PAR i.e. full sunlight and closely followed (2.5) by 50% PAR, while the minimum number (2.3) was obtained from 25% PAR. At 40 DAT, the highest number of branches plant^{-1} (6.4) was recorded from 100% PAR (full sunlight) which was statistically identical (6.3 and 6.0) with 75% PAR and 50% PAR, respectively again the minimum number (5.5) was recorded from 25% PAR. At 60 DAT, the highest number of branches plant^{-1} (8.1) was found from 75% PAR which was statistically identical (7.9) with 100% PAR (full sunlight) and closely followed (7.0) by 50% PAR, while the minimum number (6.43) was observed from 25% PAR. At 80 DAT, the highest number of branches plant^{-1} (8.4) was recorded from 50% PAR which was closely followed (8.0) by 100% PAR (full sunlight), while the minimum number (6.6) from 25% PAR. At 100 DAT, the highest number of branches plant^{-1} (13.3) was recorded from 75% PAR which was closely followed (12.6) by 100% PAR (full sunlight), while the minimum number (9.9) was recorded from 25% PAR. At 120 DAT, the highest number of branches per plant (16.1) was found from 75% PAR which was statistically identical (15.5) with 100% PAR (full sunlight) and closely followed (13.9) by 50% PAR, whereas the minimum number (13.5) was recorded from 25% PAR.

Table 8. Effect of different levels of light intensity on number of branches plant^{-1} at different days after transplanting (DAT) of ash gourd

Light level	Branches plant^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
100% PAR	2.8 ab	6.4 a	7.9 ab	8.0 b	12.6 b	15.5 a
75% PAR	3.0 a	6.3 a	8.1 a	8.4 a	13.3 a	16.1 a
50% PAR	2.5 bc	6.0 a	7.0 bc	7.2 c	10.9 c	13.9 b
25% PAR	2.3 c	5.5 b	6.4 c	6.6 d	9.9 d	13.5 b
$LSD_{(0.05)}$	0.3	0.4	1.2	0.3	0.5	1.4
CV(%)	5.8	9.9	7.2	6.2	8.0	5.8

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2.4 Dry matter content

4.2.4.1 Stem

Dry matter content in stem of ash gourd varied significantly for different levels of reduced light intensity (Table 9). The highest dry matter content in stem (149.00 g) was observed from 100% PAR i.e. full sunlight which was statistically identical (141.67 g) with 75% PAR and closely followed (136.00 g) by 50% PAR, while the lowest (125.00 g) was recorded from 25% PAR.

4.2.4.2 Leaf

Significant variation was recorded for dry matter content in leaf of ash gourd among different light intensity (Table 9). The highest dry matter content in leaf (224.67 g) was found from 100% PAR i.e. full sunlight which was statistically identical (224.00 g and 210.00 g) with 75% PAR and 50% PAR. On the other hand, the lowest (194.67 g) was recorded from 25% PAR.

4.2.4.3 Fruit

Dry matter content in fruit of ash gourd showed statistically significant variations for different light intensities (Table 9). The highest dry matter content in fruit (190.80 g) was attained from 75% PAR which was statistically identical (182.57 g and 177.67 g) with 100% PAR i.e. full sunlight and 50% PAR, whereas the lowest (160.73 g) was found from 25% PAR.

Table 9. Effect of different levels of light intensity on dry matter accumulation in the above ground parts of ash gourd

Light level	Dry matter content (g)				Weight ratio	
	Stem	Leaf	Fruit	Total	Stem	Leaf
100% PAR	149.00 a	224.67 a	182.57 a	556.47 a	0.27	0.40
75% PAR	141.67 ab	224.00 a	190.80 a	556.23 a	0.25	0.40
50% PAR	136.00 bc	210.00 ab	177.67 ab	523.67 b	0.25	0.40
25% PAR	125.00 c	194.67 b	160.73 b	480.40 c	0.23	0.41
$LSD_{(0.05)}$	11.23	16.04	19.24	29.03	--	--
CV(%)	7.07	5.41	8.75	8.75	5.32	9.55

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2.4.4 Above ground parts

Different levels of light intensity exerted significant influence on dry matter content in above ground parts of ash gourd (Table 9). The highest dry matter content in above ground parts (556.47 g) was observed from 75% PAR which was statistically identical (556.23 g) with 100% PAR i.e. full sunlight and closely followed (523.67 g) by 50% PAR, while the lowest (480.40 g) was recorded from 25% PAR.

4.2.5 Stem weight ratio

Stem weight ratio (SWR) of ash gourd showed statistically non-significant variations for different levels of light intensity (Table 9). The highest SWR (0.27) was found from 100% PAR i.e. full sunlight. On the other hand, the lowest SWR (0.23) was recorded from 25% PAR.

4.2.6 Leaf weight ratio

Statistically non-significant variations were recorded for leaf weight ratio (LWR) of ash gourd for different levels of light intensity (Table 9). The highest LWR (0.41) was found from 25% PAR while the lowest LWR (0.40) was recorded from other treatments (75% PAR).

4.2.7 Internode length

Internode length of ash gourd showed statistically significant variations for different levels of light intensity (Figure 5). The longest internode (19.80 cm) was obtained from 75% PAR which was statistically identical (19.13 cm and 18.67

cm) with 100% PAR (full sunlight) and 50% PAR, again the lowest (16.90 cm) was found from 25% PAR.

4.2.8 Individual leaf area

Significant variations were recorded for individual leaf area of ash gourd at different levels of light intensities (Figure 6). The highest individual leaf area (311.80 cm^2) was observed from 25% PAR which was closely followed (290.87 cm^2 and 290.13 cm^2) with 75% PAR and by 50% PAR, whereas the lowest (250.27 cm^2) was recorded from 100% PAR (full sunlight). Partial shade stimulated cellular expansion and cell division probably contribute to the individual leaf area increase.

4.2.9 Male flowers plant^{-1}

Number of male flowers plant^{-1} of ash gourd varied significantly for different light intensity (Table 10). The maximum number of male flowers plant^{-1} (44.60) was attained from 75% PAR which was statistically identical (43.40) with 100% PAR (full sunlight) and closely followed (41.10) by 50% PAR. On the other hand, the lowest (38.80) was obtained from 25% PAR.

4.2.10 Female flowers plant^{-1}

Number of female flowers plant^{-1} of ash gourd showed statistically significant variations for different levels of light intensity (Table 10). The maximum number of female flowers plant^{-1} (22.13) was recorded from 75% PAR which was statistically identical (21.40 and 20.40) with 50% PAR and 100% PAR (full sunlight), while the lowest (17.07) was observed from 25% PAR.

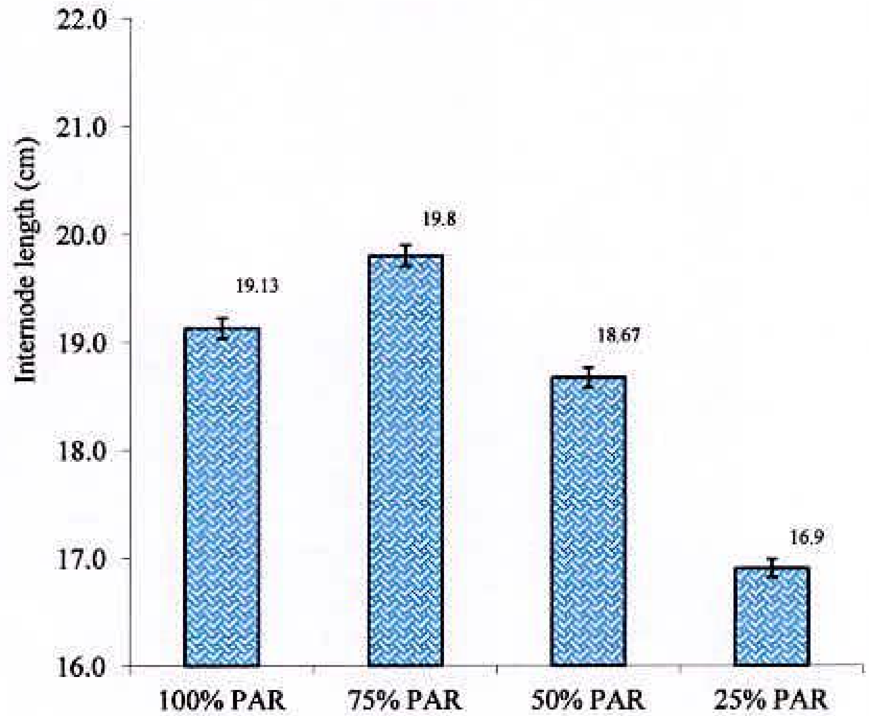

Figure 5. Effect of different levels of light intensity on internode length of ash gourd

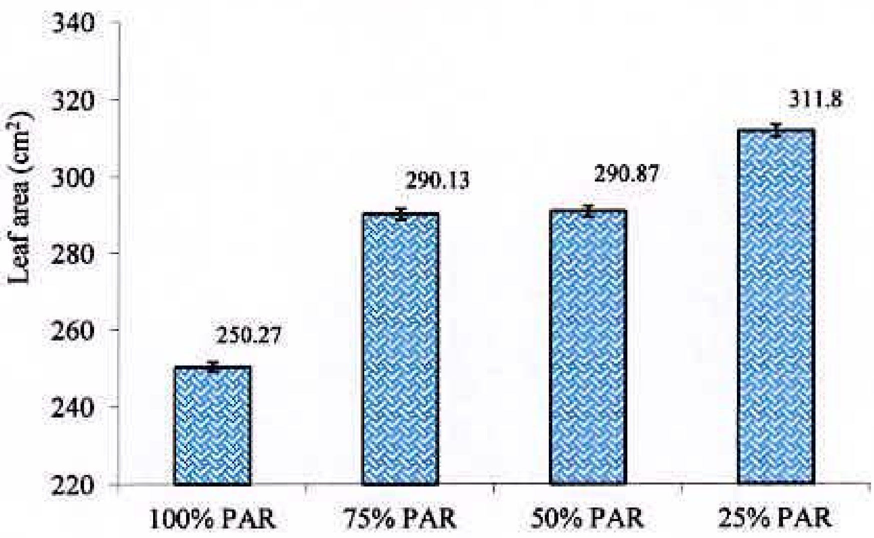

Figure 6. Effect of different levels of light intensity on individual leaf area of ash gourd

Table 10. Effect of different levels of light intensity on yield contributing characters and yield of ash gourd

Light level	Male flowers plant^{-1}	Female flowers plant^{-1}	Fruits plant^{-1}	Fruit length (cm)	Fruit diameter(cm)	Yield (t ha^{-1})
100% PAR	43.40 a	20.40 a	8.17 a	20.90 a	19.07 a	44.13 a
75% PAR	44.60 a	22.13 a	8.58 a	21.54 a	19.47 a	46.00 a
50% PAR	41.10 b	21.40 a	7.50 a	21.25 a	18.53 a	42.93 a
25% PAR	38.80 c	17.07 b	6.08 b	17.74 b	16.53 b	26.67 b
$LSD_{(0.05)}$	2.299	2.890	1.057	2.212	1.367	6.063
CV(%)	6.74	7.14	6.97	7.18	10.72	7.60

In a column mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2.11 Fruits plant^{-1}

Significant variation was recorded for number of fruits plant^{-1} in ash gourd showed for different levels of light intensity (Table 10). The maximum number of fruits per plant (8.58) was recorded from 75% PAR which was statistically identical (8.17 and 7.50) with 100% PAR (full sunlight) and 50% PAR; again the lowest (6.08) was recorded from 25% PAR.

4.2.12 Fruit length

Fruit length of ash gourd showed statistically significant variations for different light intensity (Table 10). The longest fruit (21.54 cm) was recorded from 75% PAR which was statistically identical (21.25 cm and 20.90 cm) with 50% PAR and 100% PAR (full sunlight), whereas the shortest (17.74 cm) was recorded from 25% PAR.

4.2.13 Fruit diameter

Fruit diameter of ash gourd showed statistically significant variations for different levels of light intensity (Table 10). The highest fruit diameter (19.47 cm) was observed from 75% PAR which was statistically identical (19.07 cm and 18.53 cm) with 100% PAR (full sunlight) and 50% PAR. On the other hand, the lowest (16.53 cm) was recorded from 25% PAR.

4.2.14 Individual fruit weight

Different levels of light intensity exerted remarkable influence on individual fruit weight of ash gourd (Figure 7). The highest weight of fruit (1.27 kg) was recorded from 75% PAR which was statistically identical (1.22 kg and 1.20 kg) with 50% PAR and 100% PAR (full sunlight), again the lowest weight (1.05 kg) was found from 25% PAR.

4.2.15 Yield plant^{-1}

Yield plant^{-1} of ash gourd showed statistically significant variations for different levels of light intensity (Figure 8). The highest yield plant^{-1} (11.50 kg) was recorded from 75% PAR which was statistically identical (11.03 kg and 10.73 kg) with 100% PAR (full sunlight) and 50% PAR, while the lowest yield plant^{-1} (6.67 kg) was recorded from 25% PAR.

4.2.16 Yield hectare^{-1}

Fruit yield hectare^{-1} in ash gourd varied significantly for different levels of light intensity (Table 10). The highest yield hectare^{-1} (46.00 ton) was observed from 75% PAR which was statistically identical (44.13 ton and 42.93 ton) with 100% PAR (full sunlight) and 50% PAR, whereas the lowest yield hectare^{-1} (26.67 ton) was recorded from 25% PAR. Hillman (1984) reported that up to 50% reduced sunlight, the concomitant increase in main stem length and internode length to main stem length probably due to the apical dominance as well as yield under shade condition.

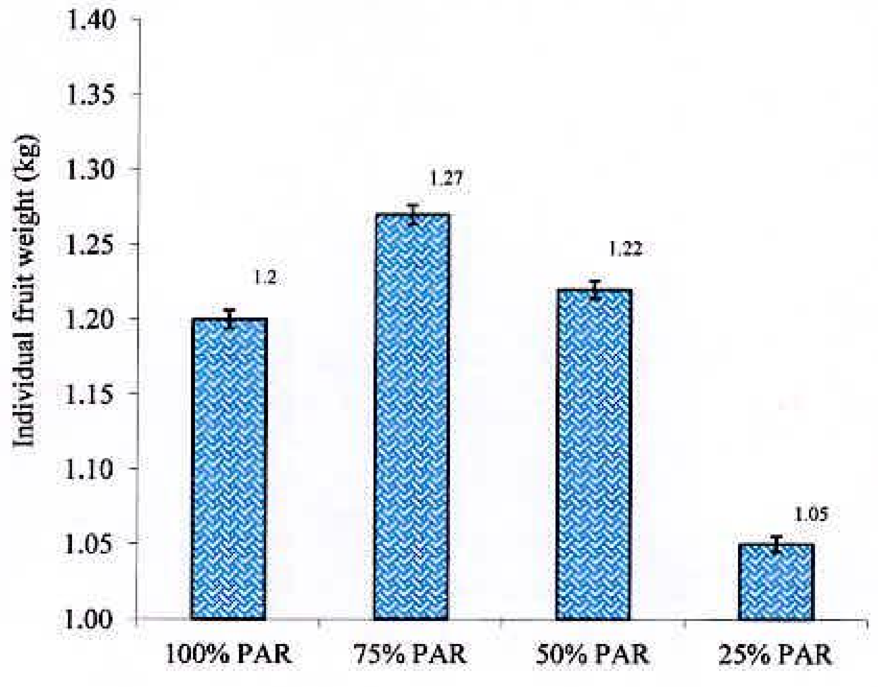

Figure 7. Effect of different levels of light intensity on individual fruit weight of ash gourd

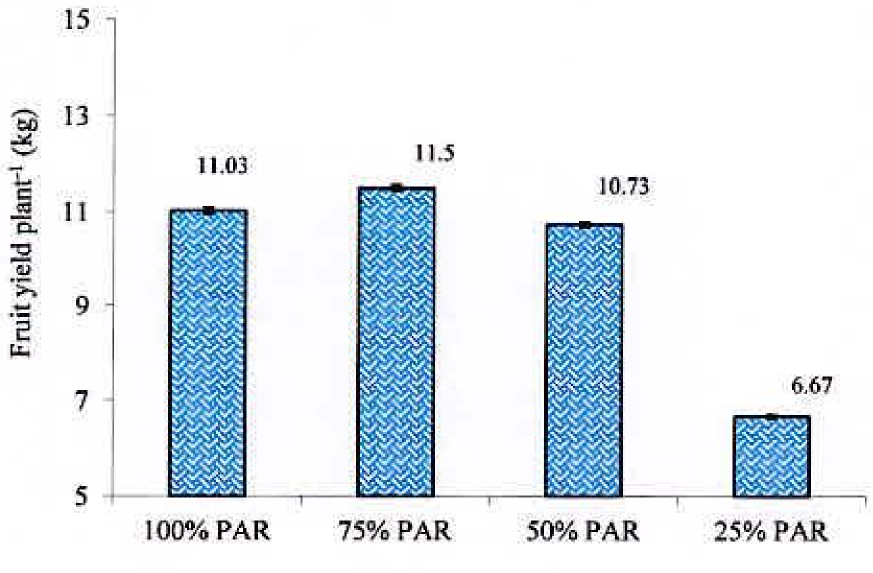

Figure 8. Effect of different levels of light intensity on fruit yield plant^{-1} of ash gourd

CHAPTER V

SUMMARY AND CONCLUSION

The experiments were conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-`1207 during the period from February to August, 2010 to observe effect of reduced light intensities on the growth and yield of bottle gourd and ash gourd. Seeds of bottle gourd (var. High green) and ash gourd (var. BARI Chal kumra-2) were selected for the experiment as test crops. Both the experiment comprised of four photo-synthetically active radiation (PAR) levels, such as, 100% PAR (full sunlight); 75% PAR; 50% PAR and 25% PAR. After crop establishment, nylon nets of different sieve sizes were used to create treatments of different reduced light and light intensity was measured by a light meter. All of the experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. Data were recorded on growth parameters and yield contributing characters and yield for bottle gourd and ash gourd.

For bottle gourd (in experiment-I) at 20, 40, 60, 80, 100 and 120 DAT, the longest stem (1.67 m, 3.83 m, 5.09 m, 7.30 m, 8.23 m and 9.02 m) was recorded from 50% PAR, while the shortest stem (1.26 m, 2.65 m, 4.45m, 6.11 m, 7.08 m and 7.90 m) was recorded from 25% PAR. At 20, 40, 60, 80, 100 and 120 DAT, the highest number of leaves plant^{-1} (45.0, 93.0, 141.0, 225.3 and 254.0) was obtained from 50% PAR again the minimum number (38.0, 73.3, 114.7, 183.7, 214.0 and 252.0) was from 25% PAR. At 20, 40, 60, 80, 100 and 120 DAT, the highest number of branches plant^{-1} (3.3, 6.8, 8.8, 9.4, 14.6 and 17.7) was recorded from 50% PAR and the minimum number (2.6, 5.9, 7.1, 7.6, 11.2 and 14.9) was found from 25% PAR. The highest dry matter content in stem, leaf, fruit and above ground parts (178.00 g, 252.67 g, 206.80 g and 634.53 g) was observed from 100% PAR and the lowest (149.33 g, 214.00 g, 180.40 g and 543.73 g) was found from 25% PAR. The highest SWR (0.28) was found from 100% PAR, whereas the lowest SWR (0.27) was recorded from 50% PAR. The highest LWR (0.40) was recorded from 100% PAR while the lowest LWR (0.39) was observed from 75% PAR. The longest internode (21.33 cm) was found from 75% PAR, again the lowest (16.80 cm) was recorded from 100% PAR. The highest leaf area (325.13 cm^2) was recorded from 25% PAR, whereas the lowest (270.27 cm^2) was attained from 100% PAR. The maximum number of male flowers plant^{-1} (45.43) was attained from 75% PAR and, the lowest (31.27) was recorded from 50% PAR. The maximum number of female flowers plant^{-1} (21.07) was observed from 75% PAR, whereas the lowest (15.13) was recorded from 50% PAR. The maximum number of fruits plant^{-1} (9.00) was found from 75% PAR, again the lowest (6.25) was recorded from 25% PAR. The longest fruit (46.17 cm) was recorded from 75% PAR, while the shortest (39.13 cm) was observed from 25% PAR. The highest diameter of fruit (23.20 cm) was recorded from 75% PAR, whereas the lowest (18.13 cm) was found from 25% PAR. The highest weight of fruit (1.89 kg) was found from 75% PAR, again the lowest weight (1.25 kg) was observed from 25% PAR. The highest yield plant^{-1} (13.10 kg) was found from 75% PAR, while the lowest (6.50 kg) was recorded from 25% PAR. The highest yield hectare^{-1} (52.40 ton) was obtained from 75% PAR, whereas the lowest (26.00 ton) was recorded from 25% PAR.

For ash gourd (in experiment-II) at 20, 40, 60, 80, 100 and 120 DAT, the longest stem (1.61 m, 3.03 m, 4.22 m, 6.22 m, 7.01 m and 7.77 m) was recorded from 75% PAR, while the shortest stem (1.17 m, 1.91 m, 3.58 m, 5.15 m, 5.93 m and 6.63 m) was recorded from 25% PAR. At 20, 40, 60, 80, 100 and 120 DAT, the highest number of leaves plant^{-1} (40.7, 85.7, 130.0, 212.7, 233.7 and 287.3) was obtained from 75% PAR again the minimum number (34.3, 66.0, 103.33, 169.0, 193.0 and 228.0) was from 25% PAR. At 20, 40, 60, 80, 100 and 120 DAT, the highest number of branches plant^{-1} (3.0, 6.3, 8.0, 8.4, 13.3 and 16.1) was recorded from 75% PAR and the minimum number (2.5, 6.0, 7.97, 7.23, 10.9 and 13.9) was found from 25% PAR. The highest dry matter content in stem (149.00 g) was observed from 100% PAR, while the lowest (125.00 g) was recorded from 25% PAR. The highest dry matter content in leaf (224.67 g) was found from 100% PAR and the lowest (194.67 g) was recorded from 25% PAR. The highest dry matter content in fruit (190.80 g) was attained from 75% PAR, whereas the lowest (160.73 g) was found from 25% PAR. The highest dry matter content in above ground parts (556.47 g) was observed from 75% PAR, while the lowest (480.40 g) was recorded from 25% PAR. The highest SWR (0.27) was found from 100% PAR and, the lowest SWR (0.25) was recorded from 75% PAR. The highest LWR (0.41) was found from 25% PAR while the lowest LWR (0.40) was recorded from other treatments. The longest internode (19.80 cm) was obtained from 75% PAR, again the lowest (16.90 cm) was found from 25% PAR. The highest leaf area

(311.80 cm^2) was observed from 25% PAR, whereas the lowest (250.27 cm^2) was recorded from 100% PAR. The maximum number of male flowers $plant^{-1}$ (44.60) was attained from 75% PAR and, the lowest (38.80) was obtained from 25% PAR. The maximum number of female flowers $plant^{-1}$ (22.13) was recorded from 75% PAR, while the lowest (17.07) was observed from 25% PAR. The maximum number of fruits $plant^{-1}$ (8.58) was recorded from 75% PAR, again the lowest (6.08) was recorded from 25% PAR. The longest fruit (21.54 cm) was recorded from 75% PAR whereas the shortest (17.74 cm) was recorded from 25% PAR. The highest diameter of fruit (19.47 cm) was observed from 75% PAR and, the lowest (16.53 cm) was recorded from 25% PAR. The highest weight of fruit (1.27 kg) was recorded from 75% PAR again the lowest weight (1.05 kg) was found from 25% PAR. The highest yield $plant^{-1}$ (11.50 kg) was recorded from 75% PAR, while the lowest yield $plant^{-1}$ (6.67 kg) was recorded from 25% PAR. The highest yield ha^{-1} (46.00 ton) was observed from 75% PAR, whereas the lowest yield per ha^{-1} (26.67 ton) was recorded from 25% PAR.

Considering the magnitude of changes in morphological parameters, dry matter accumulation, dry matter partitioning in stem, leaf and fruits yield and yield components in response to different light levels, the two cucurbits viz. bottle gourd and ash gourd were found to be almost similar. Compared to full sunlight significant adverse effect did not appear in ash gourd until the light was reduced to 25% PAR level while bottle gourd showed significantly higher fruit yield only at 75% over full sunlight.

Therefore, bottle gourd and ash gourd are suitable for growing in shaded environments in summer seasons where only about half of the natural light is available. Between these two cucurbits, bottle gourd is more suitable for 75% PAR level. However, further experiments are recommended with a large number of genotypes of each crop for confirmation of the result.

REFERENCE

Ahmed, F. and Jahan, M. A. 1998. Effect of potato/wheat intercropping on light interception, leaf area index and dry matter production. *Bangladesh Agric*. **8**(1): 67-70.

Baumann, D. T., Bastiaans, L., Goudriaan, J., Laar, H. H. and Kropff, M. J. 2002. Analyzing crop yield and plant quality in an intercropping system using an eco-physiological model for inter-plants competition. *Agril. Systems*. **73**(2): 173-203.

BBS (Bangladesh Bureau of Statistics), 2010. Statistical yearbook of Bangladesh, Ministry of Planning, Government of People's Republic of Bangladesh, Dhaka-1207.

Boardman, N.K.1977.Comparative photosynthesis of sun and shade plant. *Annu. Rev. Plant Physio*. **28**: 355-377.

Bodson, M. and Verhoyen, M. N. J. 2000. Supplementary lighting regimes strongly affect the quantity of gerbera flower yield. *Acta Hort*., **515**: 91-98.

BRRI . 2006. Annual Report for 2006. Bangladesh Rice Res. Inst., Joydebpur, Gazipur. p. 31.

Buwalda, F., Eveleens, B. and Wertwijn, R. 2000. Ornamental crops tolerate large temperature fluctuations: a potential for more efficient greenhouse heating strategies. *Acta Hort*., **515**: 141-149.

Corre, W. J. 1983. Growth and morphogenesis of sun and shade plants on the influence of light intensity. *Acta Bot. Neerl*., **32**: 49-62.

Flenet, F., Kiniry, J. R., Board, J. E., Westgate, M. E. and Reicosky, D. C. 1996. Row spacing effects on light extinction coefficients of corn, sorghum, soybean, and sunflower. *Agron. J.,* **88**(2): 185-190.

Fujita, K.K. Matsamoto,G.K Buda.O. and Ogato,S.1993 Effect of Shading on growth and Di-nitrogen fixation of kudzce and tropical pasture legumes.*Soil Sci Plant Nutri.* **39**(1); 43-54.

Gomez, K. A. and Gomez, A.A. 1984. Statistical Procedures for Agriculture Research (2nd ed.) John Wiley and Sons, New York.

Haque, M. M., Mirza Hasanuzzaman and Rahman, M. L. 2009. Effect of Light Intensity on the Morpho-physiology and Yield of Bottle Gourd (*Lagenaria vulgaris*). *Academic J. Plant Sci.,* **2**(3): 158-161.

Hillman, J. R. 1984. Apical dominance, In: M. B. Wilking, (Ed.), Advanced Plant Physiology, Pitman, London, pp. 127-148.

Kubota, F. and Hamid, A. 1992. Comparative analysis of dry matter production and photosynthesis between mungbean (*Vigna radiate* L.) and blackgram (*V. mungo* L.) in different light intensities. *J. Fac. Agr. Kyushu Univ.*, **37**(1-2): 71-80.

Labeke, M. C. and Dambre, P. 1999. Supplementary light in Gerbera not always a success. *Verbondsnieuws*. **43**(20): 27-29.

Morgan, D. C., Stanley, C. J. and Warrington, I. J. 1985. The effect of shading on fruitfulness and yield in sultana. *J. Hort. Sci.*, **60**: 473-484.

Pathiratna, L. S. S. and Perera, M. K. P. 2005. Rubber (*Hevea brasiliensis*) cinnamon (*Cinnamomum verum*) intercropping system: performance under standard inter row spacings of rubber. *Natural Rubber Res.,* **18**(2): 105-112.

Peil, R. M. and Lopez, G. J. 2002. Effect of fruit removal on growth and biomass partitioning in cucumber. *Acta Hort.*, 588: 69-74.

Peil, R. M., Gonzalez, M. M. and Lopez, G. J. 2002. Light interception of a greenhouse cucumber crop: measurements and modelling results. *Acta Hort.*, **588**: 81-87.

Rao, L. J. and Mitra, B. N. 1998. Growth and yield of peanut as influenced by degree and duration of shading. *J. Agron. Crop Sci.*, **160**: 260-265.

Rashid, M. 1999. Shobji Biggan. Rashid publishing house, 94 Puraton DOHS, Dhaka, Bangladesh. Pp. 243-285.

Rodrigo, V. H. L., Stirling, C. M., Teklehaimanot, Z. and Nugawela, A. 2001. Intercropping with banana to improve fractional interception and radiation-use efficiency of immature rubber plantations. *Field Crops Res.*, 69(3): 237-249.

Roodagi, L. I., Itnal, C. J., Biradar, D. P. and Angadi, S. A. 2001. Leaf area index, light transmission ratio and sugar yield of sugarcane as influenced by planting methods and intercropping systems. *Indian Sugar*. **51**(6): 379-382.

Schoch, P. G. 1982. Effects of shading on structural characteristics of the leaf and yield fruit in *Capsicum annum* L. *J. Amer. Soc. Hort. Sci.*, **97**(4): 461-464.

Sevelius, N. 2003. Photosynthetic features of three gerbera cultivars in low light. *Acta Hort.*, **624**: 297-302.

Sharaiha, R. K. and Battikhi, A. 2002. A study on potato/corn intercropping-microclimate modification and yield advantages. *Dirasat Agril. Sci.*, **29**(2): 97-108.

Shikata, K., Matsushita, Y., Nawata, E. and Sakuratani, T. 2003. Effect of intercropping with maize on the growth and light environment of cowpea. *Japanese J. Trop. Agric.*, **47**(1): 17-26.

Wang, J. Y., Wang, W. Q., Wu, H. X. 2003. Illumination domino effect and its influence on height growth of medicinal plant in intercropping system of Populus tomentosa and medicinal plants. *J. Zhejiang Forstry College*. **20**(1): 17-22.

Wang, S. H., Fan, S. X., Kong, Y. and Qingjun, C. 2007. Effect of light quality on the growth and photosynthetic characteristics of cucumber *Cucumis sativus* L. under solar greenhouse. *Acta Hort.*, **731**: 243-249.

Weinberger, K. and Genova, C. A. 2005. Vegetable production in Bangladesh: commercialization and rural livelihoods. Technical Bulletin No. 33. AVRDC publication number 05-621. Shanhua, Taiwan: AVRDC–The World Vegetable Center. 51 pp.

APPENDICES

Appendix I. Characteristics of the soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the soil of experimental field

Morphological features	Characteristics
Location	Experimental field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix II. Monthly record of air temperature, rainfall, relative humidity, rainfall and Sunshine of the experimental site during the period from February to August 2010

Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
February	27.1	16.7	67	30	6.7
March	31.4	19.6	54	11	8.2
April	26.2	18.1	61	88	7.8
May	27.0	19.2	63	54	8.1
June	27.1	16.7	67	145	8.2
July	31.4	19.6	54	182	7.9
August	31.22	21.4	83	142	7.8

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1207

Appendix III. Analysis of variance of the data on stem length at different days after transplanting (DAT) of bottle gourd as influenced by different light intensity

Source of variation	Degree of freedom	Mean square					
		Stem length (cm)					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.013	0.040	0.018	0.189	0.072	0.009
Treatment	3	0.108**	0.906**	0.262*	0.786*	0.693**	2.054**
Error	6	0.006	0.035	0.044	0.117	0.045	0.476

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on leaves plant^{-1} at different days after transplanting (DAT) of bottle gourd as influenced by different light intensity

Source of variation	Degree of freedom	Mean square					
		Leaves plant^{-1}					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.750	9.083	6.750	63.083	214.583	6.333
Treatment	3	33.556**	227.861**	418.306*	1160.000**	976.000**	2150.444*
Error	6	2.639	22.528	73.306	117.750	128.583	320.444

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on branches plant^{-1} at different days after transplanting (DAT) of bottle gourd as influenced by different light intensity

Source of variation	Degree of freedom	Mean square					
		Branches plant^{-1} at					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.077	0.061	0.503	0.303	0.493	0.438
Treatment	3	0.262*	0.561*	1.929*	2.013**	7.208**	5.300*
Error	6	0.036	0.111	0.286	0.130	0.160	0.941

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on dry matter accumulation in the above ground parts of bottle gourd as influenced by different light intensity

Source of variation	Source of variation	Mean square					
		Dry matter content				Weight ratio	
		Stem	Leaf	Fruit	Total	Stem	Leaf
Replication	2	7.000	108.000	19.057	252.558	0.0001	0.0001
Treatment	3	446.556**	923.556*	424.172*	5076.617**	0.0001	0.0001
Error	6	18.556	128.889	72.163	411.375	0.0001	0.0001

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on yield contributing characters and yield of bottle gourd as influenced by different levels of light intensity

Source of variation	Degree of freedom	Mean square									
		Internode length (cm)	Leaf area (cm^2)	Male flowers $Plant^{-1}$	Female flowers $Plant^{-1}$	Fruits $Plant^{-1}$	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (kg)	Yield (kg $plant^{-1}$)	Yield (t ha^{-1})
Replication	2	0.008	3.423	2.726	0.083	0.563	1.313	9.270	0.031	0.013	0.213
Treatment	3	12.101**	1844.84*	116.93**	20.537**	4.297**	28.972*	15.329*	0.226**	25.428**	406.84**
Error	6	0.331	368.383	12.899	2.003	0.188	4.764	3.012	0.021	0.607	9.707

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on stem length at different days after transplanting (DAT) of ash gourd as influenced by different levels of light intensity

Source of variation	Degree of freedom	Mean square					
		Stem length (cm)					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.020	0.014	0.008	0.030	0.036	0.056
Treatment	3	0.120**	0.820**	0.256**	0.689**	0.628**	0.672*
Error	6	0.009	0.032	0.030	0.059	0.014	0.108

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IX. **Analysis of variance of the data on leaves plant^{-1} at different days after transplanting (DAT) of ash gourd as influenced by different levels of light intensity**

Source of variation	Degree of freedom	Mean square					
		Leaves plant^{-1}					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.583	13.583	39.583	196.083	7.000	100.750
Treatment	3	24.222**	231.222**	452.556**	1190.972**	1017.417**	2106.083**
Error	6	2.139	7.806	14.139	71.639	37.333	154.417

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix X. **Analysis of variance of the data on branches plant^{-1} at different days after transplanting (DAT) of ash gourd as influenced by different levels of light intensity**

Source of variation	Degree of Freedom	Mean square					
		Branches plant^{-1} at					
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT
Replication	2	0.053	0.041	0.023	0.228	0.152	0.036
Treatment	3	0.281**	0.503**	1.767*	2.014**	7.316**	4.773*
Error	6	0.023	0.030	0.277	0.027	0.055	0.502

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix XI. Analysis of variance of the data on dry matter accumulation in the above ground parts of ash gourd as influenced by different levels of light intensity

Source of variation	Degree of Freedom	Mean square					
		Dry matter content				Weight ratio	
		Stem	Leaf	Fruit	Total	Stem	Leaf
Replication	2	43.583	65.333	170.416	637.141	0.0001	0.0001
Treatment	3	307.417**	601.778**	482.930*	3886.330**	0.0001	0.0001
Error	6	31.583	64.444	92.701	211.160	0.0001	0.0001

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix XII. Analysis of variance of the data on yield contributing characters and yield of ash gourd as influenced by different levels of light intensity

Source of variation	Degree of Freedom	Mean square									
		Internode length (cm)	Leaf area (cm^2)	Male flowers $Plant^{-1}$	Female flowers $Plant^{-1}$	Fruits $Plant^{-1}$	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (kg)	Yield (kg $plant^{-1}$)	Yield (t ha^{-1})
Replication	2	0.108	43.923	3.617	1.750	0.099	0.646	0.570	0.002	0.123	1.973
Treatment	3	4.616**	1983.06**	19.767**	15.026*	3.597**	37.439**	5.084**	0.028*	14.966**	239.45**
Error	6	0.346	105.106	1.324	2.092	0.280	2.897	0.468	0.005	0.576	9.209

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability