

**EVALUATION OF RICE (*Oryza sativa* L.) GENOTYPES
FOR LOW LIGHT INTENSITY**

by

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DAPOLI - 415 712, DIST. RATNAGIRI (M.S.)
MAY, 2018**

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A thesis submitted to the

**DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,
DAPOLI**

(Agricultural University)

Dist. Ratnagiri (Maharashtra State), India

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

PLANT PHYSIOLOGY

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**CERTIFICATE**

This is to certify that the thesis entitled “**EVALUATION OF RICE (*Oryza sativa* L.) GENOTYPES FOR LOW LIGHT INTENSITY**” Submitted to faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **PLANT PHYSIOLOGY** embodies the results of piece of *bona-fide* research work carried out by **Mr. NAVATRE RAMCHANDRA JALINDAR** (Reg. No. ADPM/16/2490) under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma and published in other form. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by her.

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Date: / /2018

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ACKNOWLEDGEMENT

*Some moments in life are cherished forever for one reason or another and this one is not exception for me. It is a moment of great pleasure in recording my fervent sense of gratitude and heartfelt thanks to my honourable research guide, **Smt. M.H. Keluskar**, Rice Physiologist, Regional Agriculture Research Station, Karjat, Dist. Raigad. I express my deep and sincere gratitude to hers for her unflagging enthusiasm, valuable guidance, constant encouragement and everlasting inspiration during whole tenure of the investigation. Also during this whole M. Sc. Programme she maintain very frankly environment for me and also provide a full freedom to do work in my own way. It was her most co-operative and painstaking attitude, which made this thesis a reality.*

*I greatly acknowledge the technical guidance; encouragement and moral support received from my advisory committee **Dr.M.M. Burondkar**, Associate Dean, College of Forestry, Dapoli. **Dr.S.G. Bhawe Sir** Director of Extension Education, Dr.B.S.K.K.V. Dapoli, and **Mr.M.B. Dalvi sir**, Professor Dept. of Plant Pathology, College of Agriculture, Dapoli.*

*I express my ecstatic thanks to Head, **Dr.B.L. Thaware**, Department of Agril. Botany, Dr.B.S.K.K.V, Dapoli for their kind co-operation and impeccable guidance during the course of study. I would also like to thanks **Dr. A.K. Shinde** Rice specialist (RARS.Karjat), **Dr. Mane Sir** associate professor, **Dr. Mahadik sir**, assistant professor, Department Agril. Botany, College of Agriculture, Dapoli., Mr. Deshpande sir, Mr. Chavan Sir, Mrs. Desai madam, Mr. Palshetkar sir, Dr. Dalvi sir, Dr. Devmore sir, Dr. D.N. Jagtap Sir, Dr. J. S. Dhekale Sir, and Dr. Sawardekar sir for their valuable suggestions, co-operation and help during the course of study.*

*I am highly obligate to, **Dr. Tapas Bhattacharya**, Honourable Vice Chancellor Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli; **Dr. U. V. Mahadkar**, Associate Dean and thanks to them.*

Heartfelt thanks are also due to all the members of faculty, laboratory, office and field staff of R.A.R.S.Karjat for their cordial assistance and timely help extended during the study.

The words at my command are inadequate to convey the depth of my heartfelt gratitude and indebtedness to my father **Shri. Jalindar Bhagwan Navatre**, mother **Sou. Radhika Jalindar Navatre**, my big brother **Shri. Santosh** and my sister in law **Rohini**, little brother **Deepak**, my nephew **Dnyanraj** (pillu), grandma **Shahabai** and all my family members for their love, support, encouragement and sacrifice made by them to shape my career and whose long cherished dreams for me are turning into reality in the form of dissertation. Their love and affection has been guiding path of my life. Without whose love, moral support, affection and guidance I wouldn't have been successful in this difficult endeavour of post graduate studies.

It is my sole prerogative to place on record my indebtedness and everlasting gratitude to my seniors, **Dr. Vaibhav, Priyanka Didi, Dhanashri Didi, Ashishdada, Shrivarsha, Pachpor sir, Roshan, Priyanka, Ashwini, Sayli, Krishnja, Prasad, Balaji, Vaibhav, Hanumant, Tushar and Yogesh**.

The My heart feels indebted for the unstinted cooperation and help rendered by my classmates **Vishal, Sanket, Govind, Vicky, Mahesh, Ayyaz, Akshay, and Arya**. The day with them are full of magic and spread with a shower of happiness. **Realy, Thanku friends**. I would be remiss, if I do not articulate my cordial feeling of thanks into words to my juniors **Sayli, Pratiksha, Akshay, Chirag, Sudhakar, Jayvant, Prajakta** and **Sudha** for their whole hearted help and support throughout my study period. I also want to thank you **Aniruddha** for his sincere and valuable help.

I also take the opportunity to acknowledge the help and love by my friends **Amit, Umesh, Rohan, Sujit, Kiran, Dada, Suhas, Sachin, Samir, Nilesi, Shrikant, Vasim, Rushi, Omkar, Onkar, Akshay, Hari, Akash, Pravin, Nitish, Gaurav, Dhanya, Alankar, Pradeep, Ram, Santosh, Girish, Hemant, Kishor, Srenik, Sharad, Abhi, Sai** and all **M. Sc. & B. Sc. Batchmates & my brothers Datta, Amol, Aditya, Ajinkya, Shreekrushana**, and sisters **Prajakta, Komal, Sarika, Pratikshya, Pramila and Seema**. I am conscious of my debt to them and equally to all my colleagues and friends who helped me directly or indirectly and offered their excellent company and warm affections throughout my stay in this Institute.

Once again, I would like to thank each and every person who helped me directly or indirectly to turn this dream come true.

Needless to say, all omissions and errors are mine...

Place: Dapili

Date: May 31th, 2018

(**Mr. Navatre Ramchandra Jalindar**)

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CHAPTER – I

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of more than half of the world population. It is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planets human population. It is cultivated over an area of 161.85 m ha with a production of 483.8 million tonnes (Anonymous, 2017-18). The total food grains production was 271.98 million tonnes for the year 2016-17 and 111.52 million tonnes rice production has been estimated in India during the period (Anonymous, 2017-18). The United States Department of Agriculture (USDA) estimated that the World Rice Production during 2017-2018 achieved 483.8 million metric tonnes, around 0.8 million tonnes more than the previous month's projection. Rice Production was 486.57 million tonnes during 2017 and 483.8 million tons could represent a decrease of 2.77 million tonnes in rice production around the globe in this year (USDA, 2017-18). Rice provides about two-third of the calorie intake for more than two billion people in Asia and a third of the calorie intake of nearly one billion people in Africa and Latin America (Shastri *et al.*, 2000).

In Maharashtra, area under rice is 1446.6 thousand ha with 2660.5 thousand tonnes production and 1839 Kg/ha productivity (Anonymous 2017-18). Average productivity of rice is 2.13 tonnes ha⁻¹ in India which is far below the world's average of 3.7 tones ha⁻¹. The major rice growing districts in Maharashtra are Thane, Raigad, Ratnagiri and Sindhudurg along with the west coast and Bhandara and Chandrapur in

the eastern parts of the states and minor areas are Tuljapur, Parbhani, Western Ghat of Pune, Satara, Kolhapur, parts of Nanded. Maximum productivity is observed in Konkan region and it contributes 42.91% of total rice production in the state. Vidarbha region covers large area under rice cultivation than other regions but it has low productivity than Konkan and Western Maharashtra region.

In Konkan region Maharashtra the average under rice is in decreasing trend. In year 2017 the area under rice was 3.79 lakh/ha, with production 16.10 lakh tons and productivity 42.5 q/ha. The maximum area is in Raigad (1.09 lakh ha) followed by Palghar (0.764), Ratnagiri (0.753), Sindhudurg (0.625) and Thane (0.550 lakh ha). The productivity of rice was maximum in Sindhudurg (47.69 q/ha), followed by Ratnagiri (45.46 q/ha), Palghar (42.26 q/ha), Raigad (39.37 q/ha), and Thane (39.40 q/ha). (Anonymous 2016-17)

Light is the main energy source for plant photosynthesis and is an environmental signal used to trigger growth and structural differentiation in plants. Without light, the net photosynthesis rate shows a negative value because of discharging CO₂ through dark respiration (Chen *et al.*, 2014).

Low irradiance during the reproductive and ripening stages has an adverse effect on potential yield because the photosynthetic activity in the leaves of rice cultivar decreases (Srivastava, 2011). Light intensity is very important component for plant growth, development, survival and crop productivity (Wang *et al.*, 2013). The researchers have been evaluated the effects of variation in light regimes on morphological characteristics, physiological characteristics,

yield and quality of agricultural crops because difficult to control light intensity (Wang *et al.*, 2007). Shade has pronounced effect on the growth of rice. It tends to increase plant height, decrease tillers and panicle number hill⁻¹, grains panicle⁻¹ and grain yield. Shade stimulates cellular expansion and rapid cell division resulting in increasing leaf length and plant height (Schoch, 1972).

Low light has detrimental effects on the physiology and yield of the rice plant. The adverse effect is more predominant at the reproductive stage and physiological parameters such as chlorophyll and soluble protein can be taken as selection indices for evaluating varieties grown under low light (Prabha *et al.*, 2004). The yield of field-grown rice mainly depends on the solar radiation throughout the growth period, especially during the reproductive and grain filling stages. Shading effects are not just about the plants growth and development, but it also has a major impact on plant photosynthesis (Fageria, 2007).

The solar radiation has a profound impact on crop growth and productivity. Shading during the vegetative growth phase slightly affects rice growth and yield, while shading during the reproductive phase has a pronounced effect on sink capacity (spikelet number per panicle and per unit land area). During ripening, shading markedly reduces grain yield because of a spurt in spikelet sterility (Singh *et al.*, 2005).

Shading applied during developmental stages could reduce the plant dry matter accumulation and disturb the redistribution of photosynthetic products from vegetative organs into grains. Ultimately, this could affect total grain

yield by reducing panicles, spikelet's, filled grains, and grain weight. However, shade before booting stage of rice mainly decreased tiller number, effective panicle number and little reduction in rice yield. When shade occurred after booting stage, the filled grain percentage and 1000-grain weight decreased, which decreased overall rice yield. In plant photosynthesis, chlorophyll is the most important photosynthetic pigment and shading also affects the chlorophyll content of plants. Shading altered light-use efficiency by increasing leaf chlorophyll a, chlorophyll b, and total chlorophyll and decreasing chlorophyll a/b ratios (Wang *et al.*, 2013).

The effects of low light on agronomic and quality as well as the formation of grain, and mainly reviewed the physiological metabolism of rice plants, including characteristics of photosynthesis, activities of antioxidant enzymes in rice leaves and key enzymes involved in starch synthesis in grains, as well as the translocation of carbohydrate and nitrogen. These characteristics include various grain yield and rice quality components (milling and appearance as well as cooking, eating and nutritional qualities) under different rates of shading imposed at the vegetative or reproductive stages of rice plants (Liu *et al.*, 2014).

Light intensity is one of the most important environment factors that determine the basic characteristics of rice development. However, continuous cloudy weather or rainfall, especially during the grain filling stage, induces a significant loss in yield and results in poor grain quality.

Stress caused by low light often creates severe meteorological disaster in some rice growing regions worldwide. Low light condition can damage rice production dramatically; light intensity has received attention from researchers worldwide increasingly. A lack of adequate light strongly influences not only the duration of growth but also physiological and agronomic traits of rice.

Trees in paddy fields are a unique agro-ecosystem of Konkan region. Tree stands are found both on paddy floors and bunds. The co-existence of trees and rice is accepted by farmers due to many uses of the trees in their subsistence way of life such as food, medicine, animal fodder, construction material and shade. There are several agro forestry systems viz. agro horticulture, agro-silvicultural, bund plantation, boundary plantation etc. in Konkan region there is large hectarage under mango plantation. However, the effect of trees on reducing agricultural crop productivity through shade is seen as an obstacle for agro forestry promotion. The reduction effects where more clearly demonstrated in rice grown in association with artificial shading.

It is well grasped that shading is major negative effect of trees on crop growth, which constitute a major obstacle for farmer's adaptation of agro forestry. To confirm effect of shading on rice growth and gaining more knowledge in this respect, the objective of study where to determine the effect of shading on rice growth and yield under control treatment of field experiment condition. To systematically study for identification of suitable genotypes of rice under artificial

shade net, the experiment was carried out by using sixteen genotypes of rice under shade net condition.

Considering the importance of rice and need of its improvement under shade conditions this could be achieved by testing promising types having higher productivity and better adaptability under shade condition system. As rice is a native crop of Konkan and had lot of variability present among varieties and hybrids of Konkan region there for necessary attention has to be given for identification of rice genotypes which suitable for shade tolerance in Konkan.

Therefore, the main objective of experiment was identification of such rice genotypes which will be essential for developing high yielding varieties that can be survive in low light condition. Keeping the above facts, the present investigation entitled “**Evaluation of rice (*Oryza sativa* L.) genotypes for low light intensity**” was conducted with following objectives:

- ◆ To identify suitable genotypes for shade tolerance under shade net condition.
- ◆ To study the growth functions viz. AGR, RGR, NAR, LAI, and SLW of various genotypes under low light intensity.

CHAPTER-II

REVIEW OF LITERATURE

Light intensity is one of the most important environmental factors that determine the basic characteristics of rice development. However, continuous cloudy weather or rainfall, especially during the grain filling stage, induces a significant loss in yield and results in poor grain quality. Stress caused by low light often creates severe meteorological disaster in some rice growing regions worldwide. Low light condition can damage rice production dramatically; light intensity has received attention from researchers worldwide increasingly. A lack of adequate light strongly influences not only the duration of growth but also physiological and agronomic traits of rice. In view of the importance of low light tolerance in rice crop the available literature pertaining to the different aspect of the present investigation has been reviewed under following headings:

- ◆ To identify suitable genotypes for shade tolerance under shade net condition.
- ◆ To study the growth functions viz. AGR, RGR, NAR, LAI, SLW of various genotypes under low light intensity.

2.1 To identify suitable genotypes for shade tolerance under shade net condition

Matsushima *et al.* (1953) observed that low light conditions during the panicle differentiation or grain-filling stages exert a greater adverse effect on rice grain yield than other growth stages, which better explains the greater loss in grain yield caused by low light during the reproductive stage.

Stansel *et al.* (1965) reported that low light intensity increases sterility and reduces yield of rice crops.

Chonan, (1967) reported that the leaf area significantly increased at low light condition whereas, only increases by 5.76% under 50% of natural light however, it increases by 29.83% under 20% of natural light. Conversely, mesophyll thickness and the number of cells per square millimeter in leaves decrease by 14.61% and 15.86%, respectively, when rice plants are grown under 20% of natural light.

Wada, (1968) reported that low light increased the rate of leaf and Culm sheath dry matter weight produced compared with the total dry matter weight of above ground (leaves + culm + sheaths + panicles). Moreover, low light also decreases the dry matter weight in the panicles, showing that most of the dry matter produced is used to sustain the growth of leaves, culm and sheaths rather than being allocated to panicles.

Lium, B. and Shoaf, T. (1976). studied that Dimethyl sulfoxide (DMSO) and 90% acetone extracted equal amounts of chlorophyll from diatoms and blue-green algae, but DMSO was superior to 90% acetone for all green algae tested giving 2–60 times more chlorophyll depending on the species. The absorbance spectra of pure chlorophyll a (and b) from 600 nm to 750 nm were identical whether dissolved in 90% acetone or a mixture of DMSO and 90% acetone (1:1 v/v). Thus, several equations for estimating chlorophyll concentration based on extinction in 90% acetone are applicable with this solvent.

Vergara *et al.* (1976) reported that spikelet sterility is one of the major constraints in rice productivity as it influences

directly the grain yield by limiting the number of filled grains per unit area.

Yoshida *et al.* (1976) reported that the lower grain yield during wet season was mostly due to high sterility of spikelet's and consequent reduction in the number of filled grains per panicle per unit ground area.

Venkateswarlu *et al.* (1977) observed that yield was progressively reduced with low light intensity. Obviously, under shading stability in certain characters like panicle number, grains per panicle, dry matter production and percentage of filled grains were important. Considering the importance of plant type concept, we have to keep in view two approaches either to widen the horizons of varietal adaptation or to go in for stress oriented tailoring of plant. Low light intensity (40-50% of natural light) at different growth stages and subsequent exposure to natural light was assessed on growth and productivity in two genotypes during *kharif* and three genotypes during *Rabi*. Varieties Sona and Vijaya during *kharif* and Sona, Vijaya and RP-4-14 during *Rabi* transplanted on shade. Light intensity measured by Toshiba luxmeter. Total chlorophyll content increased under shading irrespective of season, variety, and growth phase. Total dry matter, grain per panicle, filled grains per panicle, grain yield progressively reduced under shade for growth phases. The height of rice plant was significantly greater under shading and reduction in various yield components (i.e. number of tillers and panicles per plant, number of grains per panicle) and It is now increasingly realized that when not limited by water, temperature and pest-disease problem, growth and productivity of crop plant influenced by solar radiation. In South-East Asia

60-70% rice is grown during monsoon season when light intensity is 40-60% less than that of dry season.

Janardhan *et al.* (1980) reported that nutrient source organs (leaves + culm + sheaths) cannot provide adequate amounts of assimilates under low light condition to meet the requirements of tiller emergence and grain growth because of the impaired photosynthetic rate.

Yoshida, S. (1981) observed that the low light intensity is one of the important constraints for lower yield in monsoon season has been reported by several workers. Solar radiation has profound impact on crop growth and productivity. During rainy season, photosynthesis is generally impaired because of the reduction in light intensity. This constitutes a major constraint to rice productivity in tropics.

Thangraj and Sivasubramaniam (1990) evaluated four varieties *viz.* IR-20, CO-43, ponni, white ponni by artificial shading (1/16" mesh size) to prevent 30-40 percent solar radiation. The low light intensity from panicle initiation to harvesting significantly reduced total dry matter, no. of panicles, No. of spikelets, filled grain and grain yield. Panni appeared to more tolerant with least reduction in grain yield (15.9%), followed by white ponni (23.4%), CO-43 (25.7%) and IR-20 (45.4%).

Hidema *et al.* (1991) observed that leaf chlorophyll content was lower in full sun conditions than in low irradiance environments.

Patma *et al.* (1993) revealed that low light yield caused by due to shading effect. The objective of study were to determine the effect of quantities of leaf litter and level of shading on rice

significantly greater under shading (No shading , 20% shading and 50% shading) the height of rice significantly greater under shading. The reduction of various yield components (i.e. no. of tillers, panicle per hills, number of grain per panicle) and increase in percent unfilled grain led to overall reduction in grain yield in under shade.

Murty *et al.* (1994) studied on the effect of 50% normal sunlight during reproductive and ripening stages on grain yield and yield parameters with elite restorers in hybrid rice breeding programmers. IR 19058-107-1, ARC11353 and Bhavani consistently showed higher yield under low light with least reduction in yield from normal light. The restorers recorded higher biomass as well as harvest index leading to greater sink potential and grain number/m². The yield was associated with both biomass and harvest index (HI) under low light, but only with HI under normal light. Evidently, selection of elite restorers for low light stress should be based on both high dry matter and harvest index.

Baig *et al.* (1996) conducted an experiment with six parents and 9 hybrids in dry season grown in field along with a control 'Swarnaprabha' to study the effect of low-light stress. Low light (50% of the normal light) was stimulated in the field by covering the plant population with suitable wooden screens. Low light was induced during reproductive and ripening stage of the crop. Controls were maintained under normal sun light of 300cal/ cm²/day in wet season and 420 cal/ cm²/day in dry season. In wet season, total dry matter, grain yield and harvest index were at par in the hybrids and parents under normal light but marginally higher in the later under low light. The yield was

significantly associated with total dry matter ($r=0.954^{**}$) and harvest index ($r=0.883^{**}$) under low light. During dry season, the Vajram and MTU-9992 recorded higher yield through greater dry matter and harvest index in normal and low light.

Voleti *et al.* (1996) studied the time course of grain filling pattern in two rice (*Oryza sativa* L.) cultivars, grown under normal and low light intensities. The number of spikelet's, partially filled grains and high density grains were monitored at 5 days interval during grain filling period from uniform panicles tagged at anthesis. The low light tolerant cultivar Swarnaprabha had more high density grains and less partially filled grains throughout the grain filling period and at harvest as compared to cultivar Ratna under both normal and low light intensities. The opening of spikelet's in two flushes in Swarnaprabha seemed to more efficient resource allocation and hence better yield as compared to Ratna, in which the opening of spikelets was in a single flush on day 10.

Cai *et al.* (1999) observed that the rice growth under 45% shading at different stages (early, middle 1, middle 2 and later stages) decreased the accumulation rate of dry matter and the uptake of nutrients but increased the nutrient content in rice plant which was affected its yield in varying degrees. Shading mainly decreased tiller number, effective panicle number, leaf area index and reduced yield by 11.56%, but increased plant height at early growth stage. At middle 1 stage, shading showed no significant influence on rice growth and the yield was reduced by only 5.46%. At middle 2 stages, shading mainly decreased grains per panicle, 1000 grain weight and the yield was reduced markedly by 30.80%. At later stage, shading decreased the

percentage of filled grains, 1000 grain weight, and the yield was the lowest reduced by 55.40%.

Kobata *et al.* (2000) reported that when rice is shaded during the early grain filling stage, shade does not affect the grain dry matter increment, nevertheless, if adequate assimilates are not available during the remainder of the grain filling stage, the final grain weight will be reduced significantly. Therefore, they speculate that under low light conditions, the ratio of source to sink in rice may decrease from the heading to maturity stages.

Nakano, H (2000) conducted a experiment on rice cv. Kibinohana and seedlings were grown in pots under 0, 50, 80 or 95% shading for 16 or 28 days after emergence and observed the heavy shading delayed heading and tillering. Under heavy shading, the number and culm diameter of tillers which emerged after 2 to 3 weeks were lower than under light shading. Under 95% shading, the number of tillers which emerged after 2 to 3 weeks, the survival rate and the spikelet number were lower than under light shading. The spikelet number and the percentage of ripened grains were low in late-emerging tillers the low light intensity decreased rice grain yield and quality with a poor production of tillers, impaired capacity for panicles to differentiate, an abnormal grain filling process.

Singh, S. (2000) reported that light is an important abiotic factor, which determines leaf area development. Low light intensity impacts on the plant morphology with great extent. The internodes of plants under low light intensity are generally longer which significantly leads to stem elongation. Leaves of plant have larger surface area than that of plant grown under

normal light. But the leaves and stems are extensively thinner, specifically leaves with one layer of palisade cells. Chlorophyll content of leaves increase under reduced light intensity. Low light stress (65% NL) in general caused significant increase in stature and foliage growth of rice plant (such as internodes', leaf sheath, leaf blade, leaf per tiller and per plant). While decreases in biological and economical yield remarkably in all the rice cultivars (especially Mansarovar and Pokkali) but did not affect the same in IR-50.

Ding *et al.* (2004) observed that the leaf length, leaf width, leaf area and growth duration significantly increased under low light condition.

Prabha *et al.* (2004) reported that low light has been a detrimental effect on the physiology and yield of the rice plant. The adverse effect is more predominant at the reproductive stage. Further, physiological parameters such as chlorophyll and soluble protein can be taken as selection indices for evaluating varieties grown under low light.

Swain and Nayak (2004) studied the effect of prolonged lowlight stress during reproductive phase and moisture stress at early stages on rate of maintenance respiration (R_m) in rice. Along with normal irradiance level, low light stress (50% of normal light) treatment was imposed from maximum tillering stage to maturity in five high yielding rice varieties (Ratna, IR-64, Swarnaprabha, IR_36, IR-72). Under light stress condition there was an increase in maintenance respiration at all growth stages over normal light. Swarnaprabha exhibited least increase in maintenance respiration(18%) followed by IR-36 (2500). Total biomass and grain weight decreased under low light by 30 and

36 per cent respectively. Swarnaprabha recorded least reduction in biomass and grain weight 25 and 29 per cent respectively.

Singh *et al.* (2005) reported that the solar radiation has a profound impact on crop growth and productivity. Shading during the vegetative growth phase slightly affects rice growth and yield, while shading during the reproductive phase has a pronounced effect on sink capacity (spikelet number per panicle and per unit land area). During ripening, shading markedly reduces grain yield because of a spurt in spikelet sterility.

Zhu *et al.* (2008) reported that low light tolerant varieties exhibit higher chlorophyll b and lower chlorophyll a/b content in their leaves as compared to those perform poorly in low light, when imposed low light for 15 d (treatment at the initial heading stage).

Golam, (2009) investigated that the effect of shade of the trees on the yield of paddy and green straw of two different rice varieties, local variety, Kazolshail and high yielding variety, BRRI-32. The yields of paddy of Kazolshail in the shaded and un-shaded area were 0.76 and 2.21 t ha⁻¹ respectively whereas; yields of paddy of BRRI-32 in the shaded and un-shaded area were 1.83 and 3.63 t ha⁻¹, respectively. The yields of green straw of Kazolshail in the shaded and un-shaded area were 4.89 and 10.11 t ha⁻¹, respectively and yield of green straw of BRRI-32 in the shaded and un-shaded area were 7.61 and 14.17 t ha⁻¹, respectively. The results revealed that the yield of paddy of Kazolshail and BRRI-32 in the unshaded area are 190.79% and 98.36% higher than in the shaded area, respectively. The yield of green straw of Kazolshail and BRRI-32 in the un-shaded area are

106.75% and 86.20% higher than in the shaded area respectively.

Goto *et al.* (2009) reported that when plants receive only low light during the reproductive stage, it generates a strong influence on rice grain yield and quality than those received low light during the vegetative stage.

Liu *et al.* (2009) reported that leaf chlorophyll a and b content during the grain filling stage is markedly enhanced in low light tolerant varieties after being treated by low light from the transplanting to the booting stages, whereas the opposite is found in varieties that perform poorly in low light.

Wang, (2011) observed that Chlorophyll a and b are important pigments involved in the absorption and transmission of solar energy with part of chlorophyll a involved in converting solar energy into electrochemical energy.

Yang *et al.* (2011) studied on effects of pre-flowering light deficiency on rice biomass production and physiology. The shading rates were set at 55% and 85% from jointing through initial heading stage. Natural light condition was set as the control of the experiment. They observed that yield of light deficient treatments (shading rates of 55% and 85%) dropped significantly by 48.25% and 70.54% compared with the control. The drop was mainly due to fewer numbers of spikes per plant and grains per panicle.

Deng *et al.* (2012) studied on effects of different growing stage shading (tillering stage, elongating-heading stage and filling stage) on rice grain-filling and yield with sixteen hybrid rice varieties. They reported that the grain filling and yield were

obviously affected by shading. During tillering stage, shading made the effective panicles reduce significantly, the filled grain degree and filled grain percentage decline by 3.00%, 4.03% respectively and the yield by 17.34%.

Sun *et al.* (2012) reported that hybrid rice *Chuanxiang 9838* with medium shade-endurance was taken as the test material to investigate the effects of different sowing dates and low-light stress at heading stage on the flag leaf photosynthetic rate $P(n)$, osmotic regulators, antioxidant enzyme activities and the grain yield of hybrid rice. Sowing date and low-light stress at heading stage had significant effects on the flag leaf $P(n)$ and antioxidant enzyme activities and plant dry matter accumulation at heading stage and the grain yield. With the delay of sowing date, the whole period of rice growth and development shortened notably, and the grain yield decreased to different degrees. Compared with the control, short term slight low-light stress (20% shading) at heading stage could relieve the harms from high temperature and strong light, and further, relieve the decrease of flag leaf $P(n)$ and plant dry matter accumulation at heading stage, adjust the flag leaf antioxidant enzyme activities, and moderately improve the seed setting rate. However, short-term medium low-light stress (40% shading) and serious low-light stress (60% shading) were not beneficial to the rice growth. The low light intensity decreases culm-sheath dry matter exports and translocation rates, which leads to an increase in the rate of culm-sheath dry matter weight compared with the total dry matter weight of shoots as well as a reduction in the dry matter weight of panicles.

Wang Li *et al.* (2012) studied the responses of five rice varieties to low-light stress at different growth stages through pot experiments under artificially controlled shading condition using white cotton yarn screen. By a completely randomized design, the pot experiments were carried out on the experimental farm of Sichuan Agricultural University in 2009. In experiment 1, one-layer and two-layer white cotton yarn screens, which shaded about 53% and 73% of the full light intensity respectively, were covered on the top of rice canopy of Gangyou 906 at tillering elongation stage, elongation-booting stage, booting-heading stage, and heading-maturing stage respectively. In experiment 2, the response of root system of II you 498, Gangyou 188, Gangyou 527 and Chuanxiang 9838 to shading was studied at tillering-elongation stage and booting-heading stage by covering with one-layer white cotton yarn screen. The screens were more than 2.0 m above the ground to ensure good ventilation and were large enough to fully cover the shaded plots. Plants without covers were set as control (CK). Root/shoot ratio, root volume, maximal root length, root total absorbing area, root active absorbing area and root alpha-naphthylamine oxidizing activity were analyzed at the end of shading treatment.

Bhagirath *et al.* (2013) conducted four different experiments in a screen house to determine the effects of shade on growth and grain yield of three weedy rice biotypes (WRM from Malaysia, WRS from Sri Lanka, and WRV from Vietnam) and one cultivated rice variety (Rc 222 from the Philippines). The shade regimes did not influence plant height of any weedy rice biotypes and cultivated rice however; the height was influenced by the biotypes. At full sunlight or continuous shade of 50%, shoot and root biomass of the WRV accession was greater than

other three biotypes. However, the continuous shade of 75% eliminated these differences among the biotypes. The shade treatments significantly reduced shoot and root biomass of cultivated rice as compared to full sunlight. However, such differences for weedy rice biotypes were observed at only 75% of shade or when plants were transferred from full sunlight to 75% of shade. Compared with the full sunlight, shoot biomass of cultivated rice declined by 57% and 72% when grown in 50% and 75% of shade respectively. The results show that shade through weed competitive cultivars and use of high seeding rate of cultivated rice can reduce weedy rice growth.

Du Yan xiu *et al.* (2013) reviewed research progress on the impact of low light stress on photosynthesis, vegetative growth, yield and quality of rice and noted that low light stress affected every aspect of vegetative growth (plant height, tiller number, root growth, stoma regulation and chlorophyll development), photosynthesis, dry matter accumulation and partition, and yield and quality of rice. Light not only provided energy for photosynthesis but was also a signal for photomorphogens. Plant light receptors sensed changes in ambient light signal (including light quantity/fluoresce, quality/wavelength, direction and duration) which correspondingly regulated photomorphogens. Shades induced low light stress in crops. Plant phytochromes detected changes of red/far-red light ratio under shade conditions, leading to a series of changes in morphological traits.

Hermann Restrepo *et al.* (2013) studied to assess the effect of two irradiance levels (100 and 50% natural light) at three different growth stages on yield and physiological characteristics of two rice cultivars (Fedearroz 50 and Fedearroz

733). The plants were exposed to low irradiance for 5 days consecutive by using black net cloth (about 50% of normal) at the panicle primordium, flowering and grain filling stages. The obtained results showed that the leaf chlorophyll content (SPAD readings) was higher in rice leaves under low irradiance. The chlorophyll content from the shade treatment apparently remained constant until the grain filling phase, then decreased slightly in the "F50" rice plants and remarkably in the "F733" plants. Stomatal conductance (gs) was negatively affected by shading, with the effect being more adverse in the "F733" plants. At the flowering and grain filling phases, grain yield was reduced by the low light treatments by around 20% in the "F50" plants. While, in "F733" they were only affected by shading at the grain filling stage, causing a decrease of around 25%. These results seem to indicate that "F773" may have a better capacity for partitioning dry matter than "F50" in spite of the fact that the gas exchange characteristics were conditioned by low irradiance conditions at the reproductive and ripening phases.

Gbadamosi *et al.* (2014) studied the effect of light regimes on the growth and yield of Nigerian local rice variety Ofada rice. Seeds were collected from Igbemo-Ekiti, Nigeria (lat7° 42'E and long 5° 24'N). They were pre-treated by soaking in water for 24 hours and sown in germinating trays filled with top-soil and watered regularly. A total of four troughs each with dimension of 2.5m × 1m × 0.25m were filled with top soil and flooded. Three seedlings hill-1 were transplanted at 20cm x 20cm spacing. Two days later, the troughs were covered with one, two and three layers of green colored fine mesh net to achieved 75%,50% and 25% light intensity respectively. The fourth trough (control) with no covering had 100% light intensity. Five hills from each trough

were randomly selected and measurements of height and number of tillers were taken at 25 and 45 days after transplanting. Growth and yield parameters such as plant heights (PH), total number of tillers per plant (TNOT), number of effective tillers (EFT), flag leaf length (FLL), panicle length (PANL), panicle weight (PANW), number of grain per panicle (NOG/P), number of spikelet per panicle (NSPP), number of filled and unfilled grain, 1000 grain weight (1000-GW), economic yield (EW), straw weight (SW) and harvest index (HI) were assessed. There were significant differences in PH, TNOT, EFT, number of unfilled grain per panicle, PANW, 1000-GW, HI, EY and BY. Plant height, TNOT, EFT, 1000-GW, EY increased with increasing light intensity while number of unproductive tillers increased with reduced light.

LIU Qi-hua *et al.* (2014) reported that Light intensity is one of the most important environmental factors that determine the basic characteristics of rice development. However, continuously cloudy weather or rainfall, especially during the grain-filling stage, induces a significant loss in yield and results in poor grain quality. Stress caused by low light often creates severe meteorological disasters in some rice-growing regions worldwide. This review was based on our previous research and related research regarding the effects of low light on rice growth, yield and quality as well as the formation of grain. Furthermore, we discussed why grain yield and quality are reduced under the low light environment. Next, we summarized the need for future research that emphasizes methods can effectively improve rice grain yield and quality under low light stress. These research findings can provide a beneficial reference for rice cultivation management and breeding program in low light environments.

Varon *et al.* (2015) reported that the rice plants are susceptible to low light or high temperature conditions during the reproductive and maturity stages. Two rice cultivars, Fedearroz 50 ('F50') and Fedearroz 733 ('F733') were planted on three planting dates, January 1st (PD1), February 15th (PD2) and April 1st (PD3) and exposed to different climatic conditions during the different stages of rice development. The various weather parameters, solar radiation fluctuated the most among the three different planting dates with PD1 having the highest number of days with values $\geq 450 \text{ cal}\cdot\text{cm}^{-2}\cdot\text{d}^{-1}$. The yield components were influenced by the planting time. PD3 showed the lowest number of tillers per unit of area and the highest percentage of sterility spikelets. With respect to grain yield, PD1 and PD3 performed better for both 'F50' and 'F733.' On the other hand, the optimum leaf area index was reached at approximately 85-90 days for both cultivars for all three different planting dates. Solar radiation had a high correlation with the biomass production (dry matter) and leaf area index. The rice planting date should be adjusted so that the reproductive stage and grain filling do not coincide mainly with periods of low solar radiation ($\leq 430 \text{ cal}\cdot\text{cm}^{-2}\cdot\text{d}^{-1}$) in tropical conditions.

2.2 To study the growth functions viz. AGR, RGR, NAR, LAI, SLW of various genotypes under low light intensity.

Asana and Salunke (1971) showed that there was a fairly good linear relation between the leaf area and the total dry matter between 12 and 36 and between 21 and 35 days after transplantation in the field and in pot culture, respectively. However NAR of the 3 varieties did not differ consistently. In general the NAR decreased during the first 5 weeks after

photosynthetic efficiency showed strong positive association with photosynthetic rate.

Janardhan and Murty (1980) studied eight cultivars of rice under normal and low light intensities. They observed that Relative Growth Rate (RGR) and NAR decreased but leaf area ratio (LAR) increased under low light. Ptb-10 and T141 maintain higher RGR and NAR than others even under low light. Elongation of leaf blade appears to be characteristics feature in increasing LAR under low light.

Sahu *et al.* (1980) reported that the low light intensity is likely to reduce the harvest index (HI) because of inadequate grain filling. The high photosynthesis rate may be strategized at low light with high light harvesting efficiency, high chlorophyll content, greater dry matter production and HI.

Burondkar (1985) studied 21 rice genotypes and reported remarkable differences in respect of Absolute Growth Rate (AGR), RGR, NAR and LAR amongst all the 21 varieties. The mean AGR values observed to be maximum during the period from 60-90 days after sowing. Maximum RGR values observed during the period from 30-60 days after sowing and thereafter gradual decline noticed in subsequent stage of growth. Mean NAR values were maximum during 60-90 days period after sowing in early and midlate varieties, whereas late varieties had maximum NAR during the period from 30-60 days after sowing. Study about leaf area ratio (LAR) revealed that all the genotypes had maximum mean leaf area ratio during the period from 30-60 days after sowing and thereafter gradual decline in subsequent stages.

Murty and Pattanaik (1986) examined 66 traditional indica rice varieties. They observed large variation in NAR during

20-40 DAT. NAR had high association with specific leaf weight, relative growth rate and total dry weight, whereas it had negative relation with leaf area ratio.

Chaturvedi *et al.* (1989) conducted an experiment during wet season with three rice cultivars- IR46, IR64 and mahsuri under shade and water deficit condition. Post flowering shade (50% reduction of incident radiation) 5 to 20 days after panicle emergence (DAPE) had a more adverse effect on yield than pre flowering shade from 10 to 25 days after panicle initiation (DAPI). Pre flowering shade resulted in reduce leaf area, tiller number and spikelet/ panicle, whereas, post flowering shade resulted filled spikelet fraction and grain weight. Crop growth rate (CGR) was reduced more by pre-flowering than by post flowering shade, but CGRs of both treatments were less than those of unshaded controls.

Thangaraj *et al.* (1990) studied on rice cv. IR20, Co43, Ponni and White Ponni which grown in the monsoon season under unshaded or shaded (30-40% reduction in solar radiation) from panicle initiation to harvest. Shading increased plant height, LAI and total leaf chlorophyll content and reduced tiller number and DM production. Grain yield was reduced from 5.09-5.84 to 3.19-4.28 t/ha by shading and the decrease was greatest (45.4%) in IR20 whereas, least (15.9%) in Ponni. The Panicles/m, spikelet's/panicle, grains/panicle, percentage filled grains and 1000 grains weight were decreased by shading.

Gautam and Sharma (1993) studied pattern and magnitude of variation due to planting schedules and plant densities on six growth parameters with three rice varieties of different growth duration. LAR decreased with increasing crop

age in all the years under all the planting schedules and plant densities. LAR and Leaf Area Duration (LAD) increased with increasing plant density. Rate of decrease in LAR was faster transplantation. As during this time the leaf sheath were not sufficiently exposed to make an appreciable contribution to the photosynthetic surface.

Hendrik Poorter, (1989) reported that large inter specific differences exist in the potential relative growth rate (RGR) of plants. Which physiological, morphological, chemical and/or allocation-related factors explain this variation in growth rate? In a first experiment growth of eight herbaceous wild species was analyzed, varying twofold in RGR. No correlation was found between RGR and the rate of photosynthesis per unit leaf area. The growth parameter net assimilation rate (NAR) was even negatively correlated with RGR. Biomass allocation to the leaves (leaf weight ratio, LWR) and the ratio between leaf area and leaf weight (specific leaf area, SLA) were positively correlated with RGR. There was an even stronger correlation between RGR and the ratio of total leaf area to total plant weight (leaf area ratio, LAR). RGR also correlated positively with the photosynthetic nitrogen use efficiency and the nitrogen productivity. The paramount importance of LAR and SLA in determining potential RGR was confirmed in a review of 60 prior publications. In general an inherently higher RGR was explained for 80 - 90% by a higher LAR and only for 10 - 20% by a higher NAR. Exceptions were found for shade species, trees and C4 species. The first two groups have a low potential RGR caused by a distinctly lower NAR. The low NAR of shade species in comparison with sun species is a consequence of their low maximum rate of photosynthesis. Trees have a lower NAR than herbaceous

species, at least partly caused by a difference in chemical composition. C₄ plants mostly showed higher values for NAR than C₃ plants. Differences in potential RGR between species are habitat related. Fast growing species are found in nutrient-rich environments with a relatively high supply of light and water. Inherently slow growing species can be found in all kinds of adverse environments. It is postulated that differences in RGR are a consequence of selection for traits underlying RGR, caused by the specific demands of a plant's environment. In a highly productive habitat with a dense canopy, a high LWR and a high SLA will improve the competitive ability of a species. Adaptation to an adverse environment, where physiological integrity of organs during a longer time is important will often decrease LWR and/or SLA. Differences in NAR are thought to be only of secondary importance.

Nayak *et al.* (1993) studied crop growth model for simulating rice growth under low light stress condition during wet season and observed that adaptable cultivar showed higher leaf area duration in wet season during post anthesis phase whereas converse trend was noticed in case of Non adoptable cv. Ratna.

Shaobing Peng, *et al.* (1993) reported that chlorophyll meter provides a simple, quick, and nondestructive method to estimate leaf N status of rice (*Oryza sativa* L.), but the linear relationship between leaf N concentration of a dry-weight basis (N_{dw}) and the meter reading differs depending on a developmental stage and genotype. The objective was to determine whether prediction of (N_{dw}) with the chlorophyll meter can be improved by a simple correction for specific leaf weight (SLW). Leaf N status

was estimated by a chlorophyll meter (SPAD-502) and measured directly by micro-Kjel-dahl procedure. Specific leaf weight was calculated as the ratio of dry weight to leaf area. In one field study 'IR72', measurements were taken at mid tillering, panicle initiation, and flowering stages on the uppermost fully expanded leaves of both N-deficient and N-sufficient plants. For another set of measurement made on the flag leaves of five genotypes grown in the field and greenhouse, prediction of N_{dw} was also improved, from $r^2 = 0.51$ based on SPAD values alone to $r^2 = 0.87$ based on the SPAD/SLW ratio. These results demonstrate that SLW influences the prediction of N_{dw} by the chlorophyll meter, and that the adjustment of SPAD values for SLW greatly increases the accuracy of the prediction. However, when SPAD values are adjusted for SLW, the chlorophyll meter's estimate of N_{dw} is no longer as quick, simple, or nondestructive as the non adjusted SPAD values.

Nanja Reddy *et al.* (1995) conducted a pot culture experiment to examine the influence of low light on photosynthetic characters of rice genotype differing in their net assimilation rates. At any given light intensity, high NAR types maintained relatively greater photosynthetic character compared to low NAR types.

Chauhan *et al.* (1996) studied the pattern of variation in physiological parameters at different growth stages. Amongst seven improved upland cultivars studied the highest LAD (63.3 days). It was maximum between 5 days after rice emergence (DARE) and flowering. Crop Growth Rate (CGR) and RGR followed the similar trend of variation. They further observed

that between 45 DARE and flowering NAR varied from 53 to 148 mm dm⁻² day. Attaining maximum value during 45 DARE and flowering.

Nanja Reddy *et al.* (1996) carried the four field experiments and found that LAI and LAD had a positive effect on TDM at flowering and at maturity. However, TDM from (lowering to maturity was negatively related with LAI and LAD during wet season suggested that the increase in source size beyond an optimum level does not increase the productivity.

Sahoo and Guru (1998) examined physiological aspects of 10 short duration cultivars of rice and found that LAR, RGR, NAR, CGR and LAD were positively associated with grain yield LAD between flowering to maturity and LAI and LAR at flowering were found to be suitable physiological parameters to fit in regression equation for predicting grain yield of rice. Amongst different cultivar studied, Sarathi exhibited highest values for LAI (6.7) LAR (68.3 cm/ g) and LAD (66.3 m² days) whereas the highest value for RGR, NAR and CGR was noticed in IR36.

Chauhan *et al.* (1999) studied 22 rainfed upland rice varieties and elite breeding lines and reported that net assimilation rate and leaf area duration between 30 and 45 days after rice emergence were significantly associated with dry matter accumulation at flowering.

Srinivasulu *et al.* (1999) conducted field experiment with an objective to study the growth performance of recently developed rice hybrids under different planting densities. Their observation revealed that rice hybrids recorded higher LAI, CGR, RGR and NAR over the conventional cv. Claitanya, particularly

during the early stage of growth these differences were narrowed down towards maturity.

Singh and Jain (2000) carried out morpho-physiological analysis of growth and yield in traditional tall and improved semi tall rice cultivar and found, the significant varietal differences for RGR at all growth stages. The RGR was found maximum during active tillering to panicle initiation stage and declined gradually with subsequent growth stages. Among the cultivars studied traditional tall cultivars manifested higher RGR than those of improved semi-tall ones during active tillering to panicle initiation stage, but registered lower values of the same during later growth stages. Varieties also showed significant difference in NAR and LAR during various 'growth stages. NAR and LAR showed inverse relation with each other in all the cultivars during various growth stages. CGR in general was highest during active tillering to panicle initiation stage and reduced subsequently.

San-oh *et al.* (2004) reported that the solar radiation and temperature showed a significant positive influence on the dry matter production and LAI of rice crop. The elasticity values were higher for the climatic variable solar radiation, indicating that a change in solar energy has a greater impact on the LAI than a change in temperature.

Ahmad *et al.* (2009) reported that the low light can affect the morphological, physiological and yield parameters of rice crops such as the plant height, source-sink relationships, LAI, crop growth rate (CGR), net assimilation rate (NAR), number of panicles per square meter and number of filled spikelet.

Thakur, A., *et al.* (2009) conducted experiments were in Bhubaneswar, Orissa, India, during the dry season (January–May) in 2008 and 2009 to investigate whether practices of the System of Rice Intensification (SRI), including alternate wetting and drying (AWD) during the vegetative stage of plant growth, could improve rice plants' morphology and physiology and what would be their impact on resulting crop performance, compared with currently recommended scientific management practices (SMP), including continuous flooding (CF) of paddies. With SRI practices, grain yield was increased by 48% in these trials at the same time, there was average water saving of 22% compared with inundated SMP rice. Water productivity with AWD-SRI management practices was almost doubled (0.68 g l^{-1}) compared to CF-SMP (0.36 g l^{-1}). Significant improvements were observed in the morphology of SRI plants in terms of root growth, plant/culm height, tiller number per hill, tiller perimeter, leaf size and number, leaf area index (LAI), specific leaf weight (SLW), and open canopy structure.

Ren Wan Jun *et al.* (2012) conducted an experiment with 9 rice genotypes, in which shading was applied with a transmittance of 51% (or 49% shading) and 31% (or 69% shading) starting from 10% panicle heading. Low-light stress significantly affected leaf characteristics with some inter-genotypic differences. The length and width of leaves in shading treatments were greater than those of the unshaded control. The average LAI of 49% shading was higher and that of 69% shading but was lower than that of the control. The SLA [specific leaf area] of the genotypes D You 68 and Gang You 22, and levels of chlorophyll a, chlorophyll b and chlorophyll a + b increased, while chlorophyll a/b decreased with a decrease in light

intensity. The relative dry matter weight of leaves in shading treatments was higher than that of the control.

Barmudoi, B. *et al.* (2016) investigated that the effects of low light (\approx mean PPFD169-493 $\mu\text{M s}^{-1}\text{m}^{-1}$), red light (\approx mean PPFD657843 $\mu\text{M s}^{-1}\text{m}^{-1}$) and normal light (\approx meanPPFD1061-1260 $\mu\text{M s}^{-1}\text{m}^{-1}$) on physiological changes including yield attributes, nutritional status at Panicle initiation (PI), flowering and harvest stages in winter rice (genotype: Monoharsali) under pot and field conditions. They were observed the reduction in available PPFD at flowering as compared to PI stage of the crop. The genotype exhibited significantly higher total dry matter (TDM) and lower leaf area index (LAI) values at normal light or red light than at reduced light situation. The bio economical yield and harvest index (HI) under normal light exceeded those at low light regime. The yield attributes viz., number of panicles, number of field grains per panicle, 1000 grain weight (test weight), high density (HD) grains, potential 1000 grain weight and sink capacity were superior at normal or red light to low light condition. The total carbohydrate content was higher in grains and sink capacity was maximum with the normal /red light illuminations at harvest stage. At PI stage, leaf nitrogen content was reduced by low light, but it increased at flowering stage significantly. Grain protein contents, under normal/red light exceeded its value at low light treatment. A positive correlation of most of the yield attributes with grain yield at normal/red light, and a negative correlation of these parameters were found at low light conditions.

CHAPTER – III

MATERIALS AND METHODS

The present investigation entitled “**Evaluation of rice (*Oryza sativa* L.) Genotypes for low light intensity**” was carried out at Regional Agricultural Research Station, Karjat, Dist. Raigad (MH) during *Kharif* 2017. The details of geographical area, climate and methodologies during the course of investigation are briefly described.

3.1 Geographical situation

Geographically, Karjat is situated in the western part of Maharashtra at 18°91’67” North latitude and 73°33’ East longitude with an altitude of 194 meters (636 ft) above the mean sea level with warm and humid conditions throughout the year. The mean annual precipitation is 3500 mm which is generally received during the month from June to October at the location. The meteorological data during the period of experimentation was recorded at the meteorological observatory of the Regional Agriculture Research Station, Karjat (Raigad). The detail of the meteorological data is presented in Appendix I. The soil of the experimental site is medium black.

3.2 Weather condition during crop growth period

The meteorological data of Rainfall, Rainy days, Temperature Humidity and Humidity from June to November 2017 has been furnished in Appendix-I

3.3 Experimental details

The experiment was laid out in three replication of low light (Shade Net) and normal light (Without Shade Net) condition using *factorial* RBD during *kharif*, 2017. The experiment details are given below:

Crop	: Rice
Season	: <i>Kharif</i> 2017
Design	: <i>Factorial</i> Randomized Block Design
Rice entries	: 16
Plot size	: 3×1 m ²
Number of treatments	: 02
Number of replications	: 03
Date of nursery sowing	: 22 th June, 2017
Date of transplanting	: 17 th July, 2017
Spacing	: Plant to Plant - 15 cm : Row to Row - 20 cm
Treatments details	T1 : Control (Without Shade Net) T2 : Low light (Shade Net)

3.4 Experimental design

The experiment comprised of sixteen varieties of rice laid out in *factorial* randomized block design with three replications in artificial shading and open condition. The seeds were sown on 22th June 2017 on raised beds. After 26 days, seedlings were transplanted with spacing of 20 cm between row and 15 cm between plants in rows with plot size 3 x 1 m. for each variety in the plot. The field experiment was conducted at normal fertility level on lateritic soil. Fertilizers applications were done @ 100 kg N, 50 kg P₂O₅ and 50 kg K₂O per hectare. Intercultural operations were carried out in open and shade condition at a time.

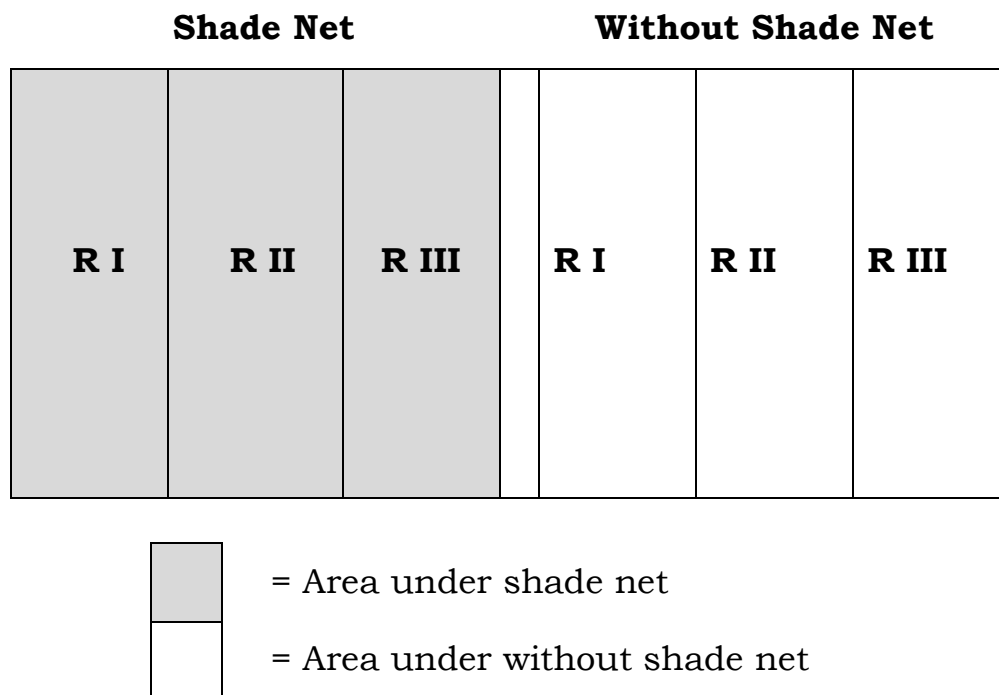


Fig 1. Experimental design

3.5 Construction of shade condition

The plots were artificially shaded by using 50 per cent shade net. Such that 50-60 per cent of natural light was only received by the crop canopy. The shades were erected in the field in the form of tents. The net was fastened tight to the wire which served as a lining connecting the wooden (bamboo) supports all round both at the bottom and top of the supports. The shade constructed leaving one foot height space from the ground open for ventilation.

The material used to construct artificial shade

1. 50 per cent shade net of 20m×12 m. size with 3 pieces.
2. 45 wooden poles (bamboo) i.e. : 30 poles of 6 feet
: 15 poles of 9 feet
3. Iron wire (15 kg.)

The natural incidence of light intensity received was 41.05 Klux (Wet season) measured with luxmeter.

Thirty days seedlings were transplanted with recommended spacing of 20cm×15cm.

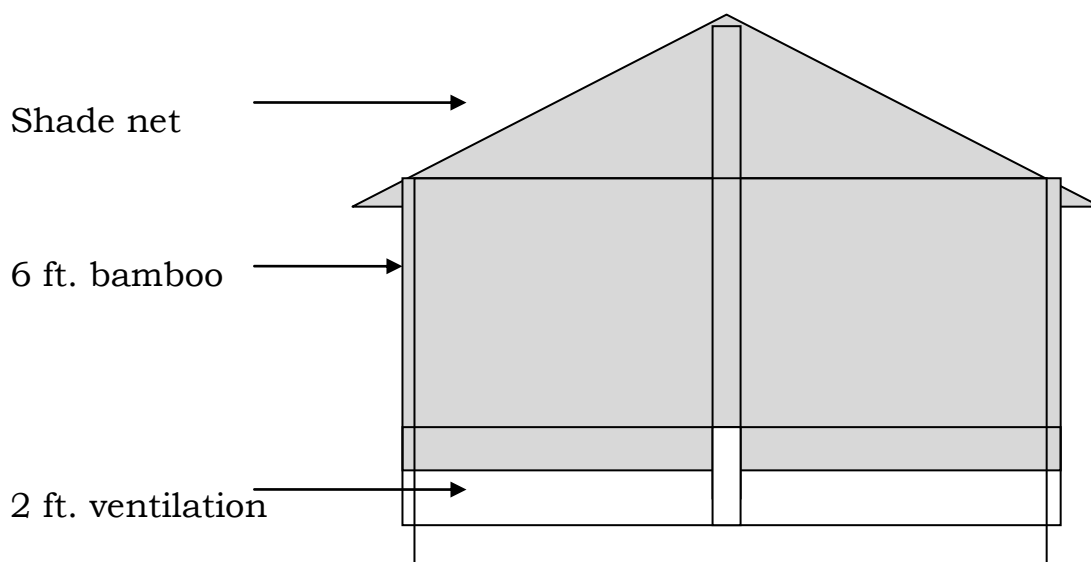


Fig.2. Front view of artificial shade net

3.6 Experimental materials

The following materials were used for study which comprised of 16 rice genotypes and Karjat-7 & Swarnaprabha included as check variety. The tested rice genotypes material was collected from Regional Agricultural Research Station, Karjat, Dist. Raigad.

Sr. No.	Name of the entries
1.	Sahyadri-5
2.	Karjat-8
3.	Karjat-9
4.	Ratnagiri-4
5.	Ratnagiri-5
6.	Palghar-2

7.	Phondaghat-1
8.	Karjat -1-1-12-24-1-13
9.	Karjat -5-17-25-29-6
10.	Karjat -5-10-10-16-13
11.	Karjat -BM4
12.	Karjat -6-22-9-14-13
13.	Karjat -5-8-13-15-7
14.	Karjat -5-7-10-12-2
15.	Karjat- 7 (Check Variety)
16.	Swarnaprabha (Check Variety)

3.7 Cultural practices

3.7.1 Raising of nursery

Well pulverized raised nursery beds were prepared. The size of each nursery beds were 1 x 0.25 m² and drainage channel of 30 cm width was provided between the beds. The basal dose of fertilizers was given at the time of nursery bed preparation @ 100 kg N, 50 kg P₂O₅ and 50 kg K₂O ha⁻¹. The seeds were sown in the raised nursery bed by hand drilling methods in rows, using 50 g seeds per meter square. Light and frequent irrigation were given until the seedlings were transplanted.

3.7.2 Field preparation

The final preparation of the field was done by two criss-cross tractor ploughing followed by harrowing. The soil surface was leveled well and the field was divided into three replications and it was laid out as per plan.

3.7.3 Fertilizer application

The fertilizers were applied as per the requirement of crop 100:50:50 kg ha⁻¹ N:P:K was applied in the form of urea, DAP and

MOP respectively. The half dose of N was applied as basal dressing and the rest half Nitrogen was applied in three split dose first 50% at 10-15 day after transplanting, 2nd 25% at active tillering and 3rd 25% at panicle initiation (PI) days after transplanting. The whole amount of phosphorus and potash was applied as basal during transplanting.

3.7.4 Transplanting

The 26 days old seedlings were transplanted in the field and Shade Net. The transplanting was done on 17th July, 2017. The one seedling was planted in each hill.

3.7.5 Light imposed studies

Low light treatment was imposed immediately after transplanting by enclosing the plots in Shade Net whereas, plants grown in field without shaded condition.

3.7.6 Weed management

The crop was kept free throughout its growth period for avoiding crop weed competition. The hand weeding was done during the crop growth.

3.7.7 Water management

After transplanting the soil was kept saturated until planted seedling get established and 5±2 cm standing water level was maintained until grain hardening stage (10 days prior to harvesting) in both low light and normal light condition. The water was drained out from the field prior to every top dressing of nitrogen and reflooded again for 24 hours.

3.7.8 Plant protection

Plant protection measures were adopted when required during the crop growth period.

3.7.9 Harvesting and threshing

The experimental crop plants were harvested from 24th October to 17th November, 2017 with the help of *Vaibhav* sickles by manual labors. Harvested produce was left on the plot itself for sun drying. After sun drying the produce was weighed plot wise. The material was threshed with the help of wooden sticks. The threshed material from each plot was kept separately and grains were separated from the chaff and straw by winnowing with the help of *supa* and clean grain were weight.

3.8 Recording observation

Following observations will be recorded at 20 days interval till the physiological maturity :

A) Morphological parameters

1. Days to 50% flowering
2. Days to maturity
3. No of tillers per plant
4. No of productive tillers per plant
5. Leaf area per plant
6. Leaves per plant
7. Stem weight per plant (g)
8. Leaf weight per plant (g)
9. Total dry weight per plant (g)
10. Plant height (cm)

B) Biophysiological parameters

Chlorophyll content (mg/g) at 30 and 50 days after transplanting (Lium, B.W. and Showaf, T.W. 1976.) DMSO Method

C) Physiological parameters

1. Light intensity as 10 days interval

D) Growth parameters

1. Absolute Growth Rate (AGR)
2. Relative Growth Rate (RGR)
3. Net Assimilation Rate (NAR)
4. Leaf Area Index (LAI)
5. Specific Leaf Weight (SLW)

E) Yield and yield attributes

1. Total number of spikelets per panicle
2. Number of filled spikelets per panicle
3. Panicle length (cm)
4. 1000 grain weight (g)
5. Grain yield per plant (g)
6. Straw weight per plant (g)
7. Harvest Index (%).

3.9 Morphological parameters**3.9.1 Days to 50 % flowering**

The number of days required for flowering in almost half of the plant population is termed as days to 50% flowering. After visual observations was recorded for each treatment.

3.9.2 Days to maturity

The maturity stage was determined, when the stamens of spikelet are completely yellow and dried. The stage was also determined by grain hardness.

3.9.3 Number of tillers per plant

The number of tillers was counted during the dry matter sampling of hills (three) at flowering stage and was expressed in tillers plant⁻¹.

3.9.4 Number of productive tillers per plant

The number of productive tiller were counted during the dry matter sampling of hills (three) at flowering stage and was expressed in productive tillers plant⁻¹.

3.9.5 Leaf area per plant (dcm²)

Leaf area per plant was calculated with the help of formula given by Tsunoda (1964).

L.A. = Length of the leaf ■ Breadth of the leaf ■ Correlation factor (0.725)

3.9.6 Number of leaves per plant

The Number of green leaves on the five randomly selected plants was recorded and then the average number of leaves per plant was calculated.

3.9.7 Stem weight per plant (g)

The panicle and leaf portion was detached and stem portion of the rice was oven dried at 60°C for 36 to 48 hours. After complete oven drying, the stem weight of rice was recorded (g/m²).

3.9.8 Leaf weight per plant (g)

The panicle and stem portion was detached and leaf portion of the rice plant was oven dried at 60°C for 36 to 48 hours. After complete oven drying, the leaf weight was recorded (g/m²)

3.9.9 Total dry weight per plant (g)

The panicle, leaf and stem portion of the rice plants were oven dried at 60°C for 36 to 48 hours. After complete oven drying, the dry matter of was recorded (g/m²).

3.9.10 Plant height (cm)

Plant height was recorded randomly selected three tagged plants in each plot. The height was recorded in centimeter from ground level to uppermost leaf tip at flowering stage.

3.10 Biophysiological parameter

3.10.1 Total Chlorophyll contents a and b (mg/g fresh weight)

Chlorophyll content (mg/g) at 30 and 50 days after transplanting (Lium, B.W. and Showaf, T.W. 1976.) DMSO Method

1. 500 mg of dry leaf tissue was taken, cut into small pieces and suspended in test tubes containing 2 ml. of Dimethyl Sulphoxide (DMSO).
2. Test tubes were incubated at 60°C for 20 min in a water bath.
3. The supernatant was decanted and another 3 ml. of DMSO was added to the residue and incubated at 60°C for 20 min.
4. The supernatants were pooled and the volume was made up to 10 ml. by adding DMSO.
5. The chlorophyll extract was transferred to a cuvette and the absorbance was read in a Spectrophotometer (Genesys, UK) at 645 nm and 663 nm against DMSO blank Chlorophyll a, Chlorophyll b, total chlorophyll and chlorophyll a/b ratio were calculated by the following formulae:

Total chlorophyll (mg/g fresh wt.)

$$= [20.2 \times A_{645} + 8.02 \times A_{663}] \frac{V}{W \times 100}$$

Where,

A_{663} is the absorbance at 663 nm and

A_{645} is the absorption at 645 nm.

W = Weight of sample

V= Volume of the solution

3.11 Physiological parameters

3.11.1 Light intensity (Lux)

The light intensity was monitored with the help of light meter at 11:00 am. every 10 days of interval after transplanting.

3.12 Growth parameters

3.12.1 Absolute Growth Rate (AGR) (g day⁻¹)

AGR was calculated from total dry matter accumulation by using formula given by Redford (1967). It is expressed in g/day.

$$\text{AGR} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W_2 and W_1 refer as weight of total dry matter per plant at time t_2 and t_1 , respectively in days.

3.12.2 Relative Growth Rate (RGR) (g g⁻¹ day⁻¹)

The increase in dry weight per unit original dry weight of the plant per unit time is called relative growth rate. The RGR was calculated according the following formula (Leopold, 1964).

$$\text{RGR} = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Where,

W_1 = dry weight of the whole plant at start of the test period.

W_2 = dry weight of whole plant at the end of the test period.

$(t_2 - t_1)$ = period in weeks between initial and final observations.

3.12.3 Net Assimilation Rate (NAR) (g dcm⁻² day⁻¹)

Net assimilation rate is the net gain of assimilates (net photosynthesis) per unit of leaf area and time. It is expressed in g/cm²/day⁻¹. Net assimilation rate was calculated with the following formula (Watson 1947).

$$\text{Net assimilation rate} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e L_2 - \log_e L_1}{L_2 - L_1}$$

Where,

w_1 = Total dry weight of plant in g at time t_1

w_2 = Total dry weight of plant in g at time t_2

t_1 = Initial time of observation

t_2 = Final time of observation

l_1 = Leaf area plant⁻¹ at time t_1

l_2 = Leaf area plant⁻¹ at time t_2

3.12.4 Leaf Area Index (LAI)

Three plant samples were taken from the experimental plot at 50% flowering stage and the mother tillers were separated and all the leaves were removed and kept into a beaker to avoid the leaf rolling. The maximum length and width of leaves were measured and was kept till constant weight. Similarly, leaves from rest of the tillers were removed and was kept for drying up to constant weight. For leaf area, a factor 0.725 was used (Gomez, 1972). Leaf area index was calculated as follows:

Leaf area= Length (cm) x Width (cm) × Correction factor (K)

$$\text{Leaf area index} = \frac{\text{Leaf area (cm)}}{\text{Total ground area (cm)}}$$

3.12.5 Specific Leaf Weight (SLW) (g cm²)

SLW is the ratio between leaf dry weight (LW) and leaf area (LA). It gives as an idea about the thickness of the leaf.

$$\text{SLW} = \frac{\text{LW}}{\text{LA}}$$

3.13 Yield and yield attributes

3.13.1 Total number of spikelet per panicle

The observation on number of spikelet panicle⁻¹ was made at harvesting stage. Ear bearing spikelet were counted from each plot by using 0.25 meter square from each plot and then number of spikelet panicle⁻¹ m⁻² were worked out.

3.13.2 Number of filled spikelet per panicle

Number of filled spikelet panicle⁻¹ was measured after the harvesting and from the total spikelet; filled spikelet were counted and separated manually.

3.13.3 Panicle length (cm)

The length of panicle was measured from base to the tip of panicle in centimeters at the time of harvest.

3.13.4 Thousand grain weight (g)

One thousand healthy seeds were counted from the bulk produce of one plant and were dried in an oven at 60°C for 20-24 hours and weighed after proper drying through electronic balance.

3.13.5 Grain yield per plant (g)

The weight of grains (filled) of each plant in gram per meter square was recorded. Grain yield was taken from plot, the whole plot after harvesting was threshed and the yield was taken out.

3.13.6 Straw weight per plant (g)

After removing the panicles the dry matter (straw) obtained from five plants were dried in sunlight, weighted and recorded in grams and mean was calculated.

3.13.7 Harvest index (%)

The ratio of economic yield (seed) to the total above ground biomass at harvest (Synder and Carlson, 1984) was calculated by following formula.

$$\text{Harvest index (HI)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

3.14 Statistical analysis

3.14.1 Analysis of variance

Experimental data were analyzed statistically adopting the technique of analysis of variance (ANOVA) for *factorial* Randomized Block Design. The level of significance was observed at 5 percent and 1 percent probability (Gomez and Gomez, 1984).

3.14.2 Mean

The mean was recorded by summing up all the observation and then dividing by the total number of observations.

$$\bar{X} = \frac{\sum x}{n}$$

Where,

\bar{X} = Sum of all observations

n = Total number of observations

3.14.2 Descriptive analysis

Descriptive analysis (mean, critical difference and Standard error) of Morphological, Bio-physiological, Physiological, Growth parameters and Yield and yield attributed under shade net and without shade net condition.

3.14.3 Critical difference

CD = S Ed × t value at 5% at error degree of freedom

$$S\ Ed = \sqrt{\frac{2EMS}{r}}$$

Where,

SEd = Standard error of difference between two treatment means

EMS = Error mean sum of square

r = Number of replications

3.14.4 Standard error of mean

$$SEm = \sqrt{\frac{EMS}{r}}$$

Where,

SEm = Standard mean of difference between two treatment

EMS = Error mean sum of square

r = Number of replications

CHAPTER - IV

EXPERIMENTAL RESULTS

The present investigation entitled “**Evaluation of rice (*Oryza sativa* L.) genotypes for low light intensity**” was carried out at Regional Agricultural Research Station, Karjat, Dist. Raigad (MS) during *Kharif* 2017.

The main objective of the experiment was identification of such rice genotypes which will be essential for developing high yielding varieties that can be survive in low light condition. The experimental findings of the present investigation have been described under the following heads:

- 4.1 Morphological parameters
- 4.2 Biophysiological parameters
- 4.3 Physiological parameters
- 4.4 Growth parameters
- 4.5 Yield and yield attributes

4.1 Morphological parameters

4.1.1 Effects of light treatment on days to 50% flowering

The result on effects of normal and low light on days to 50% flowering of rice is presented in Table 1 and Fig. 3.

As regards treatment it was observed that the mean differences in days to 50% flowering were differed significantly. Significantly maximum days to 50% flowering were observed in T₂ than T₁ treatment.

In case of genotypes, mean days to 50% flowering differ significantly. Significantly more days to 50% flowering (110.3 days) were observed in Karjat-1-1-12-24-1-13 and Swarnaprabha which was at par with Karjat-8 over other genotypes. In case of interaction, mean of days to 50% flowering

differs significantly. Karjat-1-1-12-24-1-13 and Swarnaprabha

Table 1 Effects of normal light (Without Shade Net) and low light (Shade Net) on days to 50% flowering of rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction of days
Sahyadri-5 (G ₁)	105.3	108.3	106.8	2.8
Karjat-8 (G ₂)	107.7	109.7	108.7	1.9
Karjat-9 (G ₃)	92.7	95.3	94.0	2.9
Ratnagiri-4 (G ₄)	76.7	80.0	78.3	4.3
Ratnagiri-5 (G ₅)	69.3	72.3	70.8	4.3
Palghar-2 (G ₆)	97.0	100.3	98.7	3.4
Phondaghat-1 (G ₇)	99.0	103.7	101.3	4.7
Karjat-1-1-12-24-1-13 (G ₈)	106.7	110.3	108.5	3.4
Karjat-5-17-25-29-6 (G ₉)	98.3	101.3	99.8	3.1
Karjat-5-10-10-16-13 (G ₁₀)	89.7	92.7	91.2	3.3
Karjat-BM4 (G ₁₁)	93.7	97.7	95.7	4.3
Karjat-6-22-9-14-13 (G ₁₂)	101.7	104.3	103.0	2.6
Karjat-5-8-13-15-7 (G ₁₃)	103.7	107.3	105.5	3.5
Karjat-5-7-10-12-2 (G ₁₄)	99.7	102.7	101.2	3.0
Karjat-7 (G ₁₅)	94.7	98.7	96.7	4.2
Swarnaprabha (G ₁₆)	106.3	110.3	108.3	3.8
Mean	96.4	99.7		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.7071	0.2501		
Treatment	0.2500	0.0884		
Interaction (G × T)	0.9999	0.3537		
DAT – Days after transplanting T ₁ – Without Shade Net T ₂ – Shade Net				

showed maximum days to 50% flowering in T₂ than others. Among the genotypes in T₁ treatment average days to 50% flowering was 96.4 days to be recorded, while genotype Karjat-8 (107.7 days) recorded higher days to 50% flowering than average days to 50% flowering.

4.1.2 Effects of light treatment on days to maturity

The result on effects of normal and low light on days to maturity of rice is presented in Table 2 and Fig. 4.

As regards treatment it was observed that the mean differences in days to maturity were differed significantly.

Significantly maximum days to maturity were observed in T₂ than T₁ treatment.

Table 2 Effects of normal light (Without Shade Net) and low light (Shade Net) on days to maturity of rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction of days
Sahyadri-5 (G ₁)	141.0	143.7	142.3	1.9
Karjat-8 (G ₂)	140.0	145.3	142.7	3.8
Karjat-9 (G ₃)	120.0	124.7	122.3	3.9
Ratnagiri-4 (G ₄)	112.0	115.7	113.8	3.3
Ratnagiri-5 (G ₅)	98.3	100.0	99.2	1.7
Palghar-2 (G ₆)	125.3	130.0	127.7	3.7
Phondaghat-1 (G ₇)	127.7	129.7	128.7	1.6
Karjat-1-1-12-24-1-13 (G ₈)	139.3	142.7	141.0	2.4
Karjat-5-17-25-29-6 (G ₉)	130.0	132.7	131.3	2.1
Karjat-5-10-10-16-13 (G ₁₀)	125.0	128.7	126.8	2.9
Karjat-BM4 (G ₁₁)	130.0	133.3	131.7	2.6
Karjat-6-22-9-14-13 (G ₁₂)	135.0	137.3	136.2	1.7
Karjat-5-8-13-15-7 (G ₁₃)	137.3	139.0	138.2	1.2
Karjat-5-7-10-12-2 (G ₁₄)	134.7	138.3	136.5	2.7
Karjat-7 (G ₁₅)	125.3	130.0	127.7	3.7
Swarnaprabha (G ₁₆)	138.3	139.7	139.0	1.0
Mean	128.7	131.9		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.8423	0.2979		
Treatment	0.2978	0.1053		
Interaction (G × T)	1.1911	0.4213		
DAT – Days after transplanting T ₁ – Without Shade Net T ₂ – Shade Net				

In case of genotypes, mean days to maturity differ significantly. Significantly more days to maturity (145.3 days) were observed in Karjat-8 over other genotypes. In case of interaction, mean of days to maturity differs significantly. Karjat-8 showed maximum days to maturity in T₂ than others. Among the genotypes in T₁ treatment average days to maturity was 128.7 days to be recorded, while genotype Sahyadri-5 (141.0 days) recorded higher days to maturity than average days to maturity.

4.1.3 Effects of light treatment on number of tillers per plant

The result on effects of normal and low light on number of tillers per plant of rice at various growth stages are presented in Table 3(a), (b) & (c). Data indicated that number of tillers per plant increased continuously from 20 days after transplanting to harvest and the increase in number of tillers was more between 40 to 80 days after transplanting as compared to other stages.

As regards treatment it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in number of tillers per plant were differed significantly. Significantly higher number of tillers per plant was observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (2.3) were observed in Ratnagiri-4, Ratnagiri-5 which was at par with Sahyadri-5, and Palghar-2 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at 20 DAT. Ratnagiri-4 and Ratnagiri-5 showed higher numbers of tillers in T₁ than others. Among the genotypes in T₂ treatment average number of tillers was 1.4 tillers per plant to be recorded, while genotype Palghar-2 (1.8) recorded higher tillers than average number of tillers per plant.

At 40 DAT, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (3.6) were observed in Ratnagiri-4 which was at par with Sahyadri-5 and Ratnagiri-5 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at 40 DAT. Ratnagiri-4 showed higher numbers of tillers in T₁ than others. Among the genotypes in T₂ treatment average

number of tillers was 2.0 tillers per plant to be recorded, while genotype Palghar-2 (2.4) recorded higher tillers than average number of tillers per plant.

At 60 DAT, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (5.7) were observed in Ratnagiri-4 which was at par with Sahyadri-5, Ratnagiri-5 and Palghar-2 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at 60 DAT. Ratnagiri-4 showed higher numbers of tillers in T_1 than others. Among the genotypes in T_2 treatment average number of tillers was 3.3 tillers per plant to be recorded, while genotype Palghar-2 (3.8) recorded higher tillers than average number of tillers per plant.

At 80 DAT, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (6.7) were observed in Ratnagiri-4 which was at par with Sahyadri-5 and Ratnagiri-5 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at 80 DAT. Ratnagiri-4 showed higher numbers of tillers in T_1 than others. Among the genotypes in T_2 treatment average number of tillers was 4.4 tillers per plant to be recorded, while genotype Palghar-2 (4.8) recorded higher tillers than average number of tillers per plant.

At 100 DAT, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (7.6) were observed in Ratnagiri-4 which was at par with Ratnagiri-5, Karjat-7 and Sahyadri-5 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at 100 DAT. Ratnagiri-4 showed higher numbers of tillers in T_1 than others. Among the genotypes in T_2 treatment

Table 3(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of tillers per plant of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	2.2	1.7	1.9	25.0	3.4	2.2	2.8	35.5
Karjat-8 (G ₂)	2.1	1.3	1.7	36.8	2.9	2.2	2.6	23.1
Karjat-9 (G ₃)	2.1	1.3	1.7	36.8	3.1	2.2	2.7	28.6
Ratnagiri-4 (G ₄)	2.3	1.7	2.0	28.6	3.6	2.3	2.9	34.4
Ratnagiri-5 (G ₅)	2.3	1.7	2.0	28.6	3.3	2.3	2.8	30.0
Palghar-2 (G ₆)	2.2	1.8	2.0	20.0	3.1	2.4	2.8	21.4
Phondaghat-1 (G ₇)	2.1	1.3	1.7	36.8	3.2	1.8	2.5	44.8
Karjat-1-1-12-24-1-13 (G ₈)	2.1	1.3	1.7	36.8	3.2	2.1	2.7	34.5
Karjat-5-17-25-29-6 (G ₉)	1.8	1.3	1.6	25.0	3.0	2.1	2.6	29.6
Karjat-5-10-10-16-13 (G ₁₀)	2.0	1.1	1.6	44.4	3.1	1.8	2.4	42.9
Karjat-BM4 (G ₁₁)	1.3	1.0	1.2	25.0	2.2	1.6	1.9	30.0
Karjat-6-22-9-14-13 (G ₁₂)	1.7	1.4	1.6	13.3	2.7	2.0	2.3	25.0
Karjat-5-8-13-15-7 (G ₁₃)	1.8	1.1	1.4	37.5	2.8	1.7	2.2	40.0
Karjat-5-7-10-12-2 (G ₁₄)	1.7	1.2	1.4	26.7	2.7	1.7	2.2	37.5
Karjat-7 (G ₁₅)	2.0	1.4	1.7	27.8	2.9	1.9	2.4	34.6
Swarnaprabha (G ₁₆)	1.9	1.4	1.7	23.5	2.8	1.9	2.3	32.0
Mean	2.0	1.4			3.0	2.0		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1862	0.0659			0.2440	0.0863		
Treatment	0.0658	0.0233			0.0863	0.0305		
Interaction (G × T)	0.2633	0.0931			0.3450	0.1221		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 3(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of tillers per plant of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	5.6	3.6	4.6	36.0	6.6	4.6	5.6	30.5
Karjat-8 (G ₂)	5.1	3.4	4.3	32.6	6.1	4.3	5.2	29.1
Karjat-9 (G ₃)	4.9	3.4	4.2	29.5	6.1	4.4	5.3	27.3
Ratnagiri-4 (G ₄)	5.7	3.6	4.6	37.3	6.7	4.6	5.6	31.7
Ratnagiri-5 (G ₅)	5.6	3.7	4.6	34.0	6.6	4.7	5.6	28.8
Palghar-2 (G ₆)	5.4	3.8	4.6	30.6	6.3	4.8	5.6	24.6
Phondaghat-1 (G ₇)	5.2	3.1	4.2	40.4	6.1	4.1	5.1	32.7
Karjat-1-1-12-24-1-13 (G ₈)	5.3	3.2	4.3	39.6	6.2	4.2	5.2	32.1
Karjat-5-17-25-29-6 (G ₉)	4.9	3.3	4.1	31.8	5.9	4.4	5.2	24.5
Karjat-5-10-10-16-13 (G ₁₀)	5.0	3.1	4.1	37.8	6.0	4.2	5.1	29.6
Karjat-BM4 (G ₁₁)	4.4	2.8	3.6	37.5	5.4	3.8	4.6	30.6
Karjat-6-22-9-14-13 (G ₁₂)	4.9	3.1	4.0	36.4	5.4	4.6	5.0	16.3
Karjat-5-8-13-15-7 (G ₁₃)	4.6	3.2	3.9	29.3	5.3	4.2	4.8	20.8
Karjat-5-7-10-12-2 (G ₁₄)	4.8	3.1	3.9	34.9	5.2	4.2	4.7	19.1
Karjat-7 (G ₁₅)	5.3	3.4	4.4	35.4	5.8	4.3	5.1	25.0
Swarnaprabha (G ₁₆)	5.2	3.4	4.3	34.0	5.9	4.3	5.1	26.4
Mean	5.1	3.3			6.0	4.4		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1862	0.0659			0.2440	0.0863		
Treatment	0.0658	0.0233			0.0863	0.0305		
Interaction (G × T)	0.2633	0.0931			0.3450	0.1221		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 3(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of tillers per plant of rice (*Oryza sativa* L.)

Genotypes	100 DAT				At harvest			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	7.2	5.2	6.2	27.7	7.1	5.2	6.2	26.6
Karjat-8 (G ₂)	6.3	5.3	5.8	15.8	6.3	5.3	5.8	15.8
Karjat-9 (G ₃)	6.2	5.2	5.7	16.1	6.1	5.2	5.7	14.5
Ratnagiri-4 (G ₄)	7.6	5.3	6.4	29.4	7.4	5.3	6.4	28.4
Ratnagiri-5 (G ₅)	7.4	5.4	6.4	26.9	7.2	5.4	6.3	24.6
Palghar-2 (G ₆)	7.0	5.6	6.3	20.6	6.9	5.6	6.2	19.4
Phondaghat-1 (G ₇)	6.9	5.1	6.0	25.8	6.6	5.1	5.8	22.0
Karjat-1-1-12-24-1-13 (G ₈)	6.8	5.2	6.0	23.0	6.8	5.2	6.0	23.0
Karjat-5-17-25-29-6 (G ₉)	6.7	5.1	5.9	23.3	6.7	5.1	5.9	23.3
Karjat-5-10-10-16-13 (G ₁₀)	6.3	4.9	5.6	22.8	6.3	4.9	5.6	22.8
Karjat-BM4 (G ₁₁)	5.9	4.4	5.2	24.5	5.9	4.4	5.2	24.5
Karjat-6-22-9-14-13 (G ₁₂)	6.4	5.3	5.9	17.2	6.4	5.3	5.9	17.2
Karjat-5-8-13-15-7 (G ₁₃)	6.3	5.0	5.7	21.1	6.3	5.0	5.7	21.1
Karjat-5-7-10-12-2 (G ₁₄)	6.2	4.8	5.5	23.2	6.2	4.8	5.5	23.2
Karjat-7 (G ₁₅)	7.3	5.2	6.3	28.8	7.3	5.2	6.3	28.8
Swarnaprabha (G ₁₆)	7.0	5.2	6.1	25.4	7.0	5.1	6.1	27.0
Mean	6.7	5.2			6.7	5.1		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1862	0.0659			0.2440	0.0863		
Treatment	0.0658	0.0233			0.0863	0.0305		
Interaction (G × T)	0.2633	0.0931			0.3450	0.1221		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

average number of tillers was 5.2 tillers per plant to be recorded, while genotype Palghar-2 (5.6) recorded higher tillers than average number of tillers per plant.

At harvest, in case of genotypes, mean number of tillers per plant differ significantly. Significantly higher numbers of tillers per plant (7.4) were observed in Ratnagiri-4 which was at par with Karjat-7, Ratnagiri-5 and Sahyadri-5 over other genotypes. In case of interaction, mean of tillers per plant differs significantly at harvest. Ratnagiri-4 showed higher number of tillers in T₁ than others. Among the genotypes in T₂ treatment average number of tillers was 5.1 tillers per plant to be recorded, while genotype Palghar-2 (5.6) recorded higher tillers than average number of tillers per plant.

4.1.4 Effects of light treatment on number of productive tillers per plant

The result on effects of normal and low light on number of productive tillers per plant of rice at harvesting stage is presented in Table 4 and Fig. 5.

As regards treatment it was observed that in the at harvest stage the mean differences in number of productive tillers per plant were significantly. Significantly higher number of productive tillers per plant was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean number of productive tillers per plant differs significantly at harvest. Significantly higher numbers of productive tillers per plant (6.47) were observed in Ratnagiri-4. Ratnagiri-4 showed higher number of productive tillers in T₁ than others. Among the genotypes in T₂ treatment average number of productive tillers was 4.40 tillers per plant to

Table 4 Effects of normal light (Without Shade Net) and low light (Shade Net) on number of productive tillers per plant of rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	6.13	4.73	5.43	22.8
Karjat-8 (G ₂)	5.60	4.33	4.97	22.6
Karjat-9 (G ₃)	5.53	4.53	5.03	18.1
Ratnagiri-4 (G ₄)	6.47	4.73	5.60	26.8
Ratnagiri-5 (G ₅)	6.13	4.93	5.53	19.6
Palghar-2 (G ₆)	5.87	5.13	5.50	12.5
Phondaghat-1 (G ₇)	5.47	4.47	4.97	18.3
Karjat-1-1-12-24-1-13 (G ₈)	5.07	4.27	4.67	15.8
Karjat-5-17-25-29-6 (G ₉)	5.33	4.13	4.73	22.5
Karjat-5-10-10-16-13 (G ₁₀)	5.67	4.40	5.03	22.4
Karjat-BM4 (G ₁₁)	5.20	3.73	4.47	28.2
Karjat-6-22-9-14-13 (G ₁₂)	5.47	4.33	4.90	20.7
Karjat-5-8-13-15-7 (G ₁₃)	5.27	4.00	4.63	24.1
Karjat-5-7-10-12-2 (G ₁₄)	5.40	4.13	4.77	23.5
Karjat-7 (G ₁₅)	5.60	4.47	5.03	20.2
Swarnaprabha (G ₁₆)	5.53	4.00	4.77	27.7
Mean	5.61	4.40		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.1964	0.0695		
Treatment	0.0694	0.0246		
Interaction (G × T)	0.2778	0.0983		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

be recorded, while genotype Palghar-2 (5.13) recorded higher tillers than average number of tillers per plant.

4.1.5 Effects of light treatment on leaf area per plant (dcm²)

The result on effects of normal and low light on leaf area per plant (dcm²) of rice at various growths stages are presented in Table 5(a), (b) & (c). Data indicated that leaf area per plant increased continuously from 20 days after transplanting to harvest and the increase in leaf area was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatment it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in leaf

area per plant were differed significantly. Significantly higher leaf area per plant were observed in T₂ at 40, 60, 80, 100 DAT and at harvest except 20 DAT than T₁ treatment.

At 20 DAT, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (188.4 dcm²) was observed in Ratnagiri-4 which was at par with Sahyadri-5 over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at 20 DAT. Ratnagiri-4 showed higher leaf area per plant in T₁ than others. Among the genotypes in T₂ treatment average leaf area per plant was 114.1 dcm² to be recorded, while genotype Palghar-2 (155.7 dcm²) recorded higher leaf area than average leaf area per plant.

At 40 DAT, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (502.0 dcm²) was observed in Palghar-2 which was at par with Ratnagiri-5, Karjat-6-22-9-14-13 and Swarnaprabha over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at 40 DAT. Palghar-2 showed higher leaf area per plant in T₂ than others. Among the genotypes in T₁ treatment average leaf area per plant was 397.6 dcm² to be recorded, while genotype Swarnaprabha (477.5 dcm²) recorded higher leaf area than average leaf area per plant.

At 60 DAT, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (2012.0 dcm²) was observed in Palghar-2 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at 60 DAT. Palghar-2 showed higher leaf area per plant in T₂ than others. Among the genotypes in T₁ treatment average leaf area per plant was 1159.2

dcm² to be recorded, while genotype Ratnagiri-4 (1503.7 dcm²) recorded higher leaf area than average leaf area per plant.

At 80 DAT, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (2133.1 dcm²) was observed in Palghar-2 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at 80 DAT. Palghar-2 showed higher leaf area per plant in T₂ than others. Among the genotypes in T₁ treatment average leaf area per plant was 1302.8 dcm² to be recorded, while genotype Ratnagiri-4 (1702.7 dcm²) recorded higher leaf area than average leaf area per plant.

At 100 DAT, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (2223.0 dcm²) was observed in Palghar-2 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at 100 DAT. Palghar-2 showed higher leaf area per plant in T₂ than others. Among the genotypes in T₁ treatment average leaf area per plant was 1383.5 dcm² to be recorded, while genotype Ratnagiri-4 (1839.0 dcm²) recorded higher leaf area than average leaf area per plant.

At harvest, in case of genotype, mean leaf area per plant differs significantly. Significantly higher leaf area per plant (2215.8 dcm²) was observed in Palghar-2 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaf area per plant differs significantly at harvest. Palghar-2 showed higher leaf area per plant in T₂ than others. Among the genotypes in T₁ treatment average leaf area per plant was 1387.3 dcm² to be recorded, while genotype Ratnagiri-4 (1878.9 dcm²) recorded higher leaf area than average leaf area per plant.

Table 5(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf area per plant (dcm²) of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	183.3	133.4	158.4	27.2	393.7	474.5	434.1	-20.5
Karjat-8 (G ₂)	155.7	135.2	145.4	13.2	423.3	428.4	425.9	-1.2
Karjat-9 (G ₃)	154.4	104.6	129.5	32.3	397.7	426.1	411.9	-7.2
Ratnagiri-4 (G ₄)	188.4	140.3	164.3	25.5	378.6	454.4	416.5	-20.0
Ratnagiri-5 (G ₅)	179.4	144.3	161.8	19.6	398.9	496.5	447.7	-24.5
Palghar-2 (G ₆)	162.0	155.7	158.8	3.9	385.8	502.0	443.9	-30.1
Phondaghat-1 (G ₇)	118.3	94.3	106.3	20.3	457.4	425.3	441.4	7.0
Karjat-1-1-12-24-1-13 (G ₈)	99.8	114.7	107.2	-14.9	354.3	468.4	411.4	-32.2
Karjat-5-17-25-29-6 (G ₉)	131.1	99.1	115.1	24.4	406.8	366.3	386.5	10.0
Karjat-5-10-10-16-13 (G ₁₀)	130.0	89.0	109.5	31.6	370.6	379.7	375.1	-2.4
Karjat-BM4 (G ₁₁)	92.7	91.1	91.9	1.7	342.9	336.7	339.8	1.8
Karjat-6-22-9-14-13 (G ₁₂)	115.4	105.3	110.4	8.8	419.1	479.9	449.5	-14.5
Karjat-5-8-13-15-7 (G ₁₃)	97.2	107.9	102.5	-11.0	411.5	453.8	432.6	-10.3
Karjat-5-7-10-12-2 (G ₁₄)	103.0	85.7	94.4	16.8	362.5	363.7	363.1	-0.3
Karjat-7 (G ₁₅)	134.4	93.0	113.7	30.8	381.0	393.0	387.0	-3.1
Swarnaprabha (G ₁₆)	135.0	132.6	133.8	1.8	477.5	465.5	471.5	2.5
Mean	136.3	114.1			397.6	432.1		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	4.60	1.63			27.38	9.69		
Treatment	1.63	0.58			9.68	3.42		
Interaction (G × T)	6.51	2.30			38.72	13.70		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 5(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf area per plant (dcm²) of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	1191.2	1595.1	1393.1	-33.9	1412.4	1830.4	1621.4	-29.6
Karjat-8 (G ₂)	1162.0	1387.5	1274.7	-19.4	1362.5	1537.5	1450.0	-12.8
Karjat-9 (G ₃)	1017.4	1493.3	1255.4	-46.8	1086.7	1708.8	1397.8	-57.3
Ratnagiri-4 (G ₄)	1503.7	1600.6	1552.2	-6.4	1702.7	1675.5	1689.1	1.6
Ratnagiri-5 (G ₅)	1373.9	1820.6	1597.3	-32.5	1598.3	1951.4	1774.9	-22.1
Palghar-2 (G ₆)	1199.9	2012.0	1606.0	-67.7	1347.5	2133.1	1740.3	-58.3
Phondaghat-1 (G ₇)	1056.3	1676.1	1366.2	-58.7	1196.9	1784.9	1490.9	-49.1
Karjat-1-1-12-24-1-13 (G ₈)	996.8	1529.7	1263.2	-53.5	1091.9	1665.6	1378.8	-52.5
Karjat-5-17-25-29-6 (G ₉)	1182.6	1353.6	1268.1	-14.5	1267.1	1520.4	1393.7	-20.0
Karjat-5-10-10-16-13 (G ₁₀)	1109.3	1662.1	1385.7	-49.8	1219.9	1754.5	1487.2	-43.8
Karjat-BM4 (G ₁₁)	980.1	1072.8	1026.5	-9.5	1197.0	1298.7	1247.9	-8.5
Karjat-6-22-9-14-13 (G ₁₂)	1140.5	1691.3	1415.9	-48.3	1273.4	1733.0	1503.2	-36.1
Karjat-5-8-13-15-7 (G ₁₃)	989.8	1327.2	1158.5	-34.1	1110.9	1497.3	1304.1	-34.8
Karjat-5-7-10-12-2 (G ₁₄)	1208.0	1319.3	1263.6	-9.2	1251.3	1360.4	1305.9	-8.7
Karjat-7 (G ₁₅)	1175.2	1135.3	1155.3	3.4	1359.0	1356.0	1357.5	0.2
Swarnaprabha (G ₁₆)	1260.0	1259.7	1259.8	0.0	1366.7	1354.5	1360.6	0.9
Mean	1159.2	1496.0			1302.8	1635.1		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	124.36	43.99			131.17	46.40		
Treatment	43.97	15.55			46.38	16.41		
Interaction (G × T)	175.86	62.21			185.51	65.62		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 5(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf area per plant (dcm²) of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	1488.8	1943.3	1716.0	-30.5	1503.3	1963.6	1733.5	-30.6
Karjat-8 (G ₂)	1437.7	1624.6	1531.2	-13.0	1412.9	1643.6	1528.2	-16.3
Karjat-9 (G ₃)	1177.4	1843.7	1510.5	-56.6	1181.6	1846.8	1514.2	-56.3
Ratnagiri-4 (G ₄)	1839.0	1784.4	1811.7	3.0	1878.9	1815.2	1847.0	3.4
Ratnagiri-5 (G ₅)	1707.1	2078.2	1892.7	-21.7	1712.9	2096.8	1904.9	-22.4
Palghar-2 (G ₆)	1458.5	2223.0	1840.7	-52.4	1470.3	2215.8	1843.0	-50.7
Phondaghat-1 (G ₇)	1264.1	1866.0	1565.1	-47.6	1241.5	1836.3	1538.9	-47.9
Karjat-1-1-12-24-1-13 (G ₈)	1172.3	1776.0	1474.1	-51.5	1119.0	1798.0	1458.5	-60.7
Karjat-5-17-25-29-6 (G ₉)	1347.9	1626.8	1487.4	-20.7	1398.1	1606.0	1502.1	-14.9
Karjat-5-10-10-16-13 (G ₁₀)	1285.5	1810.4	1547.9	-40.8	1307.9	1815.4	1561.6	-38.8
Karjat-BM4 (G ₁₁)	1257.7	1341.2	1299.4	-6.6	1262.7	1300.8	1281.8	-3.0
Karjat-6-22-9-14-13 (G ₁₂)	1330.9	1828.1	1579.5	-37.4	1339.8	1840.8	1590.3	-37.4
Karjat-5-8-13-15-7 (G ₁₃)	1183.8	1584.9	1384.4	-33.9	1197.7	1609.4	1403.5	-34.4
Karjat-5-7-10-12-2 (G ₁₄)	1339.5	1444.6	1392.0	-7.8	1303.4	1451.6	1377.5	-11.4
Karjat-7 (G ₁₅)	1399.9	1449.4	1424.6	-3.5	1420.1	1464.8	1442.4	-3.1
Swarnaprabha (G ₁₆)	1445.5	1530.6	1488.1	-5.9	1446.0	1546.0	1496.0	-6.9
Mean	1383.5	1734.7			1387.3	1740.7		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	130.16	46.04			135.55	47.95		
Treatment	46.02	16.28			47.92	16.95		
Interaction (G × T)	184.08	65.11			191.69	67.81		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

4.1.6 Effects of light treatment on number of leaves per plant

The result on effects of normal and low light on number of leaves per plant of rice at various growth stages are presented in Table 6(a), (b) & (c). Data indicated that number of leaves per plant increased continuously from 20 days after transplanting to harvest and the increase in leaves was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in number of leaves per plant were differed significantly. Significantly higher number of leaves per plant were observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (8.9) were observed by Ratnagiri-4 and Palghar-2 which was at par with Sahyadri-5, Karjat-9 and Ratnagiri-5 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at 20 DAT. Ratnagiri-4 and Palghar-2 showed higher number of leaves per plant in T₁ than others. Among the genotypes in T₂ treatment average number of leaves per plant was 6.0 to be recorded, while genotype Karjat-8 (7.7) recorded higher number of leaves than average number of leaves per plant.

At 40 DAT, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (17.9) were observed by Ratnagiri-4 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at 40 DAT. Ratnagiri-4 showed higher numbers of leaves per plant in T₁ than others.

Among the genotypes in T₂ treatment average number of leaves per plant was 11.4 to be recorded, while genotype Palghar-2 (13.4) recorded higher number of leaves than average number of leaves per plant.

At 60 DAT, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (31.9) were observed by Ratnagiri-4 which was at par with Ratnagiri-5 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at 60 DAT. Ratnagiri-4 showed higher numbers of leaves per plant in T₁ than others. Among the genotypes in T₂ treatment average number of leaves per plant was 23.2 to be recorded, while genotype Palghar-2 (26.6) recorded higher number of leaves than average number of leaves per plant.

At 80 DAT, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (32.4) were observed by Ratnagiri-4 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at 80 DAT. Ratnagiri-4 showed higher numbers of leaves per plant in T₁ than others. Among the genotypes in T₂ treatment average number of leaves per plant was 23.8 to be recorded, while genotype Palghar-2 (27.4) recorded higher number of leaves than average number of leaves per plant.

At 100 DAT, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (32.8) were observed by Ratnagiri-4 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at 100 DAT. Ratnagiri-4 showed higher numbers of leaves per plant in T₁ than others. Among the genotypes in T₂ treatment average number of leaves per plant was 23.9 to be

Table 6(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of leaves per plant of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	8.6	6.2	7.4	27.3	16.1	12.2	14.2	24.1
Karjat-8 (G ₂)	7.4	7.7	7.6	-3.0	15.7	11.8	13.7	24.8
Karjat-9 (G ₃)	8.4	6.1	7.3	27.6	15.9	11.4	13.7	28.0
Ratnagiri-4 (G ₄)	8.9	5.9	7.4	33.8	17.9	12.3	15.1	31.1
Ratnagiri-5 (G ₅)	8.8	6.6	7.7	25.3	17.2	12.4	14.8	27.7
Palghar-2 (G ₆)	8.9	6.9	7.9	22.5	14.3	13.4	13.9	6.2
Phondaghat-1 (G ₇)	7.1	5.3	6.2	25.0	14.2	11.7	12.9	18.0
Karjat-1-1-12-24-1-13 (G ₈)	8.0	5.4	6.7	31.9	14.6	11.6	13.1	20.6
Karjat-5-17-25-29-6 (G ₉)	8.1	5.3	6.7	34.2	15.8	11.1	13.4	29.6
Karjat-5-10-10-16-13 (G ₁₀)	7.4	5.9	6.7	20.9	13.4	10.3	11.9	23.1
Karjat-BM4 (G ₁₁)	6.1	5.0	5.6	18.2	11.8	9.2	10.5	21.7
Karjat-6-22-9-14-13 (G ₁₂)	6.8	5.9	6.3	13.1	14.4	10.7	12.6	26.2
Karjat-5-8-13-15-7 (G ₁₃)	6.7	5.2	5.9	21.7	12.4	10.4	11.4	16.1
Karjat-5-7-10-12-2 (G ₁₄)	6.6	5.4	6.0	16.9	14.8	10.1	12.4	31.6
Karjat-7 (G ₁₅)	8.0	6.3	7.2	20.8	15.7	12.1	13.9	22.7
Swarnaprabha (G ₁₆)	7.9	6.2	7.1	21.1	15.0	12.0	13.5	20.0
Mean	7.7	6.0			15.0	11.4		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.6077	0.2150			0.7051	0.2494		
Treatment	0.2149	0.0760			0.2493	0.0882		
Interaction (G × T)	0.8595	0.3040			0.9971	0.3527		

DAT – Days after transplanting

T₁ – Without Shade Net

T₂ – Shade Net

Table 6(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of leaves per plant of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	28.4	24.9	26.7	12.5	29.2	25.4	27.3	12.9
Karjat-8 (G ₂)	25.8	22.4	24.1	12.9	27.2	22.9	25.1	15.9
Karjat-9 (G ₃)	24.4	23.8	24.1	2.7	25.3	24.4	24.9	3.5
Ratnagiri-4 (G ₄)	31.9	24.3	28.1	23.7	32.4	24.8	28.6	23.6
Ratnagiri-5 (G ₅)	29.6	26.0	27.8	12.0	30.7	26.6	28.6	13.4
Palghar-2 (G ₆)	26.7	26.6	26.6	0.4	27.4	27.4	27.4	0.0
Phondaghat-1 (G ₇)	21.2	21.9	21.6	-3.1	22.3	22.9	22.6	-2.5
Karjat-1-1-12-24-1-13 (G ₈)	24.4	23.2	23.8	5.0	26.6	23.7	25.1	10.9
Karjat-5-17-25-29-6 (G ₉)	25.9	22.3	24.1	13.7	25.9	23.3	24.6	9.9
Karjat-5-10-10-16-13 (G ₁₀)	22.6	22.1	22.3	2.0	23.0	22.7	22.8	1.4
Karjat-BM4 (G ₁₁)	22.1	20.2	21.2	8.5	22.8	21.4	22.1	5.9
Karjat-6-22-9-14-13 (G ₁₂)	23.8	22.6	23.2	5.1	24.4	23.0	23.7	5.9
Karjat-5-8-13-15-7 (G ₁₃)	24.2	22.6	23.4	6.9	24.9	23.1	24.0	7.1
Karjat-5-7-10-12-2 (G ₁₄)	22.8	21.0	21.9	7.8	24.2	21.6	22.9	11.0
Karjat-7 (G ₁₅)	24.2	23.6	23.9	2.8	24.8	24.1	24.4	2.7
Swarnaprabha (G ₁₆)	24.8	23.6	24.2	4.9	25.7	24.1	24.9	6.1
Mean	25.2	23.2			26.1	23.8		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	1.0210	0.3612			0.7261	0.2569		
Treatment	0.3610	0.1277			0.2567	0.0908		
Interaction (G × T)	1.4439	0.5108			1.0269	0.3633		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 6(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on number of leaves per plant of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	29.2	25.0	27.1	14.4	29.4	26.0	27.7	11.7
Karjat-8 (G ₂)	27.3	23.2	25.3	15.0	27.4	23.6	25.5	14.2
Karjat-9 (G ₃)	25.6	23.8	24.7	7.0	27.8	24.7	26.2	11.2
Ratnagiri-4 (G ₄)	32.8	25.0	28.9	23.7	32.9	26.9	29.9	18.2
Ratnagiri-5 (G ₅)	30.7	26.9	28.8	12.3	30.9	27.8	29.3	10.1
Palghar-2 (G ₆)	27.7	27.8	27.7	-0.4	28.0	29.6	28.8	-5.6
Phondaghat-1 (G ₇)	22.6	23.1	22.8	-2.5	22.9	24.3	23.6	-6.3
Karjat-1-1-12-24-1-13 (G ₈)	26.9	23.9	25.4	11.2	28.7	24.3	26.5	15.1
Karjat-5-17-25-29-6 (G ₉)	26.1	23.8	24.9	8.9	28.2	23.8	26.0	15.7
Karjat-5-10-10-16-13 (G ₁₀)	23.2	23.0	23.1	1.0	24.6	24.7	24.6	-0.5
Karjat-BM4 (G ₁₁)	21.9	20.8	21.3	5.1	23.0	22.0	22.5	4.3
Karjat-6-22-9-14-13 (G ₁₂)	24.7	23.3	24.0	5.4	25.8	25.1	25.4	2.6
Karjat-5-8-13-15-7 (G ₁₃)	25.1	23.4	24.3	6.6	26.2	26.9	26.6	-2.5
Karjat-5-7-10-12-2 (G ₁₄)	24.4	21.9	23.2	10.5	26.9	23.8	25.3	11.6
Karjat-7 (G ₁₅)	25.6	23.1	24.3	9.6	25.7	24.3	25.0	5.2
Swarnaprabha (G ₁₆)	26.2	24.2	25.2	7.6	27.6	24.8	26.2	10.1
Mean	26.2	23.9			27.2	25.2		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.6180	0.2186			0.5968	0.2111		
Treatment	0.2185	0.0773			0.2110	0.0746		
Interaction (G × T)	0.8739	0.3091			0.8439	0.2985		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

recorded, while genotype Palghar-2 (27.8) recorded higher number of leaves than average number of leaves per plant.

At harvest, in case of genotype, mean number of leaves per plant differs significantly. Significantly higher leaves per plant (32.9) were observed by Ratnagiri-4 over other genotypes. In case of interaction, mean of leaves per plant differs significantly at harvest. Ratnagiri-4 showed higher numbers of leaves per plant in T₁ than others. Among the genotypes in T₂ treatment average number of leaves per plant was 25.2 to be recorded, while genotype Palghar-2 (29.6) recorded higher number of leaves than average number of leaves per plant.

4.1.7 Effects of light treatment on stem weight per plant (g)

The result on effects of normal and low light on stem weight per plant (g) of rice at various growths stages are presented in Table 7(a), (b) & (c). Data indicated that stem weight per plant increased continuously from 20 days after transplanting to harvest and the increase in stem weight was more between 20 to 80 days after transplanting as compared to other stages. As regards treatment it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in stem weight per plant were differed significantly. Significantly higher stem weight per plant were observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (0.453g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at 20 DAT. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 0.188g to be recorded, while

genotypes Palghar-2 (0.254g) recorded higher stem weight than average stem weight per plant.

At 40 DAT, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (2.815g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at 40 DAT. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 1.036g to be recorded, while genotypes Palghar-2 (1.407g) recorded higher stem weight than average stem weight per plant.

At 60 DAT, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (11.263g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at 60 DAT. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 5.143g to be recorded, while genotypes Palghar-2 (6.197g) recorded higher stem weight than average stem weight per plant.

At 80 DAT, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (19.17g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at 80 DAT. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 8.847g to be recorded, while genotype Palghar-2 (10.066g) recorded higher stem weight than average stem weight per plant.

Table 7(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on stem weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.350	0.204	0.277	41.7	2.217	1.055	1.636	52.4
Karjat-8 (G ₂)	0.361	0.176	0.269	51.2	1.788	0.845	1.316	52.7
Karjat-9 (G ₃)	0.381	0.184	0.282	51.8	1.715	0.920	1.317	46.4
Ratnagiri-4 (G ₄)	0.453	0.167	0.310	63.0	2.815	1.102	1.958	60.8
Ratnagiri-5 (G ₅)	0.392	0.221	0.306	43.7	2.575	1.220	1.898	52.6
Palghar-2 (G ₆)	0.379	0.254	0.317	33.0	2.291	1.407	1.849	38.6
Phondaghat-1 (G ₇)	0.322	0.192	0.257	40.3	1.886	1.054	1.470	44.1
Karjat-1-1-12-24-1-13 (G ₈)	0.379	0.191	0.285	49.5	1.737	0.965	1.351	44.5
Karjat-5-17-25-29-6 (G ₉)	0.371	0.156	0.264	57.9	1.663	0.962	1.313	42.1
Karjat-5-10-10-16-13 (G ₁₀)	0.350	0.199	0.274	43.2	2.034	1.029	1.532	49.4
Karjat-BM4 (G ₁₁)	0.321	0.146	0.234	54.7	1.532	0.807	1.169	47.3
Karjat-6-22-9-14-13 (G ₁₂)	0.310	0.191	0.250	38.4	1.916	1.041	1.479	45.7
Karjat-5-8-13-15-7 (G ₁₃)	0.357	0.185	0.271	48.1	1.781	0.979	1.380	45.0
Karjat-5-7-10-12-2 (G ₁₄)	0.399	0.171	0.285	57.1	1.676	1.013	1.345	39.5
Karjat-7 (G ₁₅)	0.375	0.185	0.280	50.6	1.950	1.038	1.494	46.8
Swarnaprabha (G ₁₆)	0.382	0.188	0.285	50.8	1.834	1.137	1.486	38.0
Mean	0.368	0.188			1.963	1.036		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0112	0.0040			0.0458	0.0162		
Treatment	0.0040	0.0014			0.0162	0.0057		
Interaction (G × T)	0.0159	0.0056			0.0648	0.0229		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 7(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on stem weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	9.609	5.543	7.576	42.3	16.26	9.45	12.85	41.9
Karjat-8 (G ₂)	8.203	4.839	6.521	41.0	13.90	8.22	11.06	40.9
Karjat-9 (G ₃)	7.748	4.971	6.360	35.8	13.14	8.51	10.82	35.2
Ratnagiri-4 (G ₄)	11.263	5.481	8.372	51.3	19.17	9.39	14.28	51.0
Ratnagiri-5 (G ₅)	10.483	5.748	8.115	45.2	17.80	9.85	13.83	44.7
Palghar-2 (G ₆)	9.907	6.197	8.052	37.4	16.79	10.66	13.72	36.5
Phondaghat-1 (G ₇)	8.482	5.383	6.933	36.5	14.37	9.18	11.78	36.1
Karjat-1-1-12-24-1-13 (G ₈)	7.683	4.872	6.278	36.6	12.98	8.44	10.71	34.9
Karjat-5-17-25-29-6 (G ₉)	7.379	4.805	6.092	34.9	12.44	8.30	10.37	33.3
Karjat-5-10-10-16-13 (G ₁₀)	8.903	5.286	7.095	40.6	14.91	9.13	12.02	38.8
Karjat-BM4 (G ₁₁)	6.698	4.317	5.507	35.5	11.43	7.52	9.48	34.2
Karjat-6-22-9-14-13 (G ₁₂)	7.871	4.728	6.300	39.9	13.21	8.06	10.64	39.0
Karjat-5-8-13-15-7 (G ₁₃)	7.365	5.074	6.219	31.1	12.52	8.87	10.70	29.2
Karjat-5-7-10-12-2 (G ₁₄)	7.249	4.990	6.120	31.2	12.29	8.80	10.54	28.4
Karjat-7 (G ₁₅)	8.191	4.965	6.578	39.4	13.75	8.47	11.11	38.4
Swarnaprabha (G ₁₆)	8.353	5.088	6.720	39.1	14.09	8.71	11.40	38.2
Mean	8.462	5.143			14.317	8.847		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1143	0.0404			0.1996	0.0706		
Treatment	0.0404	0.0143			0.0706	0.0250		
Interaction (G × T)	0.1617	0.0572			0.2823	0.0999		

DAT – Days after transplanting

T₁ – Without Shade Net

T₂ – Shade Net

Table 7(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on stem weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	21.28	12.29	16.79	42.2	21.63	12.50	17.06	42.2
Karjat-8 (G ₂)	18.20	10.68	14.44	41.3	18.56	10.85	14.71	41.5
Karjat-9 (G ₃)	17.21	11.04	14.12	35.9	17.59	11.22	14.41	36.2
Ratnagiri-4 (G ₄)	25.11	12.23	18.67	51.3	25.56	12.39	18.98	51.5
Ratnagiri-5 (G ₅)	23.30	12.84	18.07	44.9	23.69	13.06	18.37	44.9
Palghar-2 (G ₆)	21.95	13.92	17.94	36.6	22.33	14.18	18.25	36.5
Phondaghat-1 (G ₇)	18.80	11.96	15.38	36.4	19.12	12.15	15.64	36.4
Karjat-1-1-12-24-1-13 (G ₈)	17.01	10.97	13.99	35.5	17.39	11.16	14.28	35.8
Karjat-5-17-25-29-6 (G ₉)	16.32	10.77	13.54	34.0	16.69	10.92	13.81	34.6
Karjat-5-10-10-16-13 (G ₁₀)	19.60	11.88	15.74	39.4	19.95	12.08	16.02	39.5
Karjat-BM4 (G ₁₁)	14.96	9.74	12.35	34.9	15.28	9.89	12.59	35.3
Karjat-6-22-9-14-13 (G ₁₂)	17.40	10.52	13.96	39.6	17.71	10.71	14.21	39.5
Karjat-5-8-13-15-7 (G ₁₃)	16.43	11.52	13.97	29.9	16.79	11.70	14.25	30.3
Karjat-5-7-10-12-2 (G ₁₄)	16.13	11.37	13.75	29.5	16.53	11.54	14.03	30.2
Karjat-7 (G ₁₅)	18.10	11.05	14.57	38.9	18.47	11.23	14.85	39.2
Swarnaprabha (G ₁₆)	18.47	11.35	14.91	38.5	18.85	11.54	15.20	38.8
Mean	18.767	11.507			19.134	11.695		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.2541	0.0899			0.2539	0.0898		
Treatment	0.0898	0.0318			0.0898	0.0318		
Interaction (G × T)	0.3593	0.1271			0.3591	0.1270		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

At 100 DAT, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (25.11g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at 100 DAT. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 11.507g to be recorded, while genotype Palghar-2 (13.92g) recorded higher stem weight than average stem weight per plant.

At harvest, in case of genotype, mean stem weight per plant differ significantly. Significantly higher stem weight per plant (25.56g) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of stem weight per plant differs significantly at harvest. Ratnagiri-4 showed higher stem weight per plant in T₁ than others. Among the genotypes in T₂ treatment average stem weight per plant was 11.695g to be recorded, while genotypes Palghar-2 (14.18g) recorded higher stem weight than average stem weight per plant.

4.1.8 Effects of light treatment on leaf weight per plant (g)

The result on effects of normal and low light on leaf weight per plant (g) of rice at various growths stages are presented in Table 8 (a), (b) & (c). Data indicated that leaf weight per plant increased continuously from 20 days after transplanting to harvest and the increase in leaf weight was more between 20 to 80 days after transplanting as compared to other stages. As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in leaf weight per plant were differed significantly. Significantly higher leaf weight per plant were observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant (0.221g) was observed in Sahyadri-5 which was at par with Ratnagiri-4 and Phondaghat-1 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at 20 DAT. Sahyadri-5 and Ratnagiri-5 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 0.158g to be recorded, while genotype Palghar-2 (0.198g) recorded higher leaf weight than average leaf weight per plant.

At 40 DAT, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant (2.331g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at 40 DAT. Ratnagiri-4 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 0.780g to be recorded, while genotype Palghar-2 (1.035g) recorded higher leaf weight than average leaf weight per plant.

At 60 DAT, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant (5.346g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at 60 DAT. Ratnagiri-4 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 2.211g to be recorded, while genotype Palghar-2 (3.012g) recorded higher leaf weight than average leaf weight per plant.

At 80 DAT, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant

Table 8(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.221	0.176	0.199	20.4	1.832	0.872	1.352	52.4
Karjat-8 (G ₂)	0.153	0.127	0.140	17.2	1.549	0.660	1.104	57.4
Karjat-9 (G ₃)	0.175	0.186	0.181	-6.3	1.492	0.658	1.075	55.9
Ratnagiri-4 (G ₄)	0.220	0.175	0.197	20.5	2.331	0.803	1.567	65.6
Ratnagiri-5 (G ₅)	0.218	0.186	0.202	14.7	2.240	0.948	1.594	57.7
Palghar-2 (G ₆)	0.143	0.198	0.170	-38.8	1.956	1.035	1.496	47.1
Phondaghat-1 (G ₇)	0.220	0.154	0.187	29.7	1.647	0.768	1.207	53.4
Karjat-1-1-12-24-1-13 (G ₈)	0.183	0.125	0.154	32.0	1.246	0.759	1.003	39.1
Karjat-5-17-25-29-6 (G ₉)	0.174	0.144	0.159	17.4	1.189	0.707	0.948	40.5
Karjat-5-10-10-16-13 (G ₁₀)	0.211	0.113	0.162	46.7	1.419	0.859	1.139	39.5
Karjat-BM4 (G ₁₁)	0.138	0.141	0.140	-1.9	1.111	0.543	0.827	51.1
Karjat-6-22-9-14-13 (G ₁₂)	0.152	0.166	0.159	-9.0	1.397	0.851	1.124	39.1
Karjat-5-8-13-15-7 (G ₁₃)	0.127	0.143	0.135	-12.6	1.226	0.742	0.984	39.5
Karjat-5-7-10-12-2 (G ₁₄)	0.142	0.178	0.160	-25.4	1.148	0.693	0.921	39.6
Karjat-7 (G ₁₅)	0.115	0.195	0.155	-69.6	1.487	0.767	1.127	48.4
Swarnaprabha (G ₁₆)	0.133	0.124	0.128	7.0	1.523	0.810	1.166	46.8
Mean	0.170	0.158			1.550	0.780		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0093	0.0033			0.0391	0.0138		
Treatment	0.0033	0.0012			0.0138	0.0049		
Interaction (G × T)	0.0131	0.0046			0.0553	0.0195		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 8(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	4.671	2.365	3.518	49.4	7.941	4.020	5.981	49.4
Karjat-8 (G ₂)	4.045	2.046	3.045	49.4	6.877	3.478	5.177	49.4
Karjat-9 (G ₃)	3.887	2.093	2.990	46.2	6.608	3.558	5.083	46.2
Ratnagiri-4 (G ₄)	5.346	2.451	3.898	54.1	9.088	4.167	6.627	54.1
Ratnagiri-5 (G ₅)	4.827	2.568	3.698	46.8	8.206	4.366	6.286	46.8
Palghar-2 (G ₆)	4.391	3.012	3.702	31.4	7.465	5.121	6.293	31.4
Phondaghat-1 (G ₇)	4.130	2.363	3.247	42.8	7.022	4.017	5.519	42.8
Karjat-1-1-12-24-1-13 (G ₈)	3.995	2.144	3.070	46.3	6.792	3.644	5.218	46.3
Karjat-5-17-25-29-6 (G ₉)	3.706	2.012	2.859	45.7	6.301	3.420	4.861	45.7
Karjat-5-10-10-16-13 (G ₁₀)	4.154	2.140	3.147	48.5	7.062	3.637	5.350	48.5
Karjat-BM4 (G ₁₁)	3.190	1.890	2.540	40.8	5.424	3.212	4.318	40.8
Karjat-6-22-9-14-13 (G ₁₂)	3.943	2.143	3.043	45.7	6.703	3.643	5.173	45.7
Karjat-5-8-13-15-7 (G ₁₃)	3.740	2.140	2.940	42.8	6.357	3.637	4.997	42.8
Karjat-5-7-10-12-2 (G ₁₄)	3.416	2.149	2.783	37.1	5.807	3.654	4.731	37.1
Karjat-7 (G ₁₅)	3.896	1.896	2.896	51.3	6.623	3.223	4.923	51.3
Swarnaprabha (G ₁₆)	3.960	1.960	2.960	50.5	6.732	3.332	5.032	50.5
Mean	4.081	2.211			6.938	3.758		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1244	0.0440			0.2114	0.0748		
Treatment	0.0440	0.0156			0.0747	0.0264		
Interaction (G × T)	0.1759	0.0622			0.2990	0.1058		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 8(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on leaf weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	9.927	5.025	7.476	49.4	9.706	4.849	7.277	50.0
Karjat-8 (G ₂)	8.596	4.347	6.471	49.4	8.442	4.220	6.331	50.0
Karjat-9 (G ₃)	8.261	4.448	6.354	46.2	8.085	4.261	6.173	47.3
Ratnagiri-4 (G ₄)	11.360	5.208	8.284	54.1	11.140	5.034	8.087	54.8
Ratnagiri-5 (G ₅)	10.258	5.458	7.858	46.8	10.040	5.272	7.656	47.5
Palghar-2 (G ₆)	9.331	6.401	7.866	31.4	9.188	6.203	7.696	32.5
Phondaghat-1 (G ₇)	8.777	5.021	6.899	42.8	8.557	4.866	6.712	43.1
Karjat-1-1-12-24-1-13 (G ₈)	8.490	4.555	6.523	46.3	8.307	4.431	6.369	46.7
Karjat-5-17-25-29-6 (G ₉)	7.876	4.276	6.076	45.7	7.702	4.132	5.917	46.4
Karjat-5-10-10-16-13 (G ₁₀)	8.828	4.547	6.687	48.5	8.617	4.434	6.525	48.5
Karjat-BM4 (G ₁₁)	6.779	4.016	5.398	40.8	6.641	3.875	5.258	41.7
Karjat-6-22-9-14-13 (G ₁₂)	8.379	4.554	6.466	45.7	8.227	4.388	6.308	46.7
Karjat-5-8-13-15-7 (G ₁₃)	7.947	4.547	6.247	42.8	7.820	4.404	6.112	43.7
Karjat-5-7-10-12-2 (G ₁₄)	7.259	4.567	5.913	37.1	7.117	4.390	5.754	38.3
Karjat-7 (G ₁₅)	8.278	4.028	6.153	51.3	8.163	3.833	5.998	53.0
Swarnaprabha (G ₁₆)	8.415	4.165	6.290	50.5	8.282	4.041	6.162	51.2
Mean	8.672	4.698			8.502	4.540		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.2643	0.0935			0.2658	0.0940		
Treatment	0.0934	0.0331			0.0940	0.0332		
Interaction (G × T)	0.3737	0.1322			0.3759	0.1330		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

(9.088g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at 80 DAT. Ratnagiri-4 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 3.758g to be recorded, while genotype Palghar-2 (5.121g) recorded higher leaf weight than average leaf weight per plant.

At 100 DAT, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant (11.360g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at 100 DAT. Ratnagiri-4 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 4.698g to be recorded, while genotype Palghar-2 (6.401g) recorded higher leaf weight than average leaf weight per plant.

At harvest, in case of genotype, mean leaf weight per plant differs significantly. Significantly higher leaf weight per plant (11.140g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of leaf weight per plant differs significantly at harvest. Ratnagiri-4 showed higher leaf weight in T₁ than others. Among the genotypes in T₂ treatment average leaf weight per plant was 4.540g to be recorded, while genotype Palghar-2 (6.203g) recorded higher leaf weight than average leaf weight per plant.

4.1.9 Effects of light treatment on total dry weight per plant (g) at harvesting stage

The result on effects of normal and low light on total dry weight per plant (g) of rice at various growths stages are presented in Table 9(a), (b) & (c). Data indicated that total dry

weight per plant increased continuously from 20 days after transplanting to harvest and the increase in total dry weight was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in total dry weight per plant were differed significantly. Significantly higher total dry weight per plant were observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (0.672g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of total dry weight per plant differs significantly at 20 DAT. Ratnagiri-4 showed higher total dry weight per plant in T₁ than others. Among the genotypes in T₂ treatment average total dry weight per plant was 0.346g to be recorded, while genotype Palghar-2 (0.452g) recorded higher total dry weight than average total dry weight per plant.

At 40 DAT, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (5.146g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of total dry weight per plant differs significantly at 40 DAT. Ratnagiri-4 showed higher total dry weights per plant in T₁ than others. Among the genotypes in T₂ treatment average total dry weight per plant was 1.816g to be recorded, while genotype Palghar-2 (2.442g) recorded higher total dry weight than average total dry weight per plant.

At 60 DAT, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (16.609g) was observed in Ratnagiri-4 over other

genotypes. In case of interaction, mean of total dry weight per plant differs significantly at 60 DAT. Ratnagiri-4 showed higher total dry weights per plant in T_1 than others. Among the genotypes in T_2 treatment average total dry weight per plant was 7.35g to be recorded, while genotype Palghar-2 (9.209g) recorded higher total dry weight than average total dry weight per plant.

At 80 DAT, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (28.26g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of total dry weight per plant differs significantly at 80 DAT. Ratnagiri-4 showed higher total dry weights per plant in T_1 than others. Among the genotypes in T_2 treatment average total dry weight per plant was 12.61g to be recorded, while genotype Palghar-2 (15.78g) recorded higher total dry weight than average total dry weight per plant.

At 100 DAT, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (36.46g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of total dry weight per plant differs significantly at 100 DAT. Ratnagiri-4 showed higher total dry weights per plant in T_1 than others. Among the genotypes in T_2 treatment average total dry weight per plant was 16.20g to be recorded, while genotype Palghar-2 (20.32g) recorded higher total dry weight than average total dry weight per plant.

At harvest, in case of genotype, mean total dry weight per plant differ significantly. Significantly higher total dry weight per plant (36.70g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of total dry weight per plant differs significantly at harvest. Ratnagiri-4 showed higher total dry

Table 9(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on total dry weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.571	0.380	0.48	33.4	4.049	1.927	2.99	52.4
Karjat-8 (G ₂)	0.514	0.303	0.41	41.1	3.336	1.505	2.42	54.9
Karjat-9 (G ₃)	0.556	0.370	0.46	33.5	3.207	1.577	2.39	50.8
Ratnagiri-4 (G ₄)	0.672	0.342	0.51	49.1	5.146	1.905	3.53	63.0
Ratnagiri-5 (G ₅)	0.610	0.407	0.51	33.3	4.815	2.169	3.49	55.0
Palghar-2 (G ₆)	0.522	0.452	0.49	13.4	4.248	2.442	3.35	42.5
Phondaghat-1 (G ₇)	0.542	0.347	0.44	36.0	3.533	1.821	2.68	48.4
Karjat-1-1-12-24-1-13 (G ₈)	0.562	0.316	0.44	43.8	2.984	1.724	2.35	42.2
Karjat-5-17-25-29-6 (G ₉)	0.545	0.300	0.42	44.9	2.852	1.670	2.26	41.4
Karjat-5-10-10-16-13 (G ₁₀)	0.561	0.311	0.44	44.5	3.453	1.888	2.67	45.3
Karjat-BM4 (G ₁₁)	0.460	0.287	0.37	37.6	2.642	1.350	2.00	48.9
Karjat-6-22-9-14-13 (G ₁₂)	0.462	0.356	0.41	22.8	3.313	1.892	2.60	42.9
Karjat-5-8-13-15-7 (G ₁₃)	0.484	0.328	0.41	32.2	3.007	1.721	2.36	42.8
Karjat-5-7-10-12-2 (G ₁₄)	0.541	0.349	0.44	35.5	2.824	1.706	2.27	39.6
Karjat-7 (G ₁₅)	0.490	0.380	0.43	22.4	3.437	1.805	2.62	47.5
Swarnaprabha (G ₁₆)	0.515	0.311	0.41	39.5	3.357	1.946	2.65	42.0
Mean	0.538	0.346			3.513	1.816		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0125	0.0044			0.0624	0.0221		
Treatment	0.0044	0.0016			0.0221	0.0078		
Interaction (G × T)	0.0177	0.0063			0.0882	0.0312		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 9(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on total dry weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	14.281	7.908	11.09	44.6	24.20	13.47	18.83	44.4
Karjat-8 (G ₂)	12.248	6.885	9.57	43.8	20.78	11.70	16.24	43.7
Karjat-9 (G ₃)	11.635	7.064	9.35	39.3	19.75	12.07	15.91	38.9
Ratnagiri-4 (G ₄)	16.609	7.932	12.27	52.2	28.26	13.56	20.91	52.0
Ratnagiri-5 (G ₅)	15.310	8.316	11.81	45.7	26.01	14.22	20.11	45.3
Palghar-2 (G ₆)	14.298	9.209	11.75	35.6	24.25	15.78	20.01	34.9
Phondaghat-1 (G ₇)	12.613	7.746	10.18	38.6	21.40	13.20	17.30	38.3
Karjat-1-1-12-24-1-13 (G ₈)	11.679	7.015	9.35	39.9	19.77	12.09	15.93	38.9
Karjat-5-17-25-29-6 (G ₉)	11.085	6.817	8.95	38.5	18.74	11.72	15.23	37.5
Karjat-5-10-10-16-13 (G ₁₀)	13.058	7.426	10.24	43.1	21.98	12.77	17.37	41.9
Karjat-BM4 (G ₁₁)	9.888	6.206	8.05	37.2	16.86	10.73	13.80	36.3
Karjat-6-22-9-14-13 (G ₁₂)	11.814	6.871	9.34	41.8	19.92	11.71	15.81	41.2
Karjat-5-8-13-15-7 (G ₁₃)	11.104	7.213	9.16	35.0	18.88	12.50	15.69	33.8
Karjat-5-7-10-12-2 (G ₁₄)	10.665	7.140	8.90	33.1	18.10	12.45	15.27	31.2
Karjat-7 (G ₁₅)	12.086	6.860	9.47	43.2	20.37	11.70	16.03	42.6
Swarnaprabha (G ₁₆)	12.313	7.048	9.68	42.8	20.82	12.04	16.43	42.2
Mean	12.54	7.35			21.25	12.61		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.1591	0.0563			0.2854	0.1009		
Treatment	0.0563	0.0199			0.1009	0.0357		
Interaction (G × T)	0.2250	0.0796			0.4036	0.1428		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 9(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on total dry weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	31.21	17.32	24.26	44.5	31.34	17.35	24.34	44.6
Karjat-8 (G ₂)	26.79	15.02	20.91	43.9	27.00	15.07	21.04	44.2
Karjat-9 (G ₃)	25.47	15.49	20.48	39.2	25.67	15.48	20.58	39.7
Ratnagiri-4 (G ₄)	36.46	17.43	26.95	52.2	36.70	17.43	27.06	52.5
Ratnagiri-5 (G ₅)	33.55	18.30	25.93	45.5	33.73	18.33	26.03	45.6
Palghar-2 (G ₆)	31.28	20.32	25.80	35.0	31.52	20.38	25.95	35.3
Phondaghat-1 (G ₇)	27.58	16.98	22.28	38.4	27.68	17.02	22.35	38.5
Karjat-1-1-12-24-1-13 (G ₈)	25.50	15.53	20.52	39.1	25.70	15.59	20.65	39.3
Karjat-5-17-25-29-6 (G ₉)	24.19	15.04	19.62	37.8	24.39	15.05	19.72	38.3
Karjat-5-10-10-16-13 (G ₁₀)	28.43	16.43	22.43	42.2	28.57	16.51	22.54	42.2
Karjat-BM4 (G ₁₁)	21.74	13.76	17.75	36.7	21.93	13.76	17.84	37.2
Karjat-6-22-9-14-13 (G ₁₂)	25.78	15.07	20.43	41.5	25.94	15.10	20.52	41.8
Karjat-5-8-13-15-7 (G ₁₃)	24.38	16.06	20.22	34.1	24.61	16.11	20.36	34.6
Karjat-5-7-10-12-2 (G ₁₄)	23.39	15.93	19.66	31.9	23.65	15.93	19.79	32.6
Karjat-7 (G ₁₅)	26.37	15.08	20.73	42.8	26.63	15.07	20.85	43.4
Swarnaprabha (G ₁₆)	26.89	15.52	21.20	42.3	27.13	15.58	21.36	42.6
Mean	27.44	16.20			27.64	16.23		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.3570	0.1263			0.3592	0.1271		
Treatment	0.1262	0.0447			0.1270	0.0449		
Interaction (G × T)	0.5049	0.1786			0.5080	0.1797		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

weights per plant in T₁ than others. Among the genotypes in T₂ treatment average total dry weight per plant was 16.23g to be recorded, while genotype Palghar-2 (20.38g) recorded higher total dry weight than average total dry weight per plant.

4.1.10 Effects of light treatment on plant height (cm)

The result on effects of normal and low light on plant height (cm) of rice at various growth stages are presented in Table 10(a), (b) & (c). Data indicated that plant height increased continuously from 20 days after transplanting to harvest and the increase in plant height was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in plant height were differed significantly. Significantly higher plant height were observed in T₂ at 20, 40, 60, 80, 100 DAT and at harvest than T₁ treatment.

At 20 DAT, in case of genotype, mean plant height differ significantly. Significantly higher plant height (63.00 cm) was observed in Swarnaprabha over other genotypes. In case of interaction, mean of plant height differs significantly at 20 DAT. Swarnaprabha showed higher plant height in T₂ than others. Among the genotypes in T₁ treatment average plant height was 41.85cm to be recorded, while genotype Karjat-8 (50.22 cm) recorded higher plant height than average plant height.

At 40 DAT, in case of genotype, mean plant height differ significantly. Significantly higher plant height (88.78 cm) was observed in Swarnaprabha which was at par with Karjat-5-8-13-15-7 over other genotypes. In case of interaction, mean of plant height differs significantly at 40 DAT. Swarnaprabha showed higher plant height in T₂ than others. Among the genotypes in T₁

treatment average plant height was 59.19 cm to be recorded, while genotype Palghar-2 (67.56 cm) recorded higher plant height than average plant height.

At 60 DAT, in case of genotype, mean plant height differ significantly. Significantly higher plant height (118.67 cm) was observed in Swarnaprabha which was at par with Palghar-2 over other genotypes. In case of interaction, mean of plant height differs significantly at 60 DAT. Swarnaprabha showed higher plant height in T₂ than others. Among the genotypes in T₁ treatment average plant height was 88.60 cm to be recorded, while genotype Swarnaprabha (106.00 cm) recorded higher plant height than average plant height.

At 80 DAT, in case of genotype, mean plant height differ significantly. Significantly higher plant height (125.00 cm) was observed in Karjat-6-22-9-14-13 which was at par with Karjat-8 and Palghar-2 over other genotypes. In case of interaction, mean of plant height differs significantly at 80 DAT. Karjat-6-22-9-14-13 showed higher plant height in T₂ than others. Among the genotypes in T₁ treatment average plant height was 102.51cm to be recorded, while genotype Swarnaprabha (115.78cm) recorded higher plant height than average plant height.

At 100 DAT and At harvest, in case of genotype, mean plant height differ significantly. Significantly higher plant height (123.89 cm) was observed in Karjat-8 over other genotypes. In case of interaction, mean of plant height differs significantly at 100 DAT and at harvest. Karjat-8 showed higher plant height in T₂ than others. Among the genotypes in T₁ treatment average plant height was 100.17 cm to be recorded, while genotype Karjat-BM4 (116.22 cm) recorded higher plant height than average plant height.

Table 10(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on plant height (cm) of rice (*Oryza sativa* L.)

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	40.33	49.56	44.94	-22.9	50.89	72.11	61.50	-41.7
Karjat-8 (G ₂)	50.22	48.44	49.33	3.5	54.78	71.44	63.11	-30.4
Karjat-9 (G ₃)	48.56	45.44	47.00	6.4	56.44	78.33	67.39	-38.8
Ratnagiri-4 (G ₄)	45.22	54.22	49.72	-19.9	57.56	79.22	68.39	-37.6
Ratnagiri-5 (G ₅)	41.56	46.56	44.06	-12.0	59.00	73.00	66.00	-23.7
Palghar-2 (G ₆)	42.78	50.67	46.72	-18.4	67.56	78.89	73.22	-16.8
Phondaghat-1 (G ₇)	40.22	50.11	45.17	-24.6	65.22	71.33	68.28	-9.4
Karjat-1-1-12-24-1-13 (G ₈)	42.78	48.56	45.67	-13.5	67.11	74.67	70.89	-11.3
Karjat-5-17-25-29-6 (G ₉)	41.78	42.33	42.06	-1.3	61.78	73.89	67.83	-19.6
Karjat-5-10-10-16-13 (G ₁₀)	41.78	44.67	43.22	-6.9	63.11	71.78	67.44	-13.7
Karjat-BM4 (G ₁₁)	43.33	45.22	44.28	-4.4	56.00	81.78	68.89	-46.0
Karjat-6-22-9-14-13 (G ₁₂)	39.56	47.67	43.61	-20.5	59.78	81.00	70.39	-35.5
Karjat-5-8-13-15-7 (G ₁₃)	32.89	52.00	42.44	-58.1	56.44	86.56	71.50	-53.3
Karjat-5-7-10-12-2 (G ₁₄)	34.00	44.67	39.33	-31.4	54.22	66.11	60.17	-21.9
Karjat-7 (G ₁₅)	35.78	40.89	38.33	-14.3	53.11	68.56	60.83	-29.1
Swarnaprabha (G ₁₆)	48.78	63.00	55.89	-29.2	64.11	88.78	76.44	-38.5
Mean	41.85	48.38			59.19	76.09		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	1.3570	0.4800			2.4000	0.8490		
Treatment	0.4798	0.1697			0.8485	0.3002		
Interaction (G × T)	1.9190	0.6788			3.3941	1.2006		

DAT – Days after transplanting

T₁ – Without Shade Net

T₂ – Shade Net

Table 10(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on plant height (cm) of rice (*Oryza sativa* L.)

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	81.44	100.22	90.83	-23.1	103.56	115.78	109.67	-11.8
Karjat-8 (G ₂)	95.67	109.89	102.78	-14.9	105.22	124.33	114.78	-18.2
Karjat-9 (G ₃)	90.78	106.67	98.72	-17.5	105.78	110.33	108.06	-4.3
Ratnagiri-4 (G ₄)	84.33	111.78	98.06	-32.5	100.78	116.67	108.72	-15.8
Ratnagiri-5 (G ₅)	80.44	91.22	85.83	-13.4	92.78	98.44	95.61	-6.1
Palghar-2 (G ₆)	96.67	117.00	106.83	-21.0	103.22	124.22	113.72	-20.3
Phondaghat-1 (G ₇)	98.89	106.00	102.44	-7.2	101.67	122.89	112.28	-20.9
Karjat-1-1-12-24-1-13 (G ₈)	86.00	97.78	91.89	-13.7	104.89	121.33	113.11	-15.7
Karjat-5-17-25-29-6 (G ₉)	90.44	100.67	95.56	-11.3	104.44	122.00	113.22	-16.8
Karjat-5-10-10-16-13 (G ₁₀)	92.56	94.33	93.44	-1.9	107.44	108.56	108.00	-1.0
Karjat-BM4 (G ₁₁)	91.33	101.00	96.17	-10.6	113.56	117.78	115.67	-3.7
Karjat-6-22-9-14-13 (G ₁₂)	84.44	98.89	91.67	-17.1	103.89	125.00	114.44	-20.3
Karjat-5-8-13-15-7 (G ₁₃)	81.67	105.44	93.56	-29.1	95.56	116.89	106.22	-22.3
Karjat-5-7-10-12-2 (G ₁₄)	82.56	85.00	83.78	-3.0	96.44	93.11	94.78	3.5
Karjat-7 (G ₁₅)	74.33	91.78	83.06	-23.5	85.22	89.67	87.44	-5.2
Swarnaprabha (G ₁₆)	106.00	118.67	112.33	-11.9	115.78	122.11	118.94	-5.5
Mean	88.60	102.27			102.51	114.3		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	1.4593	0.5162			1.1044	0.3907		
Treatment	0.5159	0.1825			0.3905	0.1381		
Interaction (G × T)	2.0637	0.7300			1.5619	0.5525		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 10(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on plant height (cm) of rice (*Oryza sativa* L.)

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	103.67	116.11	109.89	-12.0	103.67	116.11	109.89	-12.0
Karjat-8 (G ₂)	106.00	123.89	114.94	-16.9	106.00	123.89	114.94	-16.9
Karjat-9 (G ₃)	106.22	110.56	108.39	-4.1	106.22	110.56	108.39	-4.1
Ratnagiri-4 (G ₄)	99.44	116.67	108.06	-17.3	99.44	116.67	108.06	-17.3
Ratnagiri-5 (G ₅)	90.67	97.89	94.28	-8.0	90.67	97.89	94.28	-8.0
Palghar-2 (G ₆)	100.78	117.56	109.17	-16.6	100.78	117.56	109.17	-16.6
Phondaghat-1 (G ₇)	95.33	110.22	102.78	-15.6	95.33	110.22	102.78	-15.6
Karjat-1-1-12-24-1-13 (G ₈)	97.33	113.56	105.44	-16.7	97.33	113.56	105.44	-16.7
Karjat-5-17-25-29-6 (G ₉)	100.89	111.56	106.22	-10.6	100.89	111.56	106.22	-10.6
Karjat-5-10-10-16-13 (G ₁₀)	104.11	105.00	104.56	-0.9	104.11	105.00	104.56	-0.9
Karjat-BM4 (G ₁₁)	116.22	111.11	113.67	4.4	116.22	111.11	113.67	4.4
Karjat-6-22-9-14-13 (G ₁₂)	100.22	113.89	107.06	-13.6	100.22	113.89	107.06	-13.6
Karjat-5-8-13-15-7 (G ₁₃)	95.22	112.67	103.94	-18.3	95.22	112.67	103.94	-18.3
Karjat-5-7-10-12-2 (G ₁₄)	93.00	92.22	92.61	0.8	93.00	92.22	92.61	0.8
Karjat-7 (G ₁₅)	82.44	89.67	86.06	-8.8	82.44	89.67	86.06	-8.8
Swarnaprabha (G ₁₆)	111.11	114.33	112.72	-2.9	111.11	114.33	112.72	-2.9
Mean	100.17	109.8			100.17	109.8		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	6.2062	2.1954			6.2062	2.1954		
Treatment	2.1942	0.7762			2.1942	0.7762		
Interaction (G × T)	8.7769	3.1047			8.7769	3.1047		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

4.2 Biochemical characteristics

4.2.1 Effects of light treatment on total chlorophyll content (mg/g fresh weight) at 30 and 50 days after transplanting

The result on effects of normal and low light on total chlorophyll content of rice genotypes at 30 and 50 days after transplanting were observed are presented in Table 11.

Data indicated that weight of total chlorophyll content increased more in 50 DAT than 30 DAT.

As regards treatment it was observed that in both stages (30 and 50 DAT) the mean differences in total chlorophyll content were differed significantly. Significantly higher total chlorophyll content was observed in T₂ at 30 DAT and at 50 DAT than T₁ treatment.

At 30 DAT, in case of genotypes, mean of total chlorophyll differ significantly. Significantly higher weight of total chlorophyll (1.739 mg/g) was observed in Palghar-2 which was at par with Ratnagiri-4, Sahyadri-5, Phondaghat-1 and Karjat-5-10-10-16-13 over other genotypes. In case of interaction, mean of total chlorophyll content differs significantly at 30 DAT. Palghar-2 showed higher total chlorophyll content in T₂ than others. Among the genotypes in T₁ treatment average total chlorophyll content was 2.960 mg/g to be recorded, while genotype Ratnagiri-4 (1.535 mg/g) recorded higher total chlorophyll content than average total chlorophyll content.

At 50 DAT, in case of genotypes, mean of total chlorophyll differs significantly. Significantly higher weight of total chlorophyll (2.169 mg/g) was observed in Palghar-2 over other genotypes. In case of interaction, mean of total chlorophyll content differs significantly at 50 DAT. Palghar-2 showed higher no of tillers in T₂ than others. Among the genotypes in T₁

Table 11 Effects of normal light (Without Shade Net) and low light (Shade Net) on total chlorophyll contents (mg/g fresh weight) of rice (*Oryza sativa* L.)

Genotypes	30 DAT				50 DAT			
	T 1	T 2	Mean	Reduction (%)	T 1	T 2	Mean	Reduction (%)
Sahyadri-5 (G1)	0.945	1.620	1.282	-71.4	1.375	2.050	1.713	-49.1
Karjat-8 (G2)	0.737	1.477	1.107	-100.5	1.337	1.926	1.632	-44.0
Karjat-9 (G3)	0.716	1.496	1.106	-108.8	1.275	1.827	1.551	-43.3
Ratnagiri-4 (G4)	1.535	1.636	1.586	-6.6	1.563	2.066	1.815	-32.2
Ratnagiri-5 (G5)	1.294	1.670	1.482	-29.1	1.386	2.100	1.743	-51.6
Palghar-2 (G6)	0.958	1.739	1.348	-81.6	1.388	2.169	1.778	-56.3
Phondaghat-1 (G7)	0.873	1.594	1.233	-82.7	1.244	2.024	1.634	-62.7
Karjat-1-1-12-24-1-13 (G8)	0.695	1.125	0.910	-61.9	1.125	1.555	1.340	-38.2
Karjat-5-17-25-29-6 (G9)	0.621	1.101	0.861	-77.1	1.052	1.531	1.291	-45.6
Karjat-5-10-10-16-13 (G10)	0.845	1.569	1.207	-85.6	1.348	1.999	1.673	-48.3
Karjat-BM4 (G11)	0.594	1.008	0.801	-69.8	1.024	1.438	1.231	-40.5
Karjat-6-22-9-14-13 (G12)	0.920	1.428	1.174	-55.2	1.259	1.907	1.583	-51.5
Karjat-5-8-13-15-7 (G13)	0.853	1.410	1.131	-65.2	1.167	1.858	1.512	-59.2
Karjat-5-7-10-12-2 (G14)	0.720	1.239	0.980	-72.0	1.147	1.669	1.408	-45.6
Karjat-7 (G15)	0.924	1.428	1.176	-54.5	1.350	1.966	1.658	-45.6
Swarnaprabha (G16)	0.907	1.410	1.158	-55.4	1.349	1.955	1.652	-44.9
Mean	2.960	8.940			4.030	12.14		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.2195	0.0776			0.0036	0.0013		
Treatment	0.0776	0.0274			0.0013	0.0004		
Interaction (G × T)	0.3104	0.1098			0.0050	0.0018		

DAT – Days after transplanting

T1 –Without Shade Net

T2 – Shade Net

treatment average total chlorophyll content was 4.030 mg/g to be recorded, while genotype Ratnagiri-4 (1.563 mg/g) recorded higher total chlorophyll content than average total chlorophyll content.

4.3. Physiological parameters

4.3.1 Light intensity as 10 days interval (lux)

The result on effects of without shade net and shade net on light intensity of rice genotypes at 10 days interval were observed are presented in Table 12

The mean of maximum light intensity was observed in T₁ (16348 lux) than T₂ (9405 lux) treatment.

Table 12 Light intensity (lux) as 10 days interval

Date	Without shade net (T₁)	Shade net (T₂)	Reduction (%)
17-Jul-2017	13000	8410	38.3
27-Jul-2017	11420	8500	39.6
06-Aug-2017	17430	10870	39.9
16-Aug-2017	14200	10480	40.9
26-Aug-2017	19520	10380	42.1
05-Sep-2017	14600	10700	43.5
15-Sep-2017	16340	10031	43.5
25-Sep-2017	15950	8900	44.2
05-Oct-2017	19360	10140	44.0
15-Oct-2017	18060	10880	41.4
25-Oct-2017	16580	9310	43.8
04-Nov-2017	17590	9910	43.6
14-Nov-2017	18720	10560	43.5
24-Nov-2017	18840	10890	42.1
Mean	16348	9405	42.3

4.4 Growth parameters

4.4.1 Effects of light treatment on absolute growth rate (AGR) (g day⁻¹ plant⁻¹)

The result on effects of normal and low light on absolute growth rate (g/day/plant) of rice at various growth stages are presented in Table 13 (a), (b) & (c).

Data indicated that AGR increased continuously from 20-40 days after transplanting to 60-80 DAT and the decrease in AGR was between 60-80 DAT to 100 DAT-at harvest stage.

As regards treatments it was observed that in all the stages from 0-20 to 80-100 DAT and 100 DAT-at harvest the mean differences in AGR were differed significantly. Significantly higher AGR were observed in T₁ at 20-40, 40-60, 60-80, 80-100 and 100 DAT-at harvest than T₂ treatment.

At 20-40 DAT, in case of genotype, mean AGR differ significantly. Significantly higher AGR (0.2237g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of AGR differs significantly at 20-40 DAT. Ratnagiri-4 showed higher AGR in T₁ than others. Among the genotypes in T₂ treatment average AGR was 0.0735g to be recorded, while genotype Palghar-2 (0.0995g) recorded higher AGR than average AGR.

At 40-60 DAT, in case of genotype, mean AGR differ significantly. Significantly higher AGR (0.5732 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of AGR differs significantly at 40-60 DAT. Ratnagiri-4 showed higher AGR in T₁ than others. Ratnagiri-4 showed higher AGR in T₁ than others. Among the genotypes in T₂ treatment average AGR was 0.2769g to be recorded, while genotype Palghar-2 (0.3384g) recorded higher AGR than average AGR.

Table 13(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on absolute growth rate (g day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	20-40 DAT				40-60 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.1739	0.0774	0.13	55.5	0.5116	0.2991	0.41	41.5
Karjat-8 (G ₂)	0.1411	0.0601	0.10	57.4	0.4456	0.2690	0.36	39.6
Karjat-9 (G ₃)	0.1325	0.0604	0.10	54.5	0.4214	0.2743	0.35	34.9
Ratnagiri-4 (G ₄)	0.2237	0.0781	0.15	65.1	0.5732	0.3014	0.44	47.4
Ratnagiri-5 (G ₅)	0.2102	0.0881	0.15	58.1	0.5248	0.3074	0.42	41.4
Palghar-2 (G ₆)	0.1863	0.0995	0.14	46.6	0.5025	0.3384	0.42	32.7
Phondaghat-1 (G ₇)	0.1496	0.0737	0.11	50.7	0.4540	0.2962	0.38	34.8
Karjat-1-1-12-24-1-13 (G ₈)	0.1211	0.0704	0.10	41.8	0.4348	0.2646	0.35	39.1
Karjat-5-17-25-29-6 (G ₉)	0.1153	0.0685	0.09	40.6	0.4117	0.2574	0.33	37.5
Karjat-5-10-10-16-13 (G ₁₀)	0.1446	0.0788	0.11	45.5	0.4803	0.2769	0.38	42.3
Karjat-BM4 (G ₁₁)	0.1091	0.0532	0.08	51.3	0.3623	0.2428	0.30	33.0
Karjat-6-22-9-14-13 (G ₁₂)	0.1426	0.0768	0.11	46.1	0.4250	0.2490	0.34	41.4
Karjat-5-8-13-15-7 (G ₁₃)	0.1262	0.0697	0.10	44.8	0.4049	0.2746	0.34	32.2
Karjat-5-7-10-12-2 (G ₁₄)	0.1142	0.0679	0.09	40.5	0.3920	0.2717	0.33	30.7
Karjat-7 (G ₁₅)	0.1474	0.0713	0.11	51.7	0.4325	0.2528	0.34	41.6
Swarnaprabha (G ₁₆)	0.1421	0.0818	0.11	42.5	0.4478	0.2551	0.35	43.0
Mean	0.1487	0.0735			0.4515	0.2769		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0033	0.0012			0.0089	0.0031		
Treatment	0.0012	0.0004			0.0031	0.0011		
Interaction (G × T)	0.0046	0.0016			0.0125	0.0044		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 13(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on absolute growth rate (g day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	60-80 DAT				80-100 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.4961	0.2779	0.39	44.0	0.3502	0.1926	0.27	45.0
Karjat-8 (G ₂)	0.4265	0.2407	0.33	43.6	0.3008	0.1662	0.23	44.8
Karjat-9 (G ₃)	0.4056	0.2502	0.33	38.3	0.2860	0.1708	0.23	40.3
Ratnagiri-4 (G ₄)	0.5825	0.2814	0.43	51.7	0.4103	0.1933	0.30	52.9
Ratnagiri-5 (G ₅)	0.5349	0.2950	0.41	44.9	0.3772	0.2041	0.29	45.9
Palghar-2 (G ₆)	0.4977	0.3284	0.41	34.0	0.3516	0.2273	0.29	35.3
Phondaghat-1 (G ₇)	0.4391	0.2726	0.36	37.9	0.3090	0.1893	0.25	38.8
Karjat-1-1-12-24-1-13 (G ₈)	0.4046	0.2536	0.33	37.3	0.2867	0.1719	0.23	40.0
Karjat-5-17-25-29-6 (G ₉)	0.3829	0.2450	0.31	36.0	0.2726	0.1662	0.22	39.0
Karjat-5-10-10-16-13 (G ₁₀)	0.4459	0.2672	0.36	40.1	0.3227	0.1829	0.25	43.3
Karjat-BM4 (G ₁₁)	0.3485	0.2264	0.29	35.0	0.2442	0.1512	0.20	38.1
Karjat-6-22-9-14-13 (G ₁₂)	0.4051	0.2418	0.32	40.3	0.2933	0.1682	0.23	42.6
Karjat-5-8-13-15-7 (G ₁₃)	0.3889	0.2645	0.33	32.0	0.2749	0.1779	0.23	35.3
Karjat-5-7-10-12-2 (G ₁₄)	0.3716	0.2655	0.32	28.5	0.2646	0.1738	0.22	34.3
Karjat-7 (G ₁₅)	0.4144	0.2417	0.33	41.7	0.3000	0.1686	0.23	43.8
Swarnaprabha (G ₁₆)	0.4252	0.2495	0.34	41.3	0.3034	0.1739	0.24	42.7
Mean	0.4356	0.2626			0.3092	0.1800		
Factors	C.D.(5%)	S.Em±			C.D.(5%).	S.Em±		
Genotypes	0.0065	0.0023			0.0036	0.0013		
Treatment	0.0023	0.0008			0.0013	0.0005		
Interaction (G × T)	0.0092	0.0033			0.0051	0.0018		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 13(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on absolute growth rate (g day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	100 DAT-AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0064	0.0014	0.00	78.2
Karjat-8 (G ₂)	0.0104	0.0025	0.01	76.4
Karjat-9 (G ₃)	0.0103	0.0007	0.01	93.1
Ratnagiri-4 (G ₄)	0.0117	0.0010	0.01	91.1
Ratnagiri-5 (G ₅)	0.0087	0.0017	0.01	80.1
Palghar-2 (G ₆)	0.0118	0.0028	0.01	76.3
Phondaghat-1 (G ₇)	0.0051	0.0019	0.00	62.9
Karjat-1-1-12-24-1-13 (G ₈)	0.0098	0.0033	0.01	65.9
Karjat-5-17-25-29-6 (G ₉)	0.0098	0.0011	0.01	89.3
Karjat-5-10-10-16-13 (G ₁₀)	0.0069	0.0043	0.01	38.0
Karjat-BM4 (G ₁₁)	0.0091	0.0002	0.00	97.4
Karjat-6-22-9-14-13 (G ₁₂)	0.0079	0.0012	0.00	84.1
Karjat-5-8-13-15-7 (G ₁₃)	0.0115	0.0021	0.01	81.5
Karjat-5-7-10-12-2 (G ₁₄)	0.0129	0.0003	0.01	97.4
Karjat-7 (G ₁₅)	0.0130	0.0005	0.01	96.1
Swarnaprabha (G ₁₆)	0.0124	0.0032	0.01	74.3
Mean	0.0099	0.0018		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.0008	0.0003		
Treatment	0.0003	0.0001		
Interaction (G × T)	0.0011	0.0004		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

At 60-80 DAT, in case of genotype, mean AGR differ significantly. Significantly higher AGR (0.5825 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of AGR differs significantly at 60-80 DAT. Ratnagiri-4 showed higher AGR in T₁ than others. Ratnagiri-4 showed higher AGR in T₁ than others. Among the genotypes in T₂ treatment average AGR was 0.2626g to be recorded, while genotype Palghar-2 (0.3284g) recorded higher AGR than average AGR.

At 80-100 DAT, in case of genotype, mean AGR differ significantly. Significantly higher AGR (0.4103 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of AGR differs significantly at 80-100 DAT. Ratnagiri-4 showed higher AGR in T₁ than others. Ratnagiri-4 showed higher AGR in T₁ than others. Among the genotypes in T₂ treatment average AGR was 0.1800g to be recorded, while genotype Palghar-2 (0.2273g) recorded higher AGR than average AGR.

At 100 DAT to harvest, in case of genotype, mean AGR differ significantly. Significantly higher AGR (0.0130 g) was observed in Karjat-7 which was at par with Karjat-5-7-10-12-2 and Swarnaprabha over other genotypes. In case of interaction, mean of AGR differs significantly at 100 DAT to harvest. Karjat-7 showed higher AGR in T₁ than others. Ratnagiri-4 showed higher AGR in T₁ than others. Among the genotypes in T₂ treatment average AGR was 0.0018g to be recorded, while genotype Karjat-5-10-10-16-13 (0.0043g) recorded higher AGR than average AGR.

4.4.2 Effects of light treatment on relative growth rate (RGR) (g g⁻¹ day⁻¹ plant⁻¹)

The result on effects of normal and low light on relative growth rate (g/g/day⁻¹/plant⁻¹) of rice at various growths stages

are presented in Table 14 (a), (b) & (c). Data indicated that RGR increased continuously from 20-40 days after transplanting to 60-80 DAT and the increase more in RGR was between 20-40 DAT to 60-80 DAT stages.

As regards treatments it was observed that in all the stages from 20-40 to 80-100 DAT and 100 DAT-at harvest the mean differences in RGR were differed significantly. Significantly higher RGR were observed in T₁ at 20-40, 40-60, 60-80, 80-100 and 100 DAT-at harvest than T₂ treatment.

At 20-40 DAT, in case of genotype, mean RGR differ significantly. Significantly higher RGR (0.033g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of RGR differs significantly at 20-40 DAT. Ratnagiri-4 showed higher RGR in T₁ than others. Among the genotypes in T₂ treatment average RGR was 0.008g to be recorded, while genotype Palghar-2 (0.015g) recorded higher RGR than average RGR.

At 40-60 DAT, in case of genotype, mean RGR differ significantly. Significantly higher RGR (0.053 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of RGR differs significantly at 40-60 DAT. Ratnagiri-4 showed higher RGR in T₁ than others. Among the genotypes in T₂ treatment average RGR was 0.037g to be recorded, while genotype Palghar-2 (0.042g) recorded higher RGR than average RGR.

At 60-80 DAT, in case of genotype, mean RGR differ significantly. Significantly higher RGR (0.053 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of RGR differs significantly at 60-80 DAT. Ratnagiri-4 showed higher RGR in T₁ than others. Among the genotypes in T₂

Table 14(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on relative growth rate (g g⁻¹ day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	20-40 DAT				40-60 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.027	0.009	0.018	65.1	0.050	0.039	0.045	23.1
Karjat-8 (G ₂)	0.023	0.004	0.013	82.4	0.047	0.037	0.042	23.1
Karjat-9 (G ₃)	0.021	0.004	0.012	80.8	0.046	0.037	0.042	20.1
Ratnagiri-4 (G ₄)	0.033	0.010	0.021	70.2	0.053	0.039	0.046	26.3
Ratnagiri-5 (G ₅)	0.031	0.012	0.021	60.6	0.051	0.039	0.045	22.8
Palghar-2 (G ₆)	0.029	0.015	0.021	47.7	0.050	0.042	0.046	17.1
Phondaghat-1 (G ₇)	0.024	0.008	0.016	64.6	0.048	0.039	0.043	19.4
Karjat-1-1-12-24-1-13 (G ₈)	0.019	0.007	0.013	61.3	0.047	0.036	0.042	23.0
Karjat-5-17-25-29-6 (G ₉)	0.018	0.007	0.012	62.4	0.046	0.036	0.041	22.3
Karjat-5-10-10-16-13 (G ₁₀)	0.023	0.010	0.016	57.1	0.049	0.037	0.043	24.3
Karjat-BM4 (G ₁₁)	0.017	0.001	0.009	92.1	0.043	0.034	0.039	20.2
Karjat-6-22-9-14-13 (G ₁₂)	0.023	0.009	0.016	59.1	0.046	0.035	0.041	25.1
Karjat-5-8-13-15-7 (G ₁₃)	0.020	0.007	0.014	64.2	0.045	0.037	0.041	18.6
Karjat-5-7-10-12-2 (G ₁₄)	0.018	0.007	0.012	63.0	0.045	0.037	0.041	17.8
Karjat-7 (G ₁₅)	0.023	0.008	0.016	67.2	0.047	0.035	0.041	24.9
Swarnaprabha (G ₁₆)	0.023	0.011	0.017	53.0	0.048	0.035	0.041	25.7
Mean	0.023	0.008			0.047	0.037		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0007	0.0003			0.0006	0.0002		
Treatment	0.0003	0.0001			0.0002	0.0001		
Interaction (G × T)	0.0011	0.0004			0.0009	0.0003		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 14(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on relative growth rate (g g⁻¹ day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	60-80 DAT				80-100 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.050	0.037	0.044	25.3	0.042	0.029	0.036	30.7
Karjat-8 (G ₂)	0.047	0.034	0.040	26.7	0.039	0.026	0.033	33.1
Karjat-9 (G ₃)	0.045	0.035	0.040	23.1	0.038	0.027	0.032	29.6
Ratnagiri-4 (G ₄)	0.053	0.038	0.045	29.6	0.046	0.029	0.038	35.8
Ratnagiri-5 (G ₅)	0.051	0.039	0.045	25.1	0.044	0.031	0.037	30.4
Palghar-2 (G ₆)	0.050	0.041	0.045	18.1	0.042	0.033	0.038	22.4
Phondaghat-1 (G ₇)	0.047	0.037	0.042	22.0	0.040	0.029	0.034	26.9
Karjat-1-1-12-24-1-13 (G ₈)	0.045	0.035	0.040	22.3	0.038	0.027	0.032	29.3
Karjat-5-17-25-29-6 (G ₉)	0.044	0.035	0.039	21.9	0.037	0.026	0.031	29.2
Karjat-5-10-10-16-13 (G ₁₀)	0.048	0.036	0.042	23.4	0.040	0.028	0.034	30.5
Karjat-BM4 (G ₁₁)	0.042	0.033	0.037	22.2	0.034	0.024	0.029	30.2
Karjat-6-22-9-14-13 (G ₁₂)	0.045	0.034	0.040	24.8	0.038	0.026	0.032	31.5
Karjat-5-8-13-15-7 (G ₁₃)	0.045	0.036	0.040	18.8	0.037	0.028	0.032	25.5
Karjat-5-7-10-12-2 (G ₁₄)	0.044	0.036	0.040	16.8	0.036	0.027	0.032	25.2
Karjat-7 (G ₁₅)	0.046	0.034	0.040	25.5	0.039	0.026	0.033	32.2
Swarnaprabha (G ₁₆)	0.046	0.035	0.041	24.9	0.039	0.027	0.033	30.9
Mean	0.047	0.036			0.039	0.028		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0007	0.0003			0.0006	0.0002		
Treatment	0.0003	0.0001			0.0002	0.0001		
Interaction (G × T)	0.0011	0.0004			0.0009	0.0003		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 14(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on relative growth rate (g g⁻¹ day⁻¹ plant⁻¹) of rice (*Oryza sativa* L.)

Genotypes	100 DAT-AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0173	0.0093	0.0133	46.1
Karjat-8 (G ₂)	0.0140	0.0061	0.0100	56.3
Karjat-9 (G ₃)	0.0129	0.0068	0.0098	47.5
Ratnagiri-4 (G ₄)	0.0208	0.0094	0.0151	54.7
Ratnagiri-5 (G ₅)	0.0189	0.0105	0.0147	44.3
Palghar-2 (G ₆)	0.0173	0.0129	0.0151	25.5
Phondaghat-1 (G ₇)	0.0146	0.0089	0.0117	38.8
Karjat-1-1-12-24-1-13 (G ₈)	0.0129	0.0069	0.0099	46.4
Karjat-5-17-25-29-6 (G ₉)	0.0118	0.0060	0.0089	49.0
Karjat-5-10-10-16-13 (G ₁₀)	0.0155	0.0082	0.0118	47.5
Karjat-BM4 (G ₁₁)	0.0094	0.0041	0.0068	56.5
Karjat-6-22-9-14-13 (G ₁₂)	0.0134	0.0062	0.0098	54.0
Karjat-5-8-13-15-7 (G ₁₃)	0.0120	0.0076	0.0098	36.9
Karjat-5-7-10-12-2 (G ₁₄)	0.0112	0.0070	0.0091	36.8
Karjat-7 (G ₁₅)	0.0140	0.0067	0.0103	52.3
Swarnaprabha (G ₁₆)	0.0142	0.0070	0.0106	50.8
Mean	0.0144	0.0077		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.0005	0.0002		
Treatment	0.0002	0.0001		
Interaction (G × T)	0.0007	0.0002		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

treatment average RGR was 0.036g to be recorded, while genotype Palghar-2 (0.041g) recorded higher RGR than average RGR.

At 80-100 DAT, in case of genotype, mean RGR differ significantly. Significantly higher RGR (0.046 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of RGR differs significantly at 80-100 DAT. Ratnagiri-4 showed higher RGR in T₁ than others. Among the genotypes in T₂ treatment average RGR was 0.028g to be recorded, while genotype Palghar-2 (0.033g) recorded higher RGR than average RGR.

At 100 DAT to harvest, in case of genotype, mean RGR differ significantly. Significantly higher RGR (0.0208 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of RGR differs significantly at 100 DAT to harvest. Ratnagiri-4 showed higher RGR in T₁ than others. Among the genotypes in T₂ treatment average RGR was 0.0077g to be recorded, while genotype Palghar-2 (0.0129g) recorded higher RGR than average RGR.

4.4.3 Effects of light treatment on net assimilation rate (NAR) (g dcm⁻² day⁻¹)

The result on effects of normal and low light on net assimilation rate (g/dcm⁻²/day⁻¹) of rice at various growths stages are presented in Table 15(a), (b) & (c). Data indicated that NAR increased continuously from 20-40 days after transplanting to 60-80 DAT and the decrease in NAR was between 60-80 DAT to 100 DAT-at harvest stage.

As regards treatments it was observed that in all the stages from 20-40 to 80-100 DAT and 100 DAT-at harvest the mean differences in NAR were differ significantly. Significantly

higher NAR were observed in T₁ at 20-40, 40-60,60-80,80-100 and 100 DAT-at harvest than T₂ treatment.

At 20-40 DAT, in case of genotype, mean NAR differ significantly. Significantly higher NAR (0.0027g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of NAR differs significantly at 20-40 DAT. Ratnagiri-4 showed higher NAR in T₁ than others. Among the genotypes in T₂ treatment average NAR was 0.0006g to be recorded, while genotype Palghar-2 and Karjat-5-10-10-16-13 (0.0007g) recorded higher NAR than average NAR.

At 40-60 DAT, in case of genotype, mean NAR differ significantly. Significantly higher NAR (0.0021 g) was observed in Phondaghat-1 over other genotypes. In case of interaction, mean of NAR differs significantly at 40-60 DAT. Phondaghat-1 showed higher NAR in T₁ than others. Among the genotypes in T₂ treatment average NAR was 0.0008g to be recorded, while genotype Karjat-7 (0.0010g) recorded higher NAR than average NAR.

At 60-80 DAT, in case of genotype, mean NAR differ significantly. Significantly higher NAR (0.011g) was observed in Karjat-5-17-25-29-6 which was at par with Karjat-9, Karjat-5-10-10-16-13 and Swarnaprabha over other genotypes. In case of interaction, mean of NAR differs significantly at 60-80 DAT. Karjat-5-17-25-29-6 showed higher NAR in T₁ than others. Among the genotypes in T₂ treatment average NAR was 0.0067g to be recorded, while genotype Ratnagiri-4 and Karjat-6-22-9-14-13 (0.007g) recorded higher NAR than average NAR.

At 80-100 DAT, in case of genotype, mean NAR differ significantly. Significantly higher NAR (0.018g) was observed in Karjat-7 which was at par with Karjat-6-22-9-14-13 over other

Table 15(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on net assimilation rate (g dcm⁻² day⁻¹) of rice (*Oryza sativa* L.)

Genotypes	20-40 DAT				40-60 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0019	0.0006	0.0012	70.1	0.0019	0.0008	0.0014	55.9
Karjat-8 (G ₂)	0.0013	0.0005	0.0009	60.2	0.0017	0.0008	0.0013	51.2
Karjat-9 (G ₃)	0.0013	0.0005	0.0009	64.0	0.0019	0.0008	0.0014	58.7
Ratnagiri-4 (G ₄)	0.0027	0.0006	0.0017	76.8	0.0016	0.0008	0.0012	48.4
Ratnagiri-5 (G ₅)	0.0023	0.0006	0.0014	71.7	0.0016	0.0007	0.0012	55.3
Palghar-2 (G ₆)	0.0020	0.0007	0.0014	63.0	0.0018	0.0007	0.0013	60.6
Phondaghat-1 (G ₇)	0.0011	0.0006	0.0008	50.0	0.0021	0.0007	0.0014	65.0
Karjat-1-1-12-24-1-13 (G ₈)	0.0011	0.0005	0.0008	55.9	0.0019	0.0008	0.0013	60.7
Karjat-5-17-25-29-6 (G ₉)	0.0010	0.0006	0.0008	39.6	0.0016	0.0008	0.0012	49.4
Karjat-5-10-10-16-13 (G ₁₀)	0.0014	0.0007	0.0011	53.2	0.0019	0.0007	0.0013	64.1
Karjat-BM4 (G ₁₁)	0.0010	0.0005	0.0008	50.3	0.0016	0.0009	0.0013	41.0
Karjat-6-22-9-14-13 (G ₁₂)	0.0012	0.0005	0.0009	55.2	0.0017	0.0006	0.0012	62.7
Karjat-5-8-13-15-7 (G ₁₃)	0.0010	0.0005	0.0008	48.9	0.0019	0.0008	0.0014	58.9
Karjat-5-7-10-12-2 (G ₁₄)	0.0011	0.0006	0.0008	43.7	0.0014	0.0008	0.0011	37.6
Karjat-7 (G ₁₅)	0.0014	0.0006	0.0010	58.9	0.0016	0.0010	0.0013	38.6
Swarnaprabha (G ₁₆)	0.0011	0.0006	0.0008	41.4	0.0017	0.0009	0.0013	45.8
Mean	0.0014	0.0006			0.0017	0.0008		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.00010	0.00004			0.00017	0.00006		
Treatment	0.00004	0.00001			0.00006	0.00002		
Interaction (G × T)	0.00014	0.00005			0.00024	0.00009		

DAT – Days after transplanting

T₁ – Without Shade Net

T₂ – Shade Net

Table 15(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on net assimilation rate (g dcm⁻² day⁻¹) of rice (*Oryza sativa* L.)

Genotypes	60-80 DAT				80-100 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.005	0.003	0.00	44.9	0.010	0.004	0.01	62.2
Karjat-8 (G ₂)	0.005	0.004	0.00	31.3	0.008	0.004	0.01	49.1
Karjat-9 (G ₃)	0.008	0.003	0.01	62.9	0.006	0.003	0.00	55.9
Ratnagiri-4 (G ₄)	0.007	0.007	0.01	1.5	0.006	0.004	0.01	41.3
Ratnagiri-5 (G ₅)	0.006	0.005	0.01	3.4	0.007	0.004	0.01	41.2
Palghar-2 (G ₆)	0.007	0.006	0.01	19.3	0.007	0.007	0.01	-1.2
Phondaghat-1 (G ₇)	0.007	0.006	0.01	9.8	0.009	0.005	0.01	47.0
Karjat-1-1-12-24-1-13 (G ₈)	0.008	0.004	0.01	48.4	0.007	0.007	0.01	3.8
Karjat-5-17-25-29-6 (G ₉)	0.011	0.004	0.01	65.8	0.007	0.006	0.01	5.3
Karjat-5-10-10-16-13 (G ₁₀)	0.009	0.006	0.01	33.9	0.009	0.007	0.01	26.3
Karjat-BM4 (G ₁₁)	0.004	0.002	0.00	38.4	0.008	0.007	0.01	12.0
Karjat-6-22-9-14-13 (G ₁₂)	0.007	0.007	0.01	2.4	0.012	0.005	0.01	53.9
Karjat-5-8-13-15-7 (G ₁₃)	0.007	0.005	0.01	25.5	0.008	0.005	0.01	36.9
Karjat-5-7-10-12-2 (G ₁₄)	0.006	0.004	0.00	29.1	0.006	0.005	0.01	13.2
Karjat-7 (G ₁₅)	0.005	0.003	0.00	49.7	0.018	0.004	0.01	78.8
Swarnaprabha (G ₁₆)	0.008	0.005	0.01	44.1	0.009	0.003	0.01	63.2
Mean	0.0079	0.0067			0.0086	0.0050		
Factors	C.D.(5%)	S.Em±			C.D.(5%).	S.Em±		
Genotypes	0.0044	0.0016			0.0049	0.0017		
Treatment	0.0016	0.0005			0.0017	0.0006		
Interaction (G × T)	0.0062	0.0022			0.0070	0.0025		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 15(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on net assimilation rate (g dcm⁻² day⁻¹) of rice (*Oryza sativa* L.)

Genotypes	100 DAT-AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0005	0.0000	0.0003	89.6
Karjat-8 (G ₂)	0.0004	0.0001	0.0002	80.5
Karjat-9 (G ₃)	0.0003	0.0000	0.0002	94.0
Ratnagiri-4 (G ₄)	0.0003	0.0000	0.0002	90.1
Ratnagiri-5 (G ₅)	0.0002	0.0001	0.0001	70.6
Palghar-2 (G ₆)	0.0004	0.0001	0.0002	78.9
Phondaghat-1 (G ₇)	0.0001	0.0001	0.0001	59.8
Karjat-1-1-12-24-1-13 (G ₈)	0.0004	0.0001	0.0002	71.9
Karjat-5-17-25-29-6 (G ₉)	0.0003	0.0000	0.0002	88.6
Karjat-5-10-10-16-13 (G ₁₀)	0.0002	0.0002	0.0002	8.2
Karjat-BM4 (G ₁₁)	0.0003	0.0000	0.0001	94.3
Karjat-6-22-9-14-13 (G ₁₂)	0.0006	0.0000	0.0003	92.1
Karjat-5-8-13-15-7 (G ₁₃)	0.0004	0.0001	0.0002	80.8
Karjat-5-7-10-12-2 (G ₁₄)	0.0004	0.0000	0.0002	96.8
Karjat-7 (G ₁₅)	0.0004	0.0000	0.0002	95.9
Swarnaprabha (G ₁₆)	0.0004	0.0001	0.0003	74.7
Mean	0.0004	0.0001		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.00019	0.00007		
Treatment	0.0007	0.00002		
Interaction (G × T)	0.00026	0.00009		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

genotypes. In case of interaction, mean of NAR differs significantly at 80-100 DAT. Karjat-7 showed higher NAR in T_1 than others. Among the genotypes in T_2 treatment average NAR was 0.0050g to be recorded, while genotype Palghar-2, Karjat-BM4 and Karjat-5-10-10-16-13 (0.007g) recorded higher NAR than average NAR.

At 100 DAT to harvest, in case of genotype, mean NAR differ significantly. Significantly higher NAR (0.0006g) was observed in Karjat-6-22-9-14-13 which was at par with Sahyadri-5 over other genotypes. In case of interaction, mean of NAR differs significantly at 100 DAT to harvest. Karjat-6-22-9-14-13 showed higher NAR in T_1 than others. Among the genotypes in T_2 treatment average NAR was 0.0001g to be recorded, while genotype Karjat-5-10-10-16-13 (0.0002g) recorded higher NAR than average NAR.

4.4.4 Effects of light treatment on leaf area index (LAI)

The result on effects of normal and low light on leaf area index of rice at various growths stages are presented in Table 16(a), (b) & (c).

Data indicated that LAI increased continuously from 20 days after transplanting to harvest and the increase in LAI was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in LAI were differed significantly. Significantly higher LAI of T_2 at 40, 60, 80, 100 DAT and at harvest except 20 DAT than T_1 treatment.

At 20 DAT, in case of genotype, mean LAI differ significantly. Significantly higher LAI (0.628) was observed in

Ratnagiri-4 which was at par with Sahyadri-5 over other genotypes. In case of interaction, mean of LAI differs significantly at 20 DAT. Ratnagiri-4 showed higher LAI in T₁ than others. Among the genotypes in T₂ treatment average LAI was 0.380 to be recorded, while genotype Palghar-2 (0.519) recorded higher LAI than average LAI.

At 40 DAT, in case of genotype, mean LAI differ significantly. Significantly higher LAI (1.673) was observed in Palghar-2 which was at par with Ratnagiri-5 and Swarnaprabha over other genotypes. In case of interaction, mean of LAI differs significantly at 40 DAT. Palghar-2 showed higher LAI in T₁ than others. Among the genotypes in T₁ treatment average LAI was 1.325 to be recorded, while genotype Swarnaprabha (1.592) recorded higher LAI than average LAI.

At 60 DAT, in case of genotype, mean LAI differ significantly. Significantly higher LAI (6.707) was observed in Palghar-2 which was at par with Ratnagiri-5 and over other genotypes. In case of interaction, mean of LAI differs significantly at 60 DAT. Palghar-2 showed higher LAI in T₁ than others. Among the genotypes in T₁ treatment average LAI was 3.864 to be recorded, while genotype Ratnagiri-4 (5.012) recorded higher LAI than average LAI.

At 80 DAT, in case of genotype, mean LAI differ significantly. Significantly higher LAI (7.110) was observed in Palghar-2 which was at par with Ratnagiri-5 and over other genotypes. In case of interaction, mean of LAI differs significantly at 80 DAT. Palghar-2 showed higher LAI in T₁ than others. Among the genotypes in T₁ treatment average LAI was 4.343 to be recorded, while genotype Ratnagiri-4 (5.676) recorded higher LAI than average LAI.

Table 16(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on Leaf area index (LAI) of rice (*Oryza sativa* L.).

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.611	0.445	0.53	27.2	1.312	1.582	1.45	-20.5
Karjat-8 (G ₂)	0.519	0.451	0.48	13.2	1.411	1.428	1.42	-1.2
Karjat-9 (G ₃)	0.515	0.349	0.43	32.3	1.326	1.420	1.37	-7.2
Ratnagiri-4 (G ₄)	0.628	0.468	0.55	25.5	1.262	1.515	1.39	-20.0
Ratnagiri-5 (G ₅)	0.598	0.481	0.54	19.6	1.330	1.655	1.49	-24.5
Palghar-2 (G ₆)	0.540	0.519	0.53	3.9	1.286	1.673	1.48	-30.1
Phondaghat-1 (G ₇)	0.394	0.314	0.35	20.3	1.525	1.418	1.47	7.0
Karjat-1-1-12-24-1-13 (G ₈)	0.333	0.382	0.36	-14.9	1.181	1.561	1.37	-32.2
Karjat-5-17-25-29-6 (G ₉)	0.437	0.330	0.38	24.4	1.356	1.221	1.29	10.0
Karjat-5-10-10-16-13 (G ₁₀)	0.433	0.297	0.37	31.6	1.235	1.266	1.25	-2.4
Karjat-BM4 (G ₁₁)	0.309	0.304	0.31	1.7	1.143	1.122	1.13	1.8
Karjat-6-22-9-14-13 (G ₁₂)	0.385	0.351	0.37	8.8	1.397	1.600	1.50	-14.5
Karjat-5-8-13-15-7 (G ₁₃)	0.324	0.360	0.34	-11.0	1.372	1.513	1.44	-10.3
Karjat-5-7-10-12-2 (G ₁₄)	0.343	0.286	0.31	16.8	1.208	1.212	1.21	-0.3
Karjat-7 (G ₁₅)	0.448	0.310	0.38	30.8	1.270	1.310	1.29	-3.1
Swarnaprabha (G ₁₆)	0.450	0.442	0.45	1.8	1.592	1.552	1.57	2.5
Mean	0.454	0.380			1.325	1.440		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.0153	0.0054			0.0913	0.0323		
Treatment	0.0054	0.0019			0.0323	0.0114		
Interaction (G × T)	0.0217	0.0077			0.1291	0.0457		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 16(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on Leaf area index (LAI) of rice (*Oryza sativa* L.).

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	3.971	5.317	4.64	-33.9	4.708	6.101	5.40	-29.6
Karjat-8 (G ₂)	3.873	4.625	4.25	-19.4	4.542	5.125	4.83	-12.8
Karjat-9 (G ₃)	3.391	4.978	4.18	-46.8	3.622	5.696	4.66	-57.3
Ratnagiri-4 (G ₄)	5.012	5.335	5.17	-6.4	5.676	5.585	5.63	1.6
Ratnagiri-5 (G ₅)	4.580	6.069	5.32	-32.5	5.328	6.505	5.92	-22.1
Palghar-2 (G ₆)	4.000	6.707	5.35	-67.7	4.492	7.110	5.80	-58.3
Phondaghat-1 (G ₇)	3.521	5.587	4.55	-58.7	3.990	5.950	4.97	-49.1
Karjat-1-1-12-24-1-13 (G ₈)	3.323	5.099	4.21	-53.5	3.640	5.552	4.60	-52.5
Karjat-5-17-25-29-6 (G ₉)	3.942	4.512	4.23	-14.5	4.224	5.068	4.65	-20.0
Karjat-5-10-10-16-13 (G ₁₀)	3.698	5.540	4.62	-49.8	4.066	5.848	4.96	-43.8
Karjat-BM4 (G ₁₁)	3.267	3.576	3.42	-9.5	3.990	4.329	4.16	-8.5
Karjat-6-22-9-14-13 (G ₁₂)	3.802	5.638	4.72	-48.3	4.245	5.777	5.01	-36.1
Karjat-5-8-13-15-7 (G ₁₃)	3.299	5.012	4.16	-51.9	3.703	4.991	4.35	-34.8
Karjat-5-7-10-12-2 (G ₁₄)	4.027	4.398	4.21	-9.2	4.171	4.535	4.35	-8.7
Karjat-7 (G ₁₅)	3.917	3.784	3.85	3.4	4.530	4.520	4.52	0.2
Swarnaprabha (G ₁₆)	4.200	4.320	4.26	-2.9	4.556	4.515	4.54	0.9
Mean	3.864	5.031			4.343	5.450		
Factors	C.D.(5%)	S.Em±			C.D(5%)	S.Em±		
Genotypes	0.4145	0.1466			0.4372	0.1547		
Treatment	0.1466	0.0518			0.1546	0.0547		
Interaction (G × T)	0.5862	0.2074			0.6184	0.2187		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 16(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on Leaf area index (LAI) of rice (*Oryza sativa* L.).

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	4.963	6.478	5.72	-30.5	5.011	6.545	5.78	-30.6
Karjat-8 (G ₂)	4.792	5.415	5.10	-13.0	4.710	5.479	5.09	-16.3
Karjat-9 (G ₃)	3.925	6.146	5.04	-56.6	3.939	6.156	5.05	-56.3
Ratnagiri-4 (G ₄)	6.130	5.948	6.04	3.0	6.263	6.051	6.16	3.4
Ratnagiri-5 (G ₅)	5.690	6.927	6.31	-21.7	5.710	6.989	6.35	-22.4
Palghar-2 (G ₆)	4.862	7.410	6.14	-52.4	4.901	7.386	6.14	-50.7
Phondaghat-1 (G ₇)	4.214	6.220	5.22	-47.6	4.138	6.121	5.13	-47.9
Karjat-1-1-12-24-1-13 (G ₈)	3.908	5.920	4.91	-51.5	3.730	5.993	4.86	-60.7
Karjat-5-17-25-29-6 (G ₉)	4.493	5.423	4.96	-20.7	4.660	5.353	5.01	-14.9
Karjat-5-10-10-16-13 (G ₁₀)	4.285	6.035	5.16	-40.8	4.360	6.051	5.21	-38.8
Karjat-BM4 (G ₁₁)	4.192	4.471	4.33	-6.6	4.209	4.336	4.27	-3.0
Karjat-6-22-9-14-13 (G ₁₂)	4.436	6.094	5.26	-37.4	4.466	6.136	5.30	-37.4
Karjat-5-8-13-15-7 (G ₁₃)	3.946	5.283	4.61	-33.9	3.992	5.365	4.68	-34.4
Karjat-5-7-10-12-2 (G ₁₄)	4.465	4.815	4.64	-7.8	4.345	4.839	4.59	-11.4
Karjat-7 (G ₁₅)	4.666	4.831	4.75	-3.5	4.734	4.883	4.81	-3.1
Swarnaprabha (G ₁₆)	4.818	5.102	4.96	-5.9	4.820	5.153	4.99	-6.9
Mean	4.612	5.782			4.624	5.802		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.4339	0.1535			0.4518	0.1598		
Treatment	0.1534	0.0543			0.1597	0.0565		
Interaction (G × T)	0.6136	0.2170			0.6390	0.2260		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

At 100 DAT, in case of genotype, mean LAI differ significantly. Significantly higher LAI (7.410 g) was observed in Palghar-2 which was at par with Ratnagiri-5 and over other genotypes. In case of interaction, mean of LAI differs significantly at 100 DAT. Palghar-2 showed higher LAI in T₁ than others. Among the genotypes in T₁ treatment average LAI was 4.612 to be recorded, while genotype Ratnagiri-4 (6.130) recorded higher LAI than average LAI.

At harvest, in case of genotype, mean LAI differ significantly. Significantly higher LAI (7.386) was observed in Palghar-2 which was at par with Ratnagiri-5 and over other genotypes. In case of interaction, mean of LAI differs significantly at harvest. Palghar-2 showed higher LAI in T₁ than others. Among the genotypes in T₁ treatment average LAI was 4.624 to be recorded, while genotype Ratnagiri-4 (6.263) recorded higher LAI than average LAI.

4.4.5 Effects of light treatment on specific leaf weight (SLW) (g cm⁻²)

The result on effects of normal and low light on specific leaf weight of rice at various growths stages are presented in Table 17(a), (b) & (c). Data indicated that SLW increased continuously from 20 days after transplanting to harvest and the increase in SLW was more between 20 to 80 days after transplanting as compared to other stages.

As regards treatments it was observed that in all the stages from 20-100 DAT and at harvest the mean differences in SLW were differed significantly. Significantly higher SLW were observed in T₁ at 20, 40, 60, 80, 100 DAT and at harvest than T₂ treatment.

At 20 DAT, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0021g) was observed in Karjat-5-7-10-12-2 and Karjat-7 which was at par with Phondaghat-1 over other genotypes. In case of interaction, mean of SLW differs significantly at 20 DAT. Karjat-5-7-10-12-2 and Karjat-7 showed higher SLW in T₁ than others. Among the genotypes in T₁ treatment average SLW was 0.0013g to be recorded, while genotype Karjat-5-7-10-12-2 (0.0014g) recorded higher SLW than average SLW.

At 40 DAT, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0062 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of SLW differs significantly at 40 DAT. Ratnagiri-4 showed higher SLW in T₁ than others. Among the genotypes in T₂ treatment average SLW was 0.0018g to be recorded, while genotype Palghar-2 (0.0021g) recorded higher SLW than average SLW.

At 60 DAT, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0040 g) was observed in Karjat-1-1-12-24-1-13 which was at par with Phondaghat-1 and Sahyadri-5 over other genotypes. In case of interaction, mean of SLW differs significantly at 60 DAT. Karjat-1-1-12-24-1-13 showed higher SLW in T₁ than others. Among the genotypes in T₂ treatment average SLW was 0.0015g to be recorded, while genotype Karjat-BM4 (0.0018g) recorded higher SLW than average SLW.

At 80 DAT, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0063 g) was observed in Karjat-1-1-12-24-1-13 which was at par with Karjat-9 over other genotypes. In case of interaction, mean of SLW differs significantly at 80 DAT. Karjat-1-1-12-24-1-13 showed higher

Table 17(a) Effects of normal light (Without Shade Net) and low light (Shade Net) on specific leaf weight (g cm⁻²) of rice (*Oryza sativa* L.).

Genotypes	20 DAT				40 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0012	0.0013	0.0013	-9.3	0.0047	0.0018	0.0032	60.5
Karjat-8 (G ₂)	0.0010	0.0009	0.0010	4.8	0.0037	0.0016	0.0026	57.6
Karjat-9 (G ₃)	0.0011	0.0018	0.0015	-56.9	0.0038	0.0015	0.0027	58.9
Ratnagiri-4 (G ₄)	0.0012	0.0012	0.0012	-6.9	0.0062	0.0018	0.0040	71.3
Ratnagiri-5 (G ₅)	0.0012	0.0013	0.0013	-6.1	0.0056	0.0019	0.0038	66.0
Palghar-2 (G ₆)	0.0009	0.0013	0.0011	-44.5	0.0051	0.0021	0.0036	59.5
Phondaghat-1 (G ₇)	0.0019	0.0016	0.0017	11.9	0.0036	0.0018	0.0027	50.1
Karjat-1-1-12-24-1-13 (G ₈)	0.0018	0.0011	0.0015	40.7	0.0035	0.0016	0.0026	54.0
Karjat-5-17-25-29-6 (G ₉)	0.0013	0.0015	0.0014	-9.6	0.0029	0.0019	0.0024	34.3
Karjat-5-10-10-16-13 (G ₁₀)	0.0016	0.0013	0.0014	22.1	0.0038	0.0023	0.0031	40.8
Karjat-BM4 (G ₁₁)	0.0015	0.0015	0.0015	-3.7	0.0032	0.0016	0.0024	50.1
Karjat-6-22-9-14-13 (G ₁₂)	0.0013	0.0016	0.0014	-19.4	0.0034	0.0018	0.0026	47.2
Karjat-5-8-13-15-7 (G ₁₃)	0.0013	0.0013	0.0013	-1.2	0.0030	0.0016	0.0023	45.1
Karjat-5-7-10-12-2 (G ₁₄)	0.0014	0.0021	0.0017	-50.8	0.0032	0.0019	0.0025	39.8
Karjat-7 (G ₁₅)	0.0009	0.0021	0.0015	-145.2	0.0039	0.0020	0.0029	50.0
Swarnaprabha (G ₁₆)	0.0010	0.0009	0.0010	5.3	0.0032	0.0017	0.0025	45.7
Mean	0.0013	0.0014			0.0039	0.0018		
Factors	C.D.(5%)	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.00010	0.00003			0.00021	0.00008		
Treatment	0.00003	0.00001			0.00008	0.00003		
Interaction (G × T)	0.00014	0.00005			0.00030	0.00011		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 17(b) Effects of normal light (Without Shade Net) and low light (Shade Net) on specific leaf weight (g cm⁻²) of rice (*Oryza sativa* L.).

Genotypes	60 DAT				80 DAT			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0039	0.0015	0.0027	62.0	0.0057	0.0022	0.0040	60.7
Karjat-8 (G ₂)	0.0035	0.0015	0.0025	57.5	0.0051	0.0023	0.0037	55.1
Karjat-9 (G ₃)	0.0038	0.0014	0.0026	63.1	0.0061	0.0021	0.0041	65.5
Ratnagiri-4 (G ₄)	0.0036	0.0015	0.0026	57.2	0.0054	0.0025	0.0039	53.5
Ratnagiri-5 (G ₅)	0.0035	0.0014	0.0025	60.0	0.0052	0.0022	0.0037	56.5
Palghar-2 (G ₆)	0.0037	0.0015	0.0026	59.2	0.0055	0.0024	0.0040	56.7
Phondaghat-1 (G ₇)	0.0039	0.0014	0.0027	63.8	0.0059	0.0023	0.0041	61.6
Karjat-1-1-12-24-1-13 (G ₈)	0.0040	0.0014	0.0027	65.1	0.0063	0.0022	0.0042	65.0
Karjat-5-17-25-29-6 (G ₉)	0.0032	0.0015	0.0023	52.5	0.0050	0.0023	0.0036	54.7
Karjat-5-10-10-16-13 (G ₁₀)	0.0038	0.0013	0.0025	65.7	0.0058	0.0021	0.0039	64.3
Karjat-BM4 (G ₁₁)	0.0033	0.0018	0.0025	46.1	0.0046	0.0025	0.0035	45.6
Karjat-6-22-9-14-13 (G ₁₂)	0.0035	0.0013	0.0024	63.4	0.0053	0.0021	0.0037	60.2
Karjat-5-8-13-15-7 (G ₁₃)	0.0038	0.0014	0.0026	62.3	0.0057	0.0024	0.0041	57.4
Karjat-5-7-10-12-2 (G ₁₄)	0.0028	0.0016	0.0022	42.3	0.0046	0.0027	0.0037	42.0
Karjat-7 (G ₁₅)	0.0034	0.0017	0.0025	50.0	0.0049	0.0024	0.0036	51.4
Swarnaprabha (G ₁₆)	0.0031	0.0015	0.0023	51.8	0.0049	0.0025	0.0037	49.9
Mean	0.0035	0.0015			0.0054	0.0023		
Factors	C.D.(5%)	S.Em±			C.D(5%)	S.Em±		
Genotypes	0.00028	0.00010			0.00041	0.00015		
Treatment	0.00010	0.00003			0.00015	0.00005		
Interaction (G × T)	0.00040	0.00014			0.00058	0.00021		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

Table 17(c) Effects of normal light (Without Shade Net) and low light (Shade Net) on specific leaf weight (g cm⁻²) of rice (*Oryza sativa* L.).

Genotypes	100 DAT				AT HARVEST			
	T ₁	T ₂	Mean	Reduction (%)	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	0.0067	0.0026	0.0047	60.9	0.0065	0.0025	0.0045	61.1
Karjat-8 (G ₂)	0.0060	0.0027	0.0043	55.1	0.0060	0.0026	0.0043	57.0
Karjat-9 (G ₃)	0.0071	0.0024	0.0048	65.6	0.0069	0.0023	0.0046	66.3
Ratnagiri-4 (G ₄)	0.0062	0.0029	0.0046	52.8	0.0059	0.0028	0.0044	53.1
Ratnagiri-5 (G ₅)	0.0060	0.0026	0.0043	56.5	0.0059	0.0025	0.0042	57.4
Palghar-2 (G ₆)	0.0064	0.0029	0.0046	55.0	0.0063	0.0028	0.0045	55.3
Phondaghat-1 (G ₇)	0.0070	0.0027	0.0048	61.2	0.0069	0.0027	0.0048	61.6
Karjat-1-1-12-24-1-13 (G ₈)	0.0073	0.0026	0.0049	64.9	0.0074	0.0025	0.0050	66.8
Karjat-5-17-25-29-6 (G ₉)	0.0059	0.0026	0.0043	55.2	0.0055	0.0026	0.0041	53.4
Karjat-5-10-10-16-13 (G ₁₀)	0.0069	0.0025	0.0047	63.6	0.0066	0.0024	0.0045	63.1
Karjat-BM4 (G ₁₁)	0.0054	0.0030	0.0042	44.7	0.0053	0.0030	0.0041	43.6
Karjat-6-22-9-14-13 (G ₁₂)	0.0063	0.0025	0.0044	60.6	0.0062	0.0024	0.0043	61.4
Karjat-5-8-13-15-7 (G ₁₃)	0.0068	0.0029	0.0048	57.4	0.0066	0.0027	0.0047	58.1
Karjat-5-7-10-12-2 (G ₁₄)	0.0054	0.0032	0.0043	41.6	0.0055	0.0030	0.0042	44.7
Karjat-7 (G ₁₅)	0.0059	0.0028	0.0044	53.1	0.0058	0.0026	0.0042	54.6
Swarnaprabha (G ₁₆)	0.0058	0.0027	0.0043	53.3	0.0058	0.0026	0.0042	54.5
Mean	0.0063	0.0027			0.0062	0.0026		
Factors	C.D.(5%).	S.Em±			C.D.(5%)	S.Em±		
Genotypes	0.00047	0.00017			0.00042	0.00015		
Treatment	0.00017	0.00006			0.00015	0.00005		
Interaction (G × T)	0.00066	0.00024			0.00059	0.00021		

DAT – Days after transplanting

T₁ –Without Shade Net

T₂ – Shade Net

SLW in T₁ than others. Among the genotypes in T₂ treatment average SLW was 0.0023g to be recorded, while genotype Karjat-5-7-10-12-2 (0.0027g) recorded higher SLW than average SLW.

At 100 DAT, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0073 g) was observed in Karjat-1-1-12-24-1-13 which was at par with Karjat-9 and Phondaghat-1 over other genotypes. In case of interaction, mean of SLW differs significantly at 100 DAT. Karjat-1-1-12-24-1-13 showed higher SLW in T₁ than others. Among the genotypes in T₂ treatment average SLW was 0.0027g to be recorded, while genotype Karjat-BM4 (0.0030g) recorded higher SLW than average SLW.

At harvest, in case of genotype, mean SLW differ significantly. Significantly higher SLW (0.0074 g) was observed in Karjat-1-1-12-24-1-13 which was at par with Karjat-9 and Phondaghat-1 over other genotypes. In case of interaction, mean of SLW differs significantly at harvest. Karjat-1-1-12-24-1-13 showed higher SLW in T₁ than others. Among the genotypes in T₂ treatment average SLW was 0.0026g to be recorded, while genotype Karjat-BM4 and Karjat-5-7-10-12-2 (0.0030g) recorded higher SLW than average SLW.

4.5 Yield and yield attributes

4.5.1 Effects of light treatment on total number of spikelet's per panicle

The result on effects of normal and low light on total number of spikelet's per panicle of rice at harvesting stage is presented in Table 18 and fig. 6.

As regards treatment it was observed that in the at harvest stage the mean differences in total number of spikelet's

per panicle were significantly. Significantly higher number of spikelet's per panicle was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean total number of spikelet's per panicle differ significantly. Significantly higher total number of spikelet's per panicle (120.88) were observed in Palghar-2 which was at par with Ratnagiri-5, Ratnagiri-4, Karjat-5-10-10-16-13

Table 18 Effects of normal light (Without Shade Net) and low light (Shade Net) on total number of spikelet's per panicle at harvesting stage in rice (*Oryza sativa* L.).

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	108.12	84.99	96.55	21.4
Karjat-8 (G ₂)	98.47	69.81	84.14	29.1
Karjat-9 (G ₃)	87.68	68.64	78.16	21.7
Ratnagiri-4 (G ₄)	112.77	102.45	107.61	9.2
Ratnagiri-5 (G ₅)	114.29	88.79	101.54	22.3
Palghar-2 (G ₆)	120.88	83.31	102.10	31.1
Phondaghat-1 (G ₇)	109.45	79.80	94.63	27.1
Karjat-1-1-12-24-1-13 (G ₈)	100.86	71.52	86.19	29.1
Karjat-5-17-25-29-6 (G ₉)	95.33	69.12	82.22	27.5
Karjat-5-10-10-16-13 (G ₁₀)	112.72	81.23	96.98	27.9
Karjat-BM4 (G ₁₁)	92.06	60.79	76.43	34.0
Karjat-6-22-9-14-13 (G ₁₂)	100.17	77.99	89.08	22.1
Karjat-5-8-13-15-7 (G ₁₃)	102.51	70.15	86.33	31.6
Karjat-5-7-10-12-2 (G ₁₄)	101.07	68.13	84.60	32.6
Karjat-7 (G ₁₅)	112.56	76.27	94.41	32.2
Swarnaprabha (G ₁₆)	100.24	72.77	86.50	27.4
Mean	104.32	76.61		
Factors	C.D.(5%)	S.Em±		
Genotypes	8.730	3.088		
Treatment	3.086	1.092		
Interaction (G × T)	12.346	4.367		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

and Karjat-7 over other genotypes. In case of interaction, mean of total number of spikelet's per panicle differs significantly at harvest stage. Palghar-2 showed higher total number of spikelet's in T₁ than others. Among the genotypes in T₂ treatment average number of spikelet's per panicle was 76.61 to be

recorded, while genotype Ratnagiri-4 (102.45) recorded higher number of spikelet's than average number of spikelet's per panicle.

4.5.2 Effects of light treatment on number of filled spikelet's per panicle

The result on effects of normal and low light on number of filled spikelet's per panicle of rice at harvesting stage is presented in Table 19 and fig. 7.

Table 19 Effects of normal light (Without Shade Net) and low light (Shade Net) on number of filled spikelet's per panicle at harvesting stage in rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	70.14	57.04	63.59	18.7
Karjat-8 (G ₂)	57.63	51.99	54.81	9.8
Karjat-9 (G ₃)	56.70	46.23	51.46	18.5
Ratnagiri-4 (G ₄)	84.64	54.26	69.45	35.9
Ratnagiri-5 (G ₅)	73.51	60.29	66.90	18.0
Palghar-2 (G ₆)	69.02	63.76	66.39	7.6
Phondaghat-1 (G ₇)	65.89	57.77	61.83	12.3
Karjat-1-1-12-24-1-13 (G ₈)	59.03	53.19	56.11	9.9
Karjat-5-17-25-29-6 (G ₉)	57.09	50.24	53.66	12.0
Karjat-5-10-10-16-13 (G ₁₀)	67.09	59.57	63.33	11.2
Karjat-BM4 (G ₁₁)	50.20	48.58	49.39	3.2
Karjat-6-22-9-14-13 (G ₁₂)	64.40	52.74	58.57	18.1
Karjat-5-8-13-15-7 (G ₁₃)	57.95	54.08	56.02	6.7
Karjat-5-7-10-12-2 (G ₁₄)	56.25	53.61	54.93	4.7
Karjat-7 (G ₁₅)	62.94	59.54	61.24	5.4
Swarnaprabha (G ₁₆)	60.10	52.96	56.53	11.9
Mean	63.29	54.74		
Factors	C.D.(5%)	S.Em±		
Genotypes	5.460	1.932		
Treatment	1.931	0.683		
Interaction (G × T)	7.722	2.732		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

As regards treatment it was observed that in the at harvest stage the mean differences in number of filled spikelet's per

panicle were significantly. Significantly higher number of filled spikelet's per panicle was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean number of filled spikelet's per panicle differ significantly. Significantly higher number of filled spikelet's per panicle (84.64) were observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of number of filled spikelet's per panicle differs significantly at harvest stage. Ratnagiri-4 showed number of filled spikelet's per panicle in T₁ than others. Among the genotypes in T₂ treatment average number of filled spikelet's per panicle was 54.74 to be recorded, while genotype Palghar-2 (57.77) recorded higher number of filled spikelet's than average number of filled spikelet's per panicle.

4.5.3 Effects of light treatment on panicle length (cm)

The result on effects of normal and low light on panicle length (cm) of rice at harvesting stage is presented in Table 20 and fig. 8.

As regards treatment it was observed that in the at harvest stage the mean differences in panicle length were significantly. Significantly maximum panicle length was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean of panicle length differs significantly. Significantly maximum panicle length (22.21 cm) was observed in Sahyadri-5 which was at par with Palghar-2 and Karjat-6-22-9-14-13 over other genotypes. In case of interaction; mean of panicle length differs significantly at harvest stage. Sahyadri-5 showed higher panicle length in T₁ than others. Among the genotypes in T₂ treatment average panicle length was 19.73cm to be recorded, while genotype Karjat-5-8-13-15-7

(21.20cm) recorded higher panicle length than average panicle length.

Table 20 Effects of normal light (Without Shade Net) and low light (Shade Net) on panicle length (cm) at harvesting stage in rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	22.21	21.03	21.62	5.3
Karjat-8 (G ₂)	19.48	18.10	18.79	7.1
Karjat-9 (G ₃)	19.13	18.18	18.65	5.0
Ratnagiri-4 (G ₄)	21.38	20.20	20.79	5.5
Ratnagiri-5 (G ₅)	20.26	19.04	19.65	6.0
Palghar-2 (G ₆)	22.07	20.17	21.12	8.6
Phondaghat-1 (G ₇)	20.56	19.51	20.04	5.1
Karjat-1-1-12-24-1-13 (G ₈)	19.52	20.44	19.98	-4.7
Karjat-5-17-25-29-6 (G ₉)	18.50	19.14	18.82	-3.4
Karjat-5-10-10-16-13 (G ₁₀)	19.45	18.44	18.94	5.2
Karjat-BM4 (G ₁₁)	19.59	20.17	19.88	-2.9
Karjat-6-22-9-14-13 (G ₁₂)	21.73	20.50	21.11	5.7
Karjat-5-8-13-15-7 (G ₁₃)	20.40	21.20	20.80	-4.0
Karjat-5-7-10-12-2 (G ₁₄)	20.62	19.24	19.93	6.7
Karjat-7 (G ₁₅)	20.32	21.07	20.69	-3.7
Swarnaprabha (G ₁₆)	20.67	19.19	19.93	7.1
Mean	20.37	19.73		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.3898	0.1379		
Treatment	0.1378	0.0488		
Interaction (G × T)	0.5513	0.1950		

DAT – Days after transplanting T₁ –Without Shade Net T₂ – Shade Net

4.5.4 Effects of light treatment on 1000 grain weight (g)

The result on effects of normal and low light on 1000 grain weight (g) of rice at harvesting stage is presented in Table 21 and fig. 9.

As regards treatment it was observed that in the at harvest stage the mean differences in 1000 grain weight were significantly. Significantly maximum 1000 grain weight was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean of 1000 grain weight differs significantly. Significantly maximum 1000 grain weight (30.20 g)

was observed in Swarnaprabha over other genotypes. In case of interaction, mean of 1000 grain weight differs significantly at harvest stage. Swarnaprabha showed higher 1000 grain weight in T₁ than others. Among the genotypes in T₂ treatment average 1000 grain weight was 20.13g to be recorded, while genotype Swarnaprabha (26.07g) recorded higher 1000 grain weight than average 1000 grain weight.

Table 21 Effects of normal light (Without Shade Net) and low light (Shade Net) on 1000 grain weight (g) at harvesting stage in rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	26.20	24.36	25.28	7.0
Karjat-8 (G ₂)	13.43	12.04	12.74	10.4
Karjat-9 (G ₃)	19.71	19.32	19.51	2.0
Ratnagiri-4 (G ₄)	26.57	24.70	25.64	7.1
Ratnagiri-5 (G ₅)	12.75	12.49	12.62	2.1
Palghar-2 (G ₆)	12.73	11.94	12.34	6.2
Phondaghat-1 (G ₇)	22.34	20.74	21.54	7.2
Karjat-1-1-12-24-1-13 (G ₈)	24.97	22.37	23.67	10.4
Karjat-5-17-25-29-6 (G ₉)	24.62	20.99	22.80	14.8
Karjat-5-10-10-16-13 (G ₁₀)	18.37	16.86	17.62	8.2
Karjat-BM4 (G ₁₁)	18.51	18.06	18.29	2.4
Karjat-6-22-9-14-13 (G ₁₂)	24.29	21.78	23.04	10.3
Karjat-5-8-13-15-7 (G ₁₃)	28.89	25.67	27.28	11.1
Karjat-5-7-10-12-2 (G ₁₄)	23.31	21.95	22.63	5.8
Karjat-7 (G ₁₅)	24.03	22.89	23.46	4.8
Swarnaprabha (G ₁₆)	30.20	26.07	28.14	13.7
Mean	21.93	20.13		
Factors	C.D.(5%)	S.Em±		
Genotypes	0.9492	0.3358		
Treatment	0.3356	0.1187		
Interaction (G × T)	1.3424	0.4749		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

4.5.5 Effects of light treatment on grain yield per plant (g)

The result on effects of normal and low light on grain yield per plant (g) of rice at harvesting stage is presented in Table 22 and fig. 10.

As regards treatment it was observed that in the at harvest stage the mean differences in grain yield per plant (g) were significantly. Significantly maximum grain yield per plant was observed in T₁ than T₂ at harvest stage

In case of genotypes, mean of grain yield per plant differs significantly. Significantly maximum grain yield per plant.

Table 22 Effects of normal light (Without Shade Net) and low light (Shade Net) on grain yield per plant (g) of rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	23.33	8.04	15.69	65.5
Karjat-8 (G ₂)	19.71	6.53	13.12	66.8
Karjat-9 (G ₃)	18.35	7.05	12.70	61.5
Ratnagiri-4 (G ₄)	27.71	7.87	17.79	71.5
Ratnagiri-5 (G ₅)	24.41	8.67	16.54	64.4
Palghar-2 (G ₆)	22.46	10.36	16.41	53.8
Phondaghat-1 (G ₇)	18.29	8.50	13.39	53.5
Karjat-1-1-12-24-1-13 (G ₈)	17.59	7.37	12.48	58.1
Karjat-5-17-25-29-6 (G ₉)	17.87	6.97	12.42	61.0
Karjat-5-10-10-16-13 (G ₁₀)	20.07	7.37	13.72	63.2
Karjat-BM4 (G ₁₁)	14.85	6.07	10.46	59.0
Karjat-6-22-9-14-13 (G ₁₂)	18.03	7.58	12.80	57.9
Karjat-5-8-13-15-7 (G ₁₃)	16.09	7.93	12.01	50.7
Karjat-5-7-10-12-2 (G ₁₄)	16.17	7.52	11.84	53.4
Karjat-7 (G ₁₅)	18.51	7.08	12.79	61.7
Swarnaprabha (G ₁₆)	18.02	7.43	12.72	58.7
Mean	19.47	7.65		
Factors	C.D.(5%)	S.Em±		
Genotypes	1.2229	0.6118		
Treatment	0.4324	0.2163		
Interaction (G × T)	1.7294	0.8651		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

(27.71 g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of grain yield per plant differs significantly at harvest stage. Ratnagiri-4 showed higher grain yield per plant in T₁ than others. Among the genotypes in T₂

treatment average grain yield per plant was 7.65g to be recorded, while genotype Palghar-2 (10.36g) recorded higher grains yield than average grain yield per plant.

The overall yield reduction percentage was observed maximum in Ratnagiri-4 (71.5%) followed by Karjat-8 (66.8%) whereas; minimum was recorded in Karjat-5-8-13-15-7 (50.7%) as compared to all the tested genotypes.

4.5.6 Effects of light treatment on Straw weight per plant (g)

The result on effects of normal and low light on straw weight per plant (g) of rice at harvesting stage is presented in

Table 23 Effects of normal light (Without Shade Net) and low light (Shade Net) on straw weight per plant (g) of rice (*Oryza sativa* L.)

Genotypes	T ₁	T ₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	31.23	17.49	24.36	44.0
Karjat-8 (G ₂)	27.87	15.29	21.58	45.1
Karjat-9 (G ₃)	25.67	15.30	20.48	40.4
Ratnagiri-4 (G ₄)	36.63	17.47	27.05	52.3
Ratnagiri-5 (G ₅)	33.58	18.27	25.92	45.6
Palghar-2 (G ₆)	31.45	20.13	25.79	36.0
Phondaghat-1 (G ₇)	27.23	17.11	22.17	37.2
Karjat-1-1-12-24-1-13 (G ₈)	25.44	15.77	20.61	38.0
Karjat-5-17-25-29-6 (G ₉)	24.48	15.39	19.94	37.1
Karjat-5-10-10-16-13 (G ₁₀)	28.79	16.64	22.72	42.2
Karjat-BM4 (G ₁₁)	21.52	13.55	17.53	37.1
Karjat-6-22-9-14-13 (G ₁₂)	25.48	16.73	21.11	34.3
Karjat-5-8-13-15-7 (G ₁₃)	24.28	16.21	20.25	33.2
Karjat-5-7-10-12-2 (G ₁₄)	23.67	15.45	19.56	34.8
Karjat-7 (G ₁₅)	26.41	15.29	20.85	42.1
Swarnaprabha (G ₁₆)	27.52	15.63	21.58	43.2
Mean	27.58	16.36		
Factors	C.D.(5%)	S.Em±		
Genotypes	1.058	0.374		
Treatment	0.374	0.132		
Interaction (G × T)	1.496	0.529		

DAT – Days after transplanting T₁ – Without Shade Net T₂ – Shade Net

table 23 and fig. 11.

As regards treatment it was observed that in the at harvest stage the mean differences in straw weight per plant (g) were significantly. Significantly maximum straw weight per plant was observed in T₁ than T₂ at harvest stage

In case of genotypes, mean of straw weight per plant differs significantly. Significantly maximum straw weight per plant (36.63g) was observed in Ratnagiri-4 over other genotypes. In case of interaction, mean of straw weight per plant differs significantly at harvest stage. Ratnagiri-4 showed higher straw weight per plant in T₁ than others. Among the genotypes in T₂ treatment average straw weight per plant was 16.36g to be recorded, while genotype Palghar-2 (20.13g) recorded higher straw weight than average straw weight per plant.

4.5.7 Effects of light treatment on harvest index (%)

The result on effects of normal and low light on harvest index (%) of rice at harvesting stage is presented in Table 24 and Fig. 12.

As regards treatment it was observed that is the at harvest stage the mean differences in harvest index were significant. Significantly maximum harvest index was observed in T₁ than T₂ at harvest stage.

In case of genotypes, mean of harvest index differs significantly. Significantly maximum harvest index (43.05%) was observed in Ratnagiri-4 which was at par with Sahyadri-5, Ratnagiri-5 and Karjat-9 over other genotypes. In case of interaction, mean of harvest index differs significantly at harvest stage. Ratnagiri-4 showed higher harvest index in T₁ than others. Among the genotypes in T₂ treatment average harvest index was 31.76% to be recorded, while genotype Palghar-2 (33.95%) recorded higher harvest index than average harvest index.

Table 24 Effects of normal light (Without Shade Net) and low light (Shade Net) on harvest index (%) of rice (*Oryza sativa* L.)

Genotypes	T₁	T₂	Mean	Reduction (%)
Sahyadri-5 (G ₁)	42.77	31.48	37.12	26.4
Karjat-8 (G ₂)	41.43	29.90	35.67	27.8
Karjat-9 (G ₃)	41.73	31.52	36.63	24.5
Ratnagiri-4 (G ₄)	43.05	31.06	37.05	27.9
Ratnagiri-5 (G ₅)	42.09	32.19	37.14	23.5
Palghar-2 (G ₆)	41.66	33.95	37.81	18.5
Phondaghat-1 (G ₇)	40.14	33.20	36.67	17.3
Karjat-1-1-12-24-1-13 (G ₈)	40.81	31.85	36.33	22.0
Karjat-5-17-25-29-6 (G ₉)	42.18	31.03	36.61	26.4
Karjat-5-10-10-16-13 (G ₁₀)	41.07	30.68	35.87	25.3
Karjat-BM4 (G ₁₁)	40.82	30.96	35.89	24.2
Karjat-6-22-9-14-13 (G ₁₂)	41.38	31.01	36.19	25.1
Karjat-5-8-13-15-7 (G ₁₃)	39.61	32.86	36.24	17.1
Karjat-5-7-10-12-2 (G ₁₄)	40.64	32.66	36.65	19.6
Karjat-7 (G ₁₅)	41.22	31.63	36.43	23.3
Swarnaprabha (G ₁₆)	39.61	32.19	35.90	18.7
Mean	41.26	31.76		
Factors	C.D.(5%)	S.Em±		
Genotypes	2.5632	0.9067		
Treatment	0.9062	0.3206		
Interaction (G × T)	3.6250	1.2823		
DAT – Days after transplanting T ₁ –Without Shade Net T ₂ – Shade Net				

CHAPTER V

DISCUSSION

The primary objective of the present investigation was to identify suitable genotypes of rice (*Oryza sativa* L.) for shade tolerance by studying under shade net condition and to study the growth functions viz. Absolute growth rate, Relative growth rate, Net assimilation rate, Leaf area index and Specific leaf weight of various genotypes. All sixteen genotypes of rice evaluated for twenty three characters. The results obtained in the present investigation are discussed in this chapter.

The main objective of the experiment was identification of such rice genotypes which will be essential for developing high yielding varieties that can be survive in low light condition. The experimental findings of the present investigation have been described under the following heads:

- 5.1 Morphological parameters
- 5.2 Biophysiological parameters
- 5.3 Physiological parameters
- 5.4 Growth parameters
- 5.5 Yield and yield attributes

5.1 Morphological parameters

5.1.1 days to 50 % flowering

The maximum reduction was found in Phondaghat-1 (4.7 days) followed by Ratnagiri-4, Ratnagiri-5 and Karjat-BM4 (4.3 days) and the minimum reduction was found in Karjat-9 (1.9 days) followed by Karjat-6-22-9-14-13 (2.6 days) in days to 50 % flowering of rice as compare under shade net to without shade net condition as also recorded by Patma *et al* (1993), Barmudoi *et al.* (2016) and Thangraj and Sivasubramaniam (1990).

5.1.2 days to maturity

The maximum reduction was found in Karjat-9 (3.9 days) followed by Karjat-8 (3.8 days) and Palghar-2 (3.7 days) and the minimum reduction was found in Swarnaprabha (1.0 days) followed by Karjat-5-8-13-15-7 (1.2 days) in days to maturity of rice under shade net condition as also recorded by Patma *et al* (1993) and Thangraj and Sivasubramaniam (1990).

5.1.3 Number of tillers per plant

At 20 DAT, the maximum reduction was found in Karjat-5-10-10-16-13 (44.4 %) followed by Karjat-5-8-13-15-7 (37.5 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers per plant was found in Karjat-6-22-9-14-13 (13.3 %) followed by Palghar-2 (20.0 %).

At 40 DAT, the maximum reduction was found in Phondaghat-1 (44.8 %) followed by Karjat-5-10-10-16-13 (42.9 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers per plant was found in Palghar-2 (21.4 %) followed by Karjat-8 (23.1 %).

At 60 DAT, the maximum reduction was found in Phondaghat-1 (40.8 %) followed by Karjat-5-10-10-16-13 (39.6 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers per plant was found in Karjat-5-8-13-15-7 (29.3 %) followed by Karjat-9 (29.5 %).

At 80 DAT, the maximum reduction was found in Phondaghat-1 (32.7 %) followed by Karjat-1-1-12-24-1-13 (32.1 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers

per plant was found in Karjat-6-22-9-14-13 (16.3 %) followed by Karjat-5-7-10-12-2 (19.1 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (29.4 %) followed by Karjat-7 (28.8 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers per plant was found in Karjat-8 (15.8 %) followed by Karjat-9 (16.1 %).

At harvest, the maximum reduction was found in Karjat-7 (28.8 %) followed by Ratnagiri-4 (28.4 %) was found in number of tillers per plant of rice under shade net condition and the minimum reduction in number of tillers per plant was found in Karjat-9 (14.5 %) followed by Karjat-8 (15.8 %).

Reduction in number of tillers per plant of rice under shade as compared to without shade net condition was also recorded by Gbadamosi *et al.* (2014), Nakano, (2000), Venkateswarlu *et al.* (1977), Varon *et al.* (2015), Patma *et al.* (1993) and Liu *et al.* (2009).

5.1.4 Number of productive tillers per plant

The maximum reduction was found in Karjat-BM4 (28.2 %) followed by Swarnaprabha (27.7 %) and the minimum reduction in number of productive tillers was found in Palghar-2 (12.5 %) followed by Karjat-1-1-12-24-1-13 (15.8 %) was found in number of productive tillers per plant of rice under shade net condition.

Reduction in number of productive tillers of rice under shade net as compared to without shade net condition was also recorded by Gbadamosi *et al.* (2014), Patma *et al.* (1993), Venkateswarlu, (1977) and Ren *et al.* (2003b).

5.1.5 Leaf area per plant (cm²)

At 20 DAT, the maximum reduction was found in Karjat-9 (32.3 %) followed by Karjat-5-10-10-16-13 (31.6 %) was found in leaf area per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Karjat-1-1-12-24-1-13 (-14.9 %) followed by Karjat-5-8-13-15-7 (-11.0 %).

At 40 DAT, the maximum reduction was found in Karjat-5-17-25-29-6 (10.0 %) followed by Phondaghat-1 (7.0 %) was found in leaf area per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Karjat-1-1-12-24-1-13 (-32.2 %) followed by Palghar-2 (-24.5 %).

At 60 DAT, the maximum reduction was found in Karjat-7 (3.4 %) followed by Swarnaprabha (0.0 %) was found in leaf area per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Palghar-2 (-67.2 %) followed by Phondaghat-1 (-58.7 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (1.6 %) followed by Swarnaprabha (0.9 %) was found in leaf area per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Palghar-2 (-58.3 %) followed by Karjat-9 (-57.3 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (3.0 %) followed by Karjat-7 (-3.5 %) was found in leaf area per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Karjat-9 (-56.6 %) followed by Palghar-2 (-52.4 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (3.4 %) followed by Karjat-BM4 (-3.0 %) was found in leaf area per plant of rice under shade net condition and the

minimum reduction in leaf area per plant was found in Karjat-1-1-12-24-1-13 (-60.7 %) followed by Karjat-9 (-56.3 %).

Reduction in leaf area per plant under shade net as compared to without shade net condition was also recorded by Chonan, (1967), Ren Wan Jun *et al.* (2012), Ding *et al.* (2004), Singh, S. (2000), Sun *et al.* (2012), Asana and Salunke (1971) and Gbadamosi *et al.* (2014).

5.1.6 Effects of light treatment on number of leaves per plant

At 20 DAT, the maximum reduction was found in Karjat-5-17-25-29-6 (34.2 %) followed by Ratnagiri-4 (33.8 %) was found in number of leaves per plant of rice under shade net condition and the minimum reduction in number of leaves per plant was found in Karjat-8 (-3.0 %) followed by Karjat-6-22-9-14-13 (13.1 %).

At 40 DAT, the maximum reduction was found in Karjat-5-7-10-12-2 (31.6 %) followed by Ratnagiri-4 (31.1 %) was found in number of leaves per plant of rice under shade net condition and the minimum reduction in number of leaves per plant was found in Palghar-2 (6.2 %) followed by Ratnagiri-4 (31.1 %).

At 60 DAT, the maximum reduction was found in Ratnagiri-4 (23.7 %) followed by Karjat-5-17-25-29-6 (13.7 %) was found in number of leaves per plant of rice under shade net condition and the minimum reduction in number of leaves per plant was found in Phondaghat-1 (-3.1 %) followed by Palghar-2 (0.4 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (23.6 %) followed by Karjat-8 (15.9 %) was found in number of leaves per plant of rice under shade net condition and

the minimum reduction in number of leaves per plant was found in Phondaghat-1 (-2.5 %) followed by Palghar-2 (0.0 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (23.7 %) followed by Karjat-8 (15.0 %) was found in number of leaves per plant of rice under shade net condition and the minimum reduction in number of leaves per plant was found in Phondaghat-1 (-2.5 %) followed by Palghar-2 (-0.4 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (18.2 %) followed by Karjat-5-17-25-29-6 (15.7 %) was found in number of leaves per plant of rice under shade net condition and the minimum reduction in number of leaves per plant was found in Phondaghat-1 (-6.3 %) followed by Palghar-2 (-5.6 %).

Reduction in number of leaves per plant under shade net as compared to without shade net condition was also recorded by Singh, S. (2000), Wada, (1968), Janardhan *et al.* (1980) and Chonan, (1967)

5.1.7 Effects of light treatment on stem weight per plant (g)

At 20 DAT, the maximum reduction was found in Ratnagiri-4 (63.0 %) followed by Karjat-5-17-25-29-6 (57.9 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Palghar-2 (33.0 %) followed by Karjat-6-22-9-14-13 (38.4 %).

At 40 DAT, the maximum reduction was found in Ratnagiri-4 (60.8 %) followed by Karjat-8 (52.7 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Swarnaprabha (38.0 %) followed by Palghar-2 (38.6 %).

At 60 DAT, the maximum reduction was found in Ratnagiri-4 (51.3 %) followed by Ratnagiri-5 (45.2 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Karjat-5-8-13-15-7 (31.1 %) followed by Karjat-5-7-10-12-2 (31.2 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (51.0 %) followed by Ratnagiri-5 (44.7 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Karjat-5-7-10-12-2 (28.4 %) followed by Karjat-5-8-13-15-7 (29.2 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (51.3 %) followed by Ratnagiri-5 (44.9 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Karjat-5-7-10-12-2 (29.5 %) followed by Karjat-5-8-13-15-7 (29.9 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (51.5 %) followed by Ratnagiri-5 (44.9 %) was found in stem weight per plant of rice under shade net condition and the minimum reduction in stem weight per plant was found in Karjat-5-7-10-12-2 (30.2 %) followed by Karjat-5-8-13-15-7 (30.3 %).

Reduction in stem weight per plant under shade net as compared to without shade net condition was also recorded by Sun *et al.* (2012) reported that when the low light intensity decreases, culm sheath dry matter exports and translocation rates all decreases, which leads to an increase in the rate of culm sheath dry matter weight and decreased total dry matter

weight of shoot as well as reduction in dry matter weight of panicle. Similar results were also reported by Bhagirath *et al.* (2013), Sun *et al.* (2012)

5.1.8 Effects of light treatment on leaf weight per plant (g)

At 20 DAT, the maximum reduction was found in Karjat-5-10-10-16-13 (46.7 %) followed by Karjat-1-1-12-24-1-13 (32.0 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Karjat-7 (-69.6 %) followed by Palghar-2 (-38.8 %).

At 40 DAT, the maximum reduction was found in Ratnagiri-4 (65.6 %) followed by Ratnagiri-5 (57.7 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Karjat-1-1-12-24-1-13 and Karjat-6-22-9-14-13 (39.1 %) followed by Karjat-5-10-10-16-13 (39.5 %).

At 60 DAT, the maximum reduction was found in Ratnagiri-4 (54.1 %) followed by Karjat-7 (51.3 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Palghar-2 (31.4 %) followed by Karjat-5-7-10-12-2 (37.1 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (54.1 %) followed by Karjat-7 (51.3 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Palghar-2 (31.4 %) followed by Karjat-5-7-10-12-2 (37.1 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (54.1 %) followed by Karjat-7 (51.3 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Palghar-2 (31.4 %) followed by Karjat-5-7-10-12-2 (37.1 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (54.8 %) followed by Karjat-7 (53.0 %) was found in leaf weight per plant of rice under shade net condition and the minimum reduction in leaf weight per plant was found in Palghar-2 (32.5 %) followed by Karjat-5-7-10-12-2 (38.3 %).

Reduction in leaf weight per plant under shade net as compared to without shade net condition was also recorded by Matsushima *et al.* (1953) reported that reduction of dry matter weight in leaf is believed to be the primarily cause of the decrease in photosynthetic assimilates under low light conditions. Similar results were also reported by Zhu *et al.* (2008), Sun *et al.* (2012).

5.1.9 Effects of light treatment on total dry weight per plant (g)

At 20 DAT, the maximum reduction was found in Ratnagiri-4 (49.1 %) followed by Karjat-5-17-25-29-6 (44.9 %) was found in total dry weight per plant of rice under shade net condition and the minimum reduction in total dry weight per plant was found in Palghar-2 (13.4 %) followed by Karjat-7 (22.8 %).

At 40 DAT, the maximum reduction was found in Ratnagiri-4 (63.0 %) followed by Ratnagiri-5 (55.0 %) was found in total dry weight per plant of rice under shade net condition and the minimum reduction in total dry weight per plant was found in Karjat-5-7-10-12-2 (39.6 %) followed by Karjat-5-17-25-29-6 (41.4 %).

At 60 DAT, the maximum reduction was found in Ratnagiri-4 (52.2 %) followed by Ratnagiri-5 (45.7 %) was found in total dry weight per plant of rice under shade net condition and the minimum reduction in total dry weight per plant was

found in Karjat-5-7-10-12-2 (33.1 %) followed by Karjat-5-8-13-15-7 (35.0 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (52.0 %) followed by Ratnagiri-5 (45.3 %) was found in total dry weight per plant of rice under shade net condition and the minimum reduction in total dry weight per plant was found in Karjat-5-7-10-12-2 (31.2 %) followed by Karjat-5-8-13-15-7 (33.8 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (52.2 %) followed by Ratnagiri-5 (45.5 %) was found in total dry weight per plant of rice under shade net condition and the minimum reduction in total dry weight per plant was found in Karjat-5-7-10-12-2 (31.9 %) followed by Karjat-5-8-13-15-7 (34.1 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (52.5 %) followed by Ratnagiri-5 (45.6 %) was found and the minimum reduction in total dry weight per plant was found in Karjat-5-7-10-12-2 (32.6 %) followed by Karjat-5-8-13-15-7 (34.6 %) in total dry weight per plant of rice under shade net condition as recorded by

Reduction in total dry weight per plant under shade net as compared to without shade net condition was also recorded by Swain and Naik (2004), Baig *et al.* (1996), Murty *et al.* (1994), Venkateswarlu *et al.* (1977), Chaturvedi and Ingram (1989), Prabha *et al.* (2004), San-oh *et al.* (2004), Varon *et al.* (2015), Sun *et al.* (2012), Asana and Salunke (1971), Barmudoi *et al.* (2016) and Thangraj and Sivasubramaniam (1990).

5.1.10 Effects of light treatment on plant height (cm)

At 20 DAT, the maximum reduction was found in Karjat-9 (6.4 %) followed by Karjat-8 (3.5 %) was found in plant height

per plant of rice under shade net condition and the minimum reduction in plant height per plant was found in Karjat-5-8-13-15-7 (-58.1 %) followed by Karjat-5-7-10-12-2 (-31.4 %).

At 40 DAT, the maximum reduction was found in Phondaghat-1 (-9.4 %) followed by Karjat-5-10-10-16-13 (-13.7 %) was found in plant height per plant of rice under shade net condition and the minimum reduction in plant height per plant was found in Karjat-5-8-13-15-7 (-53.3 %) followed by Karjat-BM4 (-46.0 %).

At 60 DAT, the maximum reduction was found in Karjat-5-10-10-16-13 (-1.9 %) followed by Karjat-5-7-10-12-2 (-3.1 %) was found in plant height per plant of rice under shade net condition and the minimum reduction in plant height per plant was found in Ratnagiri-4 (-32.5 %) followed by Karjat-5-8-13-15-7 (-29.1 %).

At 80 DAT, the maximum reduction was found in Karjat-5-7-10-12-2 (3.5 %) followed by Karjat-5-10-10-16-13 (-1.0 %) was found in plant height per plant of rice under shade net condition and the minimum reduction in plant height per plant was found in Karjat-5-8-13-15-7 (-22.3 %) followed by Phondaghat-1 (-20.9 %).

At 100 DAT, the maximum reduction was found in Karjat-BM4 (4.4 %) followed by Karjat-5-7-10-12-2 (0.8 %) was found in plant height per plant of rice under shade net condition and the minimum reduction in plant height per plant was found in Karjat-5-8-13-15-7 (-18.3 %) followed by Ratnagiri-4 (-17.3 %).

At harvest, the maximum reduction was found in Karjat-BM4 (4.4 %) followed by Karjat-5-7-10-12-2 (0.8 %) was found and the minimum reduction in plant height per plant was found in Karjat-5-8-13-15-7 (-18.3 %) followed by Ratnagiri-4 (-17.3 %)

in plant height per plant of rice under shade net condition as also recorded by

Reduction in plant height under shade net as compared to without shade net condition was also recorded by Gbadamosi *et al.* (2014), Patma *et al.* (1993), Ahmad *et al.* (2009), Venkateswarlu *et al.* (1977), Bhagirath *et al.* (2013), Ren *et al.* (2003) and Thangraj and Sivasubramaniam (1990).

5.2 Biochemical characteristics

5.2.1 Effects of light treatment on total chlorophyll content (mg/g fresh weight) at 30 and 50 days after transplanting

At 30 DAT, the maximum reduction was found in Ratnagiri-4 (-6.6 %) followed by Ratnagiri-5 (29.1 %) was found in total chlorophyll content of rice under shade net condition and the minimum reduction in total chlorophyll content was found in Karjat-9 (-108.8 %) followed by Karjat-8 (-100.5 %).

50 DAT, the maximum reduction was found in Ratnagiri-4 (-32.2 %) followed by Karjat-1-1-12-24-1-13 (-38.2 %) was found and the minimum reduction in total chlorophyll content was found in Phondaghat-1 (-62.7 %) followed by Karjat-5-8-13-15-7 (-59.2 %) in total chlorophyll content of rice under shade net condition as also recorded by

Reduction in total chlorophyll content under shade net as compared to without shade net condition was also recorded by Prabha *et al.* (2004), Lium, B. and Shoaf, T. (1976). Venkateswarlu *et al.* (1977), Hermann Restrepo *et al.* (2013), Liu *et al.* (2009), Liu *et al.* (2012), Wang, (2011), Hidema *et al.* (1991), Zhu *et al.* (2008), Janardhan *et al.* (1980), Singh, S. (2000), Ren Wan Jun *et al.* (2012) and Thangraj and Sivasubramaniam (1990).

5.3. Physiological parameters

5.3.1 Light intensity as 10 days interval (lux)

The mean reduction light intensity was found in 38.4 % to 44.2 % as compared to shade net and without shade net. Reduction in light intensity under shade net as compared to without shade net condition was also recorded by Venkateswarlu *et al.* (1977), LIU Qi-hua *et al.* (2014), Du Yanxiu *et al.* (2013) and Wang Li *et al.* (2012)

5.4 Growth parameters

5.4.1 Effects of light treatment on absolute growth rate (AGR) (g/day)

At 20-40 DAT, the maximum reduction was found in Ratnagiri-4 (65.1 %) followed by Ratnagiri-5 (58.1 %) was found in absolute growth rate of rice under shade net condition and the minimum reduction in absolute growth rate was found in Karjat-5-7-10-12-2 (40.5 %) followed by Karjat-5-17-25-29-6 (40.6 %).

At 40-60 DAT, the maximum reduction was found in Ratnagiri-4 (47.4 %) followed by Swarnaprabha (43.0 %) was found in absolute growth rate of rice under shade net condition and the minimum reduction in absolute growth rate was found in Karjat-5-7-10-12-2 (30.7 %) followed by Karjat-5-8-13-15-7 (32.2 %).

At 60-80 DAT, the maximum reduction was found in Ratnagiri-4 (51.7 %) followed by Ratnagiri-5 (44.9 %) was found in absolute growth rate of rice under shade net condition and the minimum reduction in absolute growth rate was found in Karjat-5-7-10-12-2 (28.5 %) followed by Karjat-5-8-13-15-7 (32.0 %).

At 80-100 DAT, the maximum reduction was found in Ratnagiri-4 (52.9 %) followed by Ratnagiri-5 (45.9 %) was found in absolute growth rate of rice under shade net condition and the minimum reduction in absolute growth rate was found in Karjat-5-7-10-12-2 (34.3 %) followed by Karjat-5-8-13-15-7 (35.3 %).

At 100 DAT to at harvest, the maximum reduction was found in Karjat-BM4 and Karjat-5-7-10-12-2 (97.4 %) followed by Karjat-7 (96.1 %) was found in absolute growth rate of rice under shade net condition and the minimum reduction in absolute growth rate was found in Karjat-5-10-10-16-13 (38.0 %) followed by Phondaghat-1 (62.9 %).

Reduction in absolute growth rate under shade net as compared to without shade net condition was also recorded by Burondkar (1985).

5.4.2 Effects of light treatment on relative growth rate (RGR) (g/g/unit time)

At 20-40 DAT, the maximum reduction was found in Karjat-BM4 (92.1 %) followed by Karjat-8 (82.4 %) was found in relative growth rate of rice under shade net condition and the minimum reduction in relative growth rate was found in Palghar-2 (47.7 %) followed by Swarnaprabha (53.0 %).

At 40-60 DAT, the maximum reduction was found in Ratnagiri-4 (26.3 %) followed by Swarnaprabha (25.7 %) was found in relative growth rate of rice under shade net condition and the minimum reduction in relative growth rate was found in Palghar-2 (17.1 %) followed by Karjat-5-7-10-12-2 (17.8 %).

At 60-80 DAT, the maximum reduction was found in Ratnagiri-4 (29.6 %) followed by Karjat-8 (26.7 %) was found in relative growth rate of rice under shade net condition and the

minimum reduction in relative growth rate was found in Karjat-5-7-10-12-2 (16.8 %) followed by Palghar-2 (18.1 %).

At 80-100 DAT, the maximum reduction was found in Ratnagiri-4 (35.8 %) followed by Karjat-8 (33.1 %) was found in relative growth rate of rice under shade net condition and the minimum reduction in relative growth rate was found in Palghar-2 (22.4 %) followed by Karjat-5-7-10-12-2 (25.2 %).

At 100 DAT to at harvest, the maximum reduction was found in Karjat-BM4 (56.5 %) followed by Karjat-8 (56.3 %) was found in relative growth rate of rice under shade net condition and the minimum reduction in relative growth rate was found in Palghar-2 (25.5 %) followed by Karjat-5-7-10-12-2 (36.8 %).

Reduction in relative growth rate under shade net as compared to without shade net condition was also recorded by Sahoo and Guru (1998), Burondkar (1985), Srinivasulu *et al.* (1999), Janardhan and Murty (1980) and Chauhan *et al.* (1996)

5.4.3 Effects of light treatment on net assimilation rate (NAR) ($\text{g}/\text{cm}^2/\text{day}^{-1}$)

At 20-40 DAT, the maximum reduction was found in Ratnagiri-4 (76.8 %) followed by Ratnagiri-5 (71.7 %) was found in net assimilation rate of rice under shade net condition and the minimum reduction in net assimilation rate was found in Karjat-5-17-25-29-6 (39.6 %) followed by Swarnaprabha (41.4 %).

At 40-60 DAT, the maximum reduction was found in Phondaghat-1 (65.0 %) followed by Karjat-5-10-10-16-13 (64.1 %) was found in net assimilation rate of rice under shade net condition and the minimum reduction in net assimilation rate was found in Karjat-5-7-10-12-2 (37.6 %) followed by Karjat-7 (38.6 %).

At 60-80 DAT, the maximum reduction was found in Karjat-5-17-25-29-6 (65.8 %) followed by Karjat-9 (62.9 %) was found in net assimilation rate of rice under shade net condition and the minimum reduction in net assimilation rate was found in Ratnagiri-4 (1.5 %) followed by Karjat-6-22-9-14-13 (2.4 %).

At 80-100 DAT, the maximum reduction was found in Karjat-7 (78.8 %) followed by Swarnaprabha (63.2 %) was found in net assimilation rate of rice under shade net condition and the minimum reduction in net assimilation rate was found in Palghar-2 (-1.2 %) followed by Karjat-1-1-12-24-1-13 (2.4 %).

At 100 DAT to at harvest, the maximum reduction was found in Karjat-5-7-10-12-2 (96.8 %) followed by Karjat-7 (95.9 %) was found in net assimilation rate of rice under shade net condition and the minimum reduction in net assimilation rate was found in Karjat-5-10-10-16-13 (8.2 %) followed by Phondaghat-1 (59.8 %).

Reduction in assimilation rate under shade net as compared to without shade net condition was also recorded by Nanja Reddy *et al.* (1995), Chauhan *et al.* (1996), Asana and Salunke (1971), Burondkar (1985), Srinivasulu *et al.* (1999), Sahoo and Guru (1998), Ahmad *et al.* (2009) and Janardhan and Murty (1980).

5.4.4 Effects of light treatment on leaf area index (LAI)

At 20 DAT, the maximum reduction was found in Karjat-9 (32.3 %) followed by Karjat-7 (30.8 %) was found in leaf area index of rice under shade net condition and the minimum reduction in leaf area index was found in Karjat-1-1-12-24-1-13 (-14.9 %) followed by Karjat-5-8-13-15-7 (-11.0 %).

At 40 DAT, the maximum reduction was found in Karjat-5-17-25-29-6 (10.0 %) followed by Phondaghat-1 (7.0 %) was

found in leaf area index of rice under shade net condition and the minimum reduction in leaf area index was found in Karjat-1-1-12-24-1-13 (-32.2 %) followed by Palghar-2 (-30.1 %).

At 60 DAT, the maximum reduction was found in Karjat-7 (3.4 %) followed by Swarnaprabha (-2.9 %) was found in leaf area index of rice under shade net condition and the minimum reduction in leaf area index was found in Palghar-2 (-67.7 %) followed by Phondaghat-1 (-58.7 %).

At 80 DAT, the maximum reduction was found in Ratnagiri-4 (1.6 %) followed by Swarnaprabha (0.9 %) was found in leaf area index of rice under shade net condition and the minimum reduction in leaf area index was found in Palghar-2 (-58.3 %) followed by Karjat-9 (-57.3 %).

At 100 DAT, the maximum reduction was found in Ratnagiri-4 (3.0 %) followed by Karjat-7 (-3.5 %) was found in leaf area index of rice under shade net condition and the minimum reduction in leaf area index was found in Karjat-9 (-56.6 %) followed by Palghar-2 (-52.4 %).

At harvest, the maximum reduction was found in Ratnagiri-4 (3.4 %) followed by Karjat-BM4 (-3.1 %) was found in leaf area index per plant of rice under shade net condition and the minimum reduction in leaf area per plant was found in Karjat-1-1-12-24-1-13 (-60.7 %) followed by Karjat-9 (-56.3 %).

Reduction in leaf area index under shade net as compared to without shade net condition was also recorded by Ren W. J. *et al.* (2012), Varon *et al.* (2015), Srinivasulu *et al.*, (1999), Chaturvedi and Ingram (1989), Ahmad *et al.* (2009) and Barmudoi *et al.* (2016).

5.4.5 Effects of light treatment on specific leaf weight (g/cm²)

At 20 DAT, the maximum reduction was found in Karjat-1-1-12-24-1-13 (40.7 %) followed by Karjat-5-10-10-16-13 (22.1 %) was found in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-7 (-145.2 %) followed by Karjat-9 (-56.2 %).

At 40 DAT, the maximum reduction was found in Ratnagiri-4 (71.3 %) followed by Ratnagiri-5 (66.0 %) was found in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-5-17-25-29-6 (34.3 %) followed by Karjat-5-7-10-12-2 (39.8 %).

At 60 DAT, the maximum reduction was found in Karjat-5-10-10-16-13 (65.7 %) followed by Karjat-1-1-12-24-1-13 (65.1 %) was found in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-5-7-10-12-2 (42.3 %) followed by Karjat-BM4 (46.1 %).

At 80 DAT, the maximum reduction was found in Karjat-9 (65.5 %) followed by Karjat-1-1-12-24-1-13 (65.0 %) was found in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-5-7-10-12-2 (42.0 %) followed by Karjat-BM4 (45.6 %).

At 100 DAT, the maximum reduction was found in Karjat-9 (65.6 %) followed by Karjat-1-1-12-24-1-13 (64.9 %) was found in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-5-7-10-12-2 (41.6 %) followed by Karjat-BM4 (44.7 %).

At harvest, the maximum reduction was found in Karjat-1-1-12-24-1-13 (66.8 %) followed by Karjat-9 (66.3 %) was found

in specific leaf weight of rice under shade net condition and the minimum reduction in specific leaf weight was found in Karjat-BM4 (43.6 %) followed by Karjat-5-7-10-12-2 (44.7 %).

Reduction in specific leaf weight under shade net as compared to without shade net condition was also recorded by Shaobing Peng, *et al.* (1993), Thakur, A., *et al.* (2009) and Hendrik Poorter, (1989).

5.5 Yield and yield attributes

5.5.1 Effects of light treatment on total number of spikelet's per panicle

The maximum reduction was found in Karjat-BM4 (34.0 %) followed by Karjat-5-7-10-12-2 (32.6 %) and the minimum reduction was found in Ratnagiri-4 (9.2 %) followed by Sahyadri-5 (21.4 %) in total number of spikelet's per panicle. Reduction in total number of spikelet's per panicle of rice under shade as compared to without shade net condition was also recorded by Yoshida *et al.* (1976), Gbadamosi *et al.* (2014), Venkateswarlu *et al.* (1977), Nakano, (2000), Voleti *et al.* (1996), Vergara *et al.* (1976), Singh *et al.* (2005), Yang *et al.* (2011), Patma *et al.* (1993) and Thangraj and Sivasubramaniam (1990).

5.5.2 Effects of light treatment on number of filled spikelet's per panicle

The maximum reduction was found in Ratnagiri-4 (35.9 %) followed by Sahyadri-5 (18.7 %) and Karjat-9 (18.5 %) and the minimum reduction was found in Karjat-BM4 (3.2 %) followed by Karjat-5-7-10-12-2 (4.7 %) in number of filled spikelet's per panicle. Reduction in number of filled spikelet's per panicle of rice under shade net as compared to without shade net condition was also recorded by Venkateswarlu *et al.* (1977),

Barmudoi *et al.* (2016), Fageria, (2007), Ahmad *et al.* (2009), Yang *et al.* (2011), Venkateswarlu *et al.* (1977), Cai *et al.* (1999), Voleti *et al.* (1996), Vergara *et al.* (1976) and Thangraj and Sivasubramaniam (1990).

5.5.3 Effects of light treatment on panicle length (cm)

The maximum reduction was found in Palghar-2 (8.6 %) followed by Swarnaprabha (7.1 %) and Karjat-8 (7.1 %) and the minimum reduction was found in Karjat-1-1-12-24-1-13 (-4.7 %) followed by Karjat-5-8-13-15-7 (-4.0 %) in panicle length. Reduction in panicle length under shade net as compared to without shade net condition was also recorded by Gbadamosi *et al.* (2014), Patma *et al.* (1993) and Thangraj and Sivasubramaniam (1990).

5.5.4 Effects of light treatment on 1000 grain weight (g)

The maximum reduction was found in Karjat-5-17-25-29-6 (14.8 %) followed by Swarnaprabha (13.7 %) and the minimum reduction was found in Ratnagiri-5 (2.1 %) followed by Karjat-BM4 (2.4 %) in one thousand grain yield. Reduction in one thousand grain yield of rice under shade net as compared to without shade net condition. Such type of results was observed by Prabha *et al.* (2004), Cai *et al.* (1999), Stansel *et al.* (1965), Matsushima *et al.* (1953), Nayak and Murty (1993), Harmann restrepo and Garses (2013) and Barmudoi *et al.* (2016).

5.5.5 Effects of light treatment on grain yield per plant (g)

The maximum reduction was found in Ratnagiri-4 (71.5 %) followed by Karjat-8 (66.8 %) and the minimum reduction was found in Karjat-5-8-13-15-7 (50.7 %) followed by Karjat-5-7-10-12-2 (53.4 %) in grain yield.

Deng *et al.* (2012) reported that low light causes impairment of the net photosynthetic rate as well as lower dry matter accumulation and sink capacity in rice plants and these significantly reduces the number of filled grains and 1000 grain weight, thereby leading to decrease grain yield.

Reduction in grain yield of rice under shade as compared to without shade net condition was also recorded by Patma *et al.* (1993), Singh (2000), Swain *et al.* (2004) and Singh (2005). Similar results were also reported by Thangaraj *et al.* (1990), Yoshiba, S. (1981), Murty *et al.* (1994), Ahmad *et al.* (2009), Deng *et al.* (2012), Goto *et al.* (2009), Barmudoi *et al.* (2016) and Kobata *et al.* (2000).

5.5.6 Effects of light treatment on straw weight per plant (g)

The maximum reduction was found in Ratnagiri-4 (52.3 %) followed by Ratnagiri-5 (45.6 %) and the minimum reduction was found in Karjat-5-8-13-15-7 (33.2 %) followed by Karjat-6-22-9-14-13 (34.3 %) in straw weight.

Reduction in straw weight per plant of rice under shade net as compared to without shade net condition was also recorded by Gbadamosi *et al.* (2014), Murty *et al.* (1994), Golam, (2009), Ahmad *et al.* (2009) and Barmudoi *et al.* (2016).

5.5.7 Effects of light treatment on harvest index (%)

The maximum reduction was found in Ratnagiri-4 (27.9 %) followed by Karjat-8 (27.8 %) and the minimum reduction was found in Karjat-5-8-13-15-7 (17.1 %) followed by Phondaghat-1 (17.3 %) in harvest index. Reduction in harvest index of rice under shade net as compared to without shade net condition was also recorded by Sahu *et al.* (1980) reported that the low light intensity is likely to reduce the harvest index (HI)

because of inadequate grain filling. The high photosynthesis rate may be strategized at low light with high light harvesting efficiency, high chlorophyll content, greater dry matter production and HI. Similar findings were also reported by Murty *et al.* (1994), Gbadamosi *et al.* (2014), Baig *et al.* (1996), Sahu *et al.* (1980), and Barmudoi *et al.* (2016).

CHAPTER-VI

SUMMARY AND CONCLUSION

The present investigation entitled “Evaluation of rice (*Oryza sativa* L.) genotypes for low light intensity” was conducted at Regional Agricultural Research Station, Karjat, Dist. Raigad (MH). Light has long been known to be the most important factor influencing plant growth with changes in irradiance having impacts on plant growth, morphology, anatomy various aspect of physiology and cellular biochemistry and ultimately flowering time and plant productivity. Light is a crucial factor for plant growth but excess light is not utilized in photosynthesis can produce chronic photo-inhibition. It can damage rice production dramatically; light intensity has received attention from researchers worldwide increasingly. A lack of adequate light strongly influences not only the duration of growth but also physiological and agronomic traits of rice. Therefore, following objectives were conducted:

- ◆ To identify suitable genotypes for shade tolerance under shade net condition.
- ◆ To study the growth functions viz. AGR, RGR, NAR, LAI, SLW of various genotypes under low light intensity.

The experiment was laid out in *factorial* RBD with three replications during *kharif*, 2017. The sixteen rice genotypes including two check variety (Karjat-7 and Swarnaprabha) and two treatments, Without shade net (normal light) (T₁) and Shade net (low light) (T₂) condition were used for the above purpose. The tested rice genotypes material was collected from RARS, Karjat. Low light treatment was imposed immediately after

transplanting by enclosing the plots in shade net whereas, plants grown in field without shaded condition (normal light).

The observations were recorded for twenty three characters will be recorded at 20 days interval till the physiological maturity *viz*: Morphological parameters *i.e.* Days to 50% flowering, Days to maturity, No of tillers per plant, No of productive tillers per plant, Leaf area per plant, Leaves per plant, Stem weight per plant (g), Leaf weight per plant (g), Total dry weight per plant (g) and Plant height (cm)., Biophysiological parameters *i.e.* Chlorophyll content., Physiological parameters *i.e.* Light intensity., Growth parameters *i.e.* AGR, RGR, NAR, LAI, SLW., and Yield and yield attributes *i.e.* Total number of spikelets per panicle, Number of filled spikelets per panicle, Panicle length (cm), 1000 grain weight (g), Grain yield per plant (g), Straw weight per plant(g), and Harvest Index (%). The silent findings of the experiment are summarized below:

- ◆ The shade net treatment possessed maximum days to 50% flowering as compared to without shade net at flowering stage. Days to 50% flowering was recorded maximum in Karjat-1-1-12-24-1-13 and Swarnaprabha and minimum in Ratnagiri-5 genotypes in Shade net
- ◆ The shade net treatment possessed maximum days to maturity as compared to without shade net at flowering stage. Days to 50% flowering was recorded maximum in Karjat-8 and minimum in Ratnagiri-5 genotypes in Shade net
- ◆ The without shade net treatment possessed maximum number of tillers per plant as compared to shade net at various growth stage. Number of tillers per plant was recorded maximum in Palghar-2 and minimum in Karjat-

BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes. The low light intensity decreases number of tillers due to lack of photosynthesis.

- ◆ The without shade net treatment possessed maximum number of productive tillers per plant as compared to shade net at various growth stage. Number of productive tillers per plant was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes. However, the number of productive tillers per plant reduced significantly in shade net treatment as compared to without shade net condition. The low light intensity decreases number of productive tillers due to lack of photosynthesis.
- ◆ Leaf area per plant is considered to be one of the desirable parameter for photosynthetic efficiency and its partitioning. The effect of different light imposed on leaf area per plant was significantly differed in all tested rice genotypes. The highest Leaf area per plant was recorded in genotype Palghar-2 and Ratnagiri-5 and the lowest was in Karjat-BM4 under shade net condition while, it was significantly reduced under without shade net condition.
- ◆ The without shade net treatment possessed maximum number of leaves per plant as compared to shade net at various growth stage. Number of leaves per plant was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 and

Phondaghat-1 genotypes. The low light intensity decreases number of leaves per plant due to lack of sunlight.

- ◆ Stem weight significantly differed in all the genotypes under shade net and without shade net and the without shade net treatment possessed maximum stem weight per plant as compared to shade net at various growth stage. Stem weight per plant was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes. The shade net condition, leaves are not able to receive enough light for the production of photosynthetic assimilates and they have a reduced ability to produce dry matter.
- ◆ Leaf weight significantly differed in all the genotypes under shade net and without shade net and he without shade net treatment possessed maximum leaf weight per plant as compared to shade net at various growth stage. Leaf weight per plant was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes. The shade net condition, leaves are not able to receive enough light for the production of photosynthetic assimilates and they have a reduced ability to produce dry matter.
- ◆ The without shade net treatment possessed maximum total dry weight per plant as compared to shade net at various growth stages. Total dry weight per plant was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4

genotypes. The shade net condition, leaves are not able to receive enough light for the production of photosynthetic assimilates and they have a reduced ability to produce dry matter. The movement of photosynthates to aerial part is enhanced under lower light intensity but the available photo-assimilates are low due to impaired photosynthesis under reduced light intensity.

- ◆ Plant height (cm) The shade net treatment possessed maximum plant height as compared to without shade net at various growth stages. Plant height was recorded maximum in Swarnaprabha and Karjat-6-22-9-14-13 and minimum in Karjat-7 and Karjat-5-7-10-12-2 genotypes in shade net. The shade net has pronounced effect and increased the plant height due to the shade stimulates cellular expansion and rapid cell division.
- ◆ The shade net treatment exhibited maximum total chlorophyll content. The significantly highest total chlorophyll content was recorded in Palghar-2 and minimum in Karjat-BM4 under shade net condition whereas without shade net treatment, highest total chlorophyll content was recorded in Ratnagiri-4. Generally, the leaves of shade plants are thinner and their chloroplasts larger and richer in chlorophyll than the leaves of sun plants.
- ◆ The mean of maximum light intensity was observed in without shade net than shade net treatment.
- ◆ The absolute growth rate refers to the measurement and comparison of total growth per unit time. Absolute growth rate significantly differed in all the genotypes under shade net and without shade net. Absolute growth rate was

recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.

- ◆ The relative growth rate refers to as increase in dry weight per unit of original dry weight at a time interval. Relative growth rate significantly differed in all the genotypes under shade net and without shade net. Relative growth rate was recorded maximum in Palghar-2 and minimum in Karjat-BM4 genotype in shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.
- ◆ The net assimilation rate of increase in whole plant dry weight per unit of leaf area per unit time. Net assimilation rate did not significantly differ in all the genotypes under shade net and without shade net.
- ◆ The leaf area index (LAI) is the most important parameter of growth analysis. Leaf area index significantly differed in all the genotypes under shade net and without shade net. The leaf area index increased under the shade net condition whereas; decrease under without shade net treatment. The leaf area index was significantly maximum in genotypes Palghar-2 and minimum was recorded in Karjat-BM4 under shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.
- ◆ Specific Leaf Weight (SLW) The Specific Leaf Weight of increase in whole plant dry weight per unit of leaf area per unit time. Specific Leaf Weight significantly differs in all the genotypes under shade net and without shade net. The

specific Leaf Weight was significantly maximum in genotypes Karjat-BM4 and minimum was recorded Karjat-9 in under shade net whereas without shade net are maximum in Karjat-1-1-12-24-1-13 and minimum in Karjat-BM4 genotypes.

- ◆ The total number of spikelets per panicle were differed significantly in all the tested genotypes under the shade net and without shade net treatments at harvesting stage. The total number of spikelets per panicle was significantly maximum in genotypes Ratnagiri-4 and minimum was recorded Karjat-BM4 in under shade net whereas without shade net are maximum in Palghar-2 and minimum in Karjat-BM4 genotypes.
- ◆ The number of filled spikelets per panicle were differed significantly in all the tested genotypes under the shade net and without shade net treatments at harvesting stage. number of filled spikelets per panicle significantly differs in all the genotypes under shade net and without shade net. The number of filled spikelets per panicle was significantly maximum in genotypes Palghar-2 and minimum was recorded Karjat-BM4 in under shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.
- ◆ Panicle length was significantly maximum in genotypes Karjat-5-8-13-15-7 and minimum was recorded Karjat-9 in under shade net whereas without shade net are maximum in Sahyadri-5 and minimum in Karjat-9 genotypes.
- ◆ The 1000 grain weight was significantly differed among the tested rice genotypes as well as both without shade net and shade net condition at harvesting stage. The 1000 grain

weight increased under increasing normal light intensity than the low light intensity significantly diminishes grain weight. The 1000 grain weight was significantly maximum in genotypes Swarnaprabha and minimum was recorded Palghar-2 in under both shade net and without shade net.

- ◆ The grain yield per plant was differed significantly under without shade net and shade net condition in all the tested rice genotypes. The grain yield per plant was significantly maximum in genotypes Palghar-2 and minimum was recorded Karjat-BM4 in under shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.
- ◆ The Straw weight per plant was differed significantly under without shade net and shade net condition in all the tested rice genotypes. The Straw weight per plant was significantly maximum in genotypes Palghar-2 and minimum was recorded Karjat-BM4 in under shade net whereas without shade net are maximum in Ratnagiri-4 and minimum in Karjat-BM4 genotypes.
- ◆ The harvest index was differed significantly under both without shade net and shade net condition. The highest harvest index was exhibited in genotype Palghar-2 and the lowest was found in Karjat-BM4 under shade net. However, the harvest index was recorded maximum in genotype Ratnagiri-4 whereas; the minimum was recorded in Karjat-BM4 under without shade net condition. The low light intensity is likely to reduce the harvest index (HI) because of inadequate grain filling.

5.2 CONCLUSION

Based on the results, the following conclusions are drawn from the present investigation:

- ◆ The Morphological parameters *i.e.* No. of tillers per plant, No. of productive tillers per plant, Leaves per plant, Stem weight per plant (g), Leaf weight per plant (g), Total dry weight per plant (g), AGR, RGR, NAR, LAI, SLW, Total number of spikelets per panicle, Number of filled spikelets per panicle, Panicle length (cm), 1000 grain weight (g), Grain yield per plant (g), Straw weight per plant(g) and Harvest Index (%) at various growth stages were significantly reduced under shade net condition. However, Days to 50% flowering, Days to maturity, Leaf area per plant, plant height and total chlorophyll content was recorded maximum in all the genotypes under shade net condition due to the shade stimulates cellular expansion and rapid cell division as compared to without shade net.
- ◆ The highest grain yield was exhibited in genotype Palghar-2 and lowest was recorded Karjat-BM4 genotype under low light condition. The overall minimum yield reduction percentage was exhibited in genotype Karjat-5-8-13-15-7 and maximum was in Ratnagiri-4 under shade net condition. Whereas, the maximum harvest index was observed in Palghar-2 and minimum was in Karjat-8 under shade net condition.
- ◆ Therefore, on the basis of overall yield reduction percentage, harvest index and other important traits under shade net, Palghar-2 genotype can be identified as relatively tolerant to light stress. Whereas, genotype Karjat-

BM4 most sensitive for the shade net condition or low light stress in all the tested genotypes.

- ◆ Therefore, Karjat-5-8-13-15-7 and Palghar-2 produced better grain yield per plant under shade net condition and could be rated as shade tolerance genotype.

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APPENDIX I

Weather data for <i>Kharif</i> 2017 season (RARS, Karjat)							
Week No.	Meteorological Period	Rainfall (mm)	Rainy Days	Temp. °C		Humidity%	
				Max.	Min.	I	II
24	11-06-17 to 17-06-17	75.6	2.0	32.6	25.1	86.9	68.1
25	18-06-17 to 24-06-17	79.4	4.0	33.1	25.9	86.0	69.1
26	25-06-17 to 01-07-17	788.1	7.0	29.3	24.3	94.6	91.0
27	02-07-17 to 08-07-17	231.4	7.0	30.5	24.8	92.3	76.3
28	09-07-17 to 15-07-17	394.8	7.0	30.3	24.2	92.4	83.3
29	16-07-17 to 22-07-17	622.8	7.0	27.6	24.0	95.1	87.7
30	23-07-17 to 29-07-17	249.2	7.0	28.9	25.1	89.1	85.3
31	30-07-17 to 05-08-17	120.0	6.0	29.2	24.5	91.7	80.4
32	06-08-17 to 12-08-17	107.0	5.0	30.3	24.7	91.0	83.3
33	13-08-17 to 19-08-17	98.2	7.0	30.0	24.3	94.3	89.1
34	20-08-17 to 26-08-17	288.4	6.0	28.1	23.3	94.7	88.0
35	27-08-17 to 02-09-17	342.2	5.0	28.7	24.3	93.9	82.9
36	03-09-17 to 09-09-17	35.3	3.0	31.3	23.7	93.1	73.3
37	10-09-17 to 16-09-17	151.8	4.0	33.4	23.3	93.3	67.3
38	17-09-17 to 23-09-17	321.8	6.0	29.6	22.5	92.7	89.4
39	24-09-17 to 30-09-17	9.9	1.0	32.4	23.9	93.7	69.4
40	01-10-17 to 07-10-17	31.0	2.0	34.7	24.7	92.0	65.6
41	08-10-17 to 14-10-17	182.5	5.0	32.2	23.9	93.6	74.0
42	15-10-17 to 21-10-17	1.6	0.0	33.1	22.8	89.0	60.4
43	22-10-17 to 28-10-17	0.0	0.0	34.3	21.0	89.0	46.9
44	29-10-17 to 04-11-17	0.0	0.0	34.5	17.7	91.9	39.3
45	05-11-17 to 11-11-17	0.0	0.0	34.8	16.9	87.3	34.0
46	12-11-17 to 18-11-17	0.0	0.0	32.6	15.5	91.1	33.7
47	19-11-17 to 25-11-17	0.0	0.0	33.2	18.3	92.4	40.4

APPENDIX-II

ABBREVIATIONS USED

AGR	:	Absolute growth rate
C.D. (5%)	:	Critical difference at 5 percent level of significance
cm	:	Centimeter
DAS	:	Days after sowing
DAT	:	Days after transplanting
dcm ²	:	Deci-centimeter square
DMSO	:	Dimethyl Sulphoxide
<i>et al.</i>	:	And co-workers
Fig.	:	Figure
Ft	:	Feet/Foot
g	:	Gram
ha ⁻¹	:	Per hectare
HI	:	Harvest index
i.e.	:	That is
Kharif	:	Rainy season
Kg	:	Kilogram
K Lux	:	Kilo Lux
LAI	:	Leaf area index
m	:	Meter
Max	:	Maximum
MS/MH	:	Maharashtra state
Min	:	Minimum
NAR	:	Net assimilation rate
No.	:	Number
N:P:K	:	Nitrogen, phosphorus and potassium ratio
PAR	:	Photosynthetically Active Radiation
PPFD	:	Photosynthetically Photon Flux Density
RGR	:	Relative growth rate
S.Em	:	Standard error of mean
SLW	:	Specific Leaf Weight
T ₁	:	Without shade net
T ₂	:	Shade net
viz.	:	Namely
wt.	:	Weight
°C	:	Degree Celsius
°	:	Degree
'	:	Minute
&	:	And
%	:	Percent
/	:	per

**DEPARTMENT OF AGRICULTURE BOTANY,
COLLEGE OF AGRICULTURE, Dr.B.S.K.K.V., DAPOLI,
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ABSTRACT

A field experiment was conducted at Regional Agriculture Research Station, Karjat, Dist. Raigad (Maharashtra, India) during *Kharif* 2017 to study Evaluation of rice (*oryza sativa* L.) genotypes for low light intensity. The experiment consisted of two factors *viz.* two treatments (T1-Without shade net and T2-Shade net condition) and sixteen genotypes laid out in *factorial* randomized block design with three replications. Data were collected on Days to 50% flowering, Days to maturity, No. of tillers/plant, No. of productive tillers/plant, Leaf area/plant (dcm²), No. of leaves/plant, Leaf wt./plant (g), Stem wt./plant(g), Total dry wt./plant(g), Plant height (cm), Total chlorophyll content (mg/g fresh wt.), Light intensity (Lux), AGR, RGR, NAR, LAI, SLW, No. of spikelet's/plant, No. of filled spikelet's/plant, Panicle length (cm), 1000 seed wt. (g), Grain yield/plant (g), Straw wt./plant (g) and HI (%) at the interval of 20, 40, 60, 80, 100 DAT and at Harvest. Data collected were subjected to

analysis of variance. Most of the yield and yield determining attributes recorded significant difference due to treatment effects.

The Morphological parameters *i.e.* No. of tillers/plant, No. of productive tillers/plant, No. of leaves/plant, Stem wt./plant (g), Leaf wt./plant (g), Total dry wt./plant (g), AGR, RGR, NAR, LAI, SLW, Total no. of spikelets/panicle, No. of filled spikelets/panicle, Panicle length (cm), 1000 grain weight (g), Grain yield/plant (g), Straw wt./plant (g) and HI (%) at various growth stages were significantly reduced under shade net condition. However, Days to 50% flowering, Days to maturity, Leaf area/plant, plant height and total chlorophyll content was recorded maximum in all the genotypes under shade net condition due to the shade stimulates cellular expansion and rapid cell division as compared to without shade net.

The highest grain yield was exhibited in genotype Palghar-2 and lowest was recorded Karjat-BM4 genotype under low light condition. The overall minimum yield reduction percentage was exhibited in genotype Karjat-5-8-13-15-7 and maximum was in Ratnagiri-4 under shade net condition. Whereas, the maximum harvest index was observed in Palghar-2 and minimum was in Karjat-8 under shade net condition.

Therefore, on the basis of overall yield reduction percentage, HI and other important traits under shade net, Palghar-2 genotype can be identified as relatively tolerant to light stress. Whereas, genotype Karjat-BM4 was most sensitive for the shade net condition or low light stress in all the tested genotypes. Therefore, Karjat-5-8-13-15-7 and Palghar-2 produced better grain yield/plant under shade net condition and could be rated as shade tolerance genotype.

VITAE



MR. NAVATRE RAMCHANDRA JALINDAR

A CANDIDATE FOR THE AWARD OF DEGREE OF
MASTER OF SCIENCE (AGRICULTURE)

in

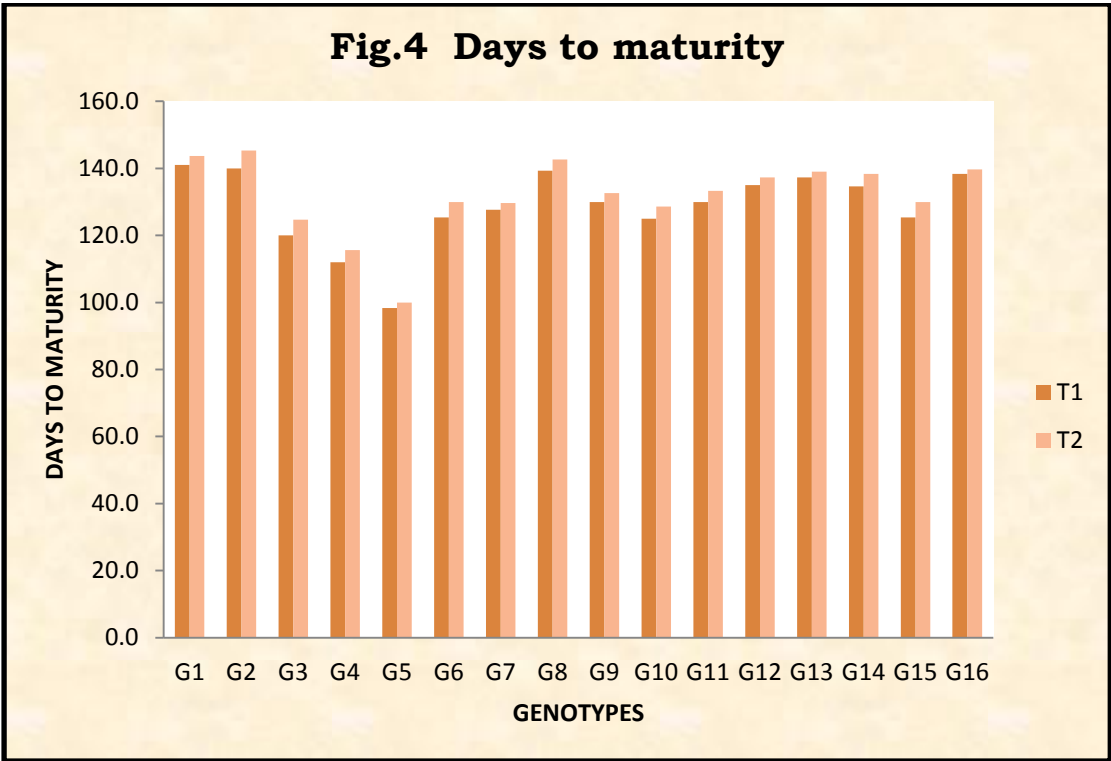
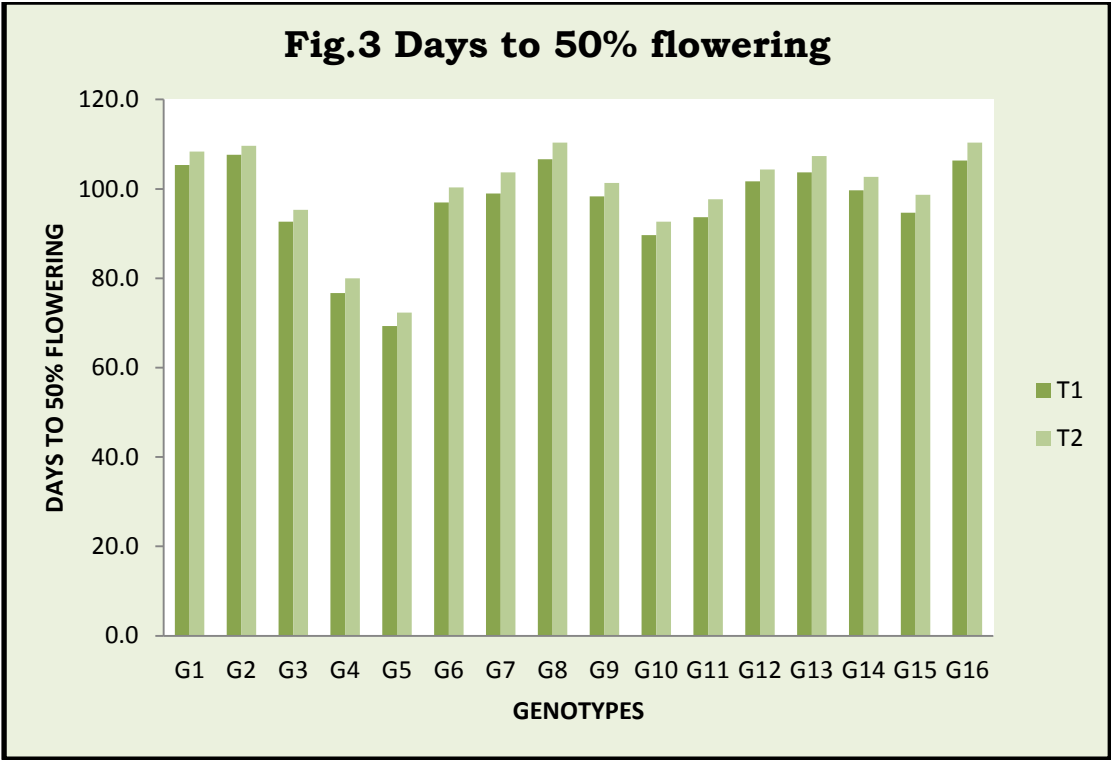
PLANT PHYSIOLOGY

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M.Sc. (Ag.)	Continue	Dr.B.S.K.K.V., Dapoli. (MS)

Signature



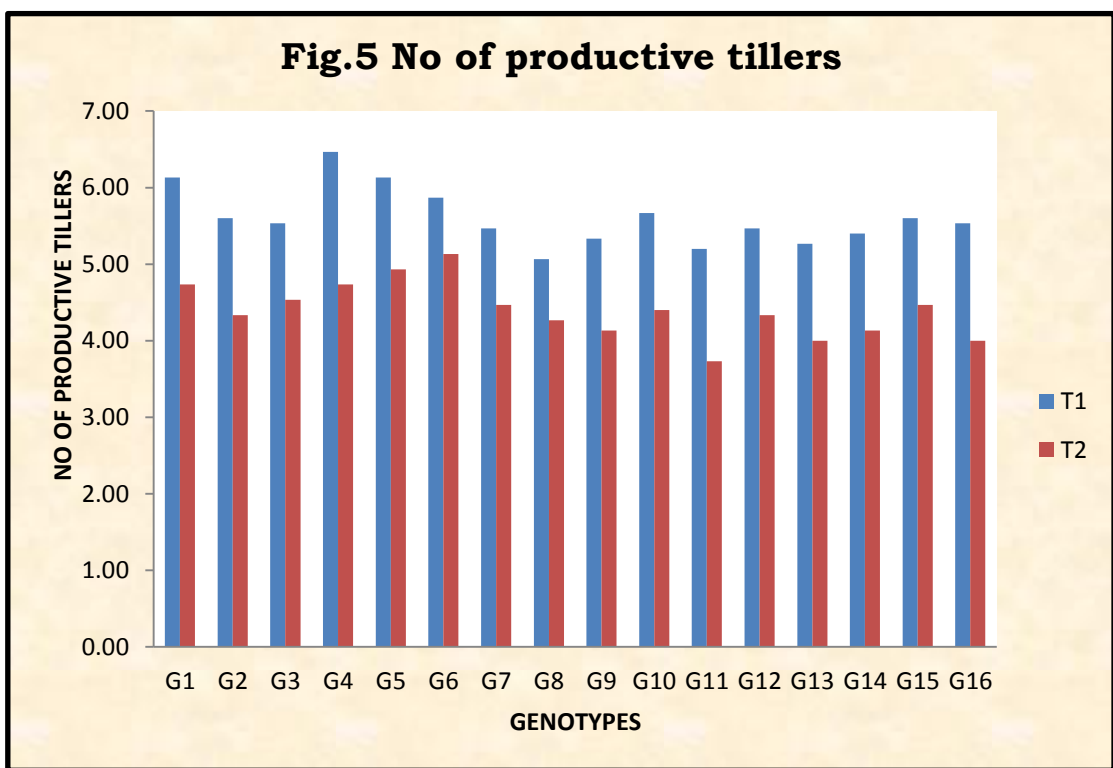


Fig.6 Total number of spikelet's per panicle

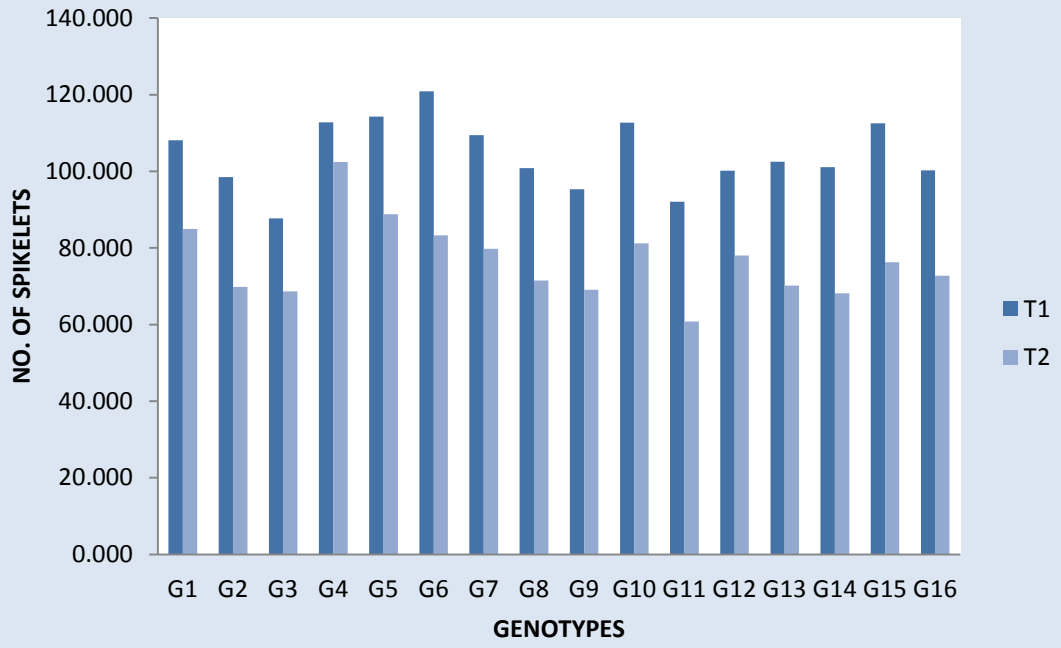


Fig.7 Number of filled spikelet's per panicle

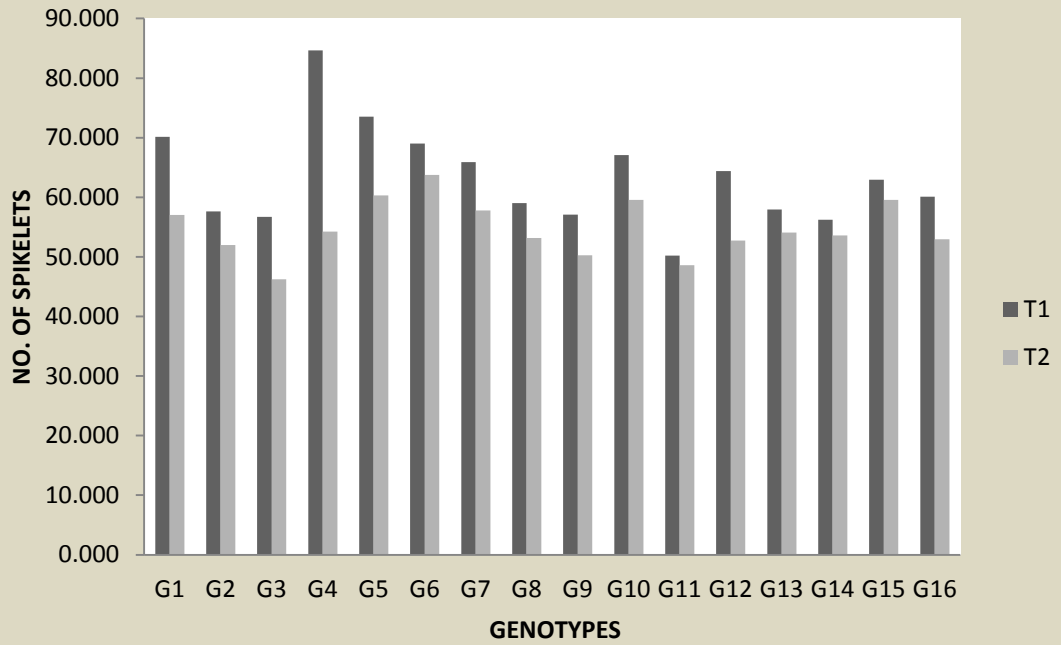
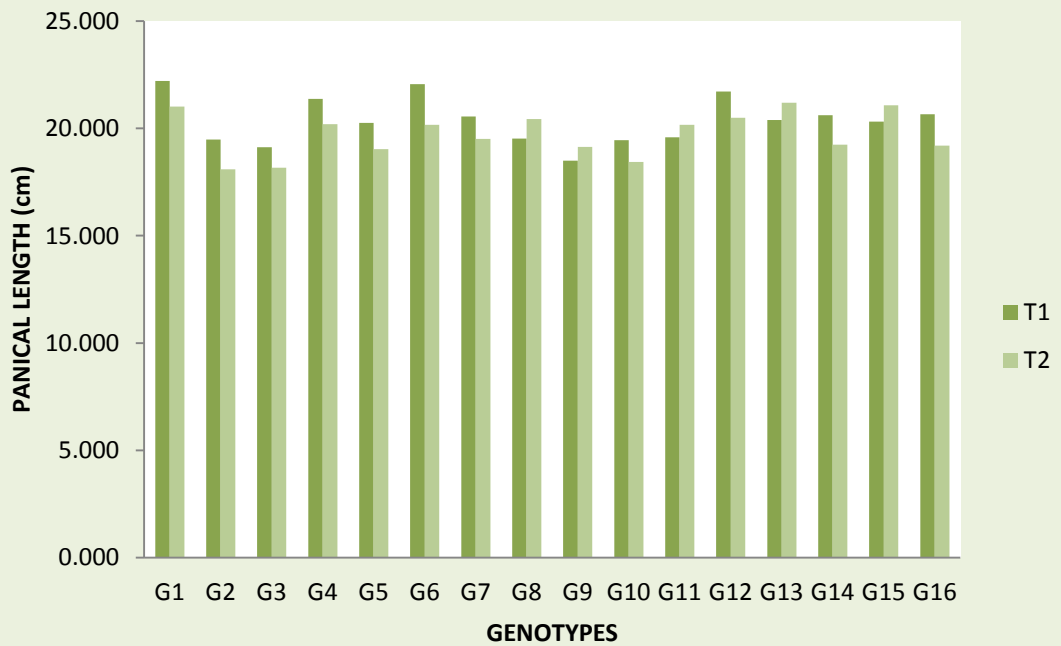
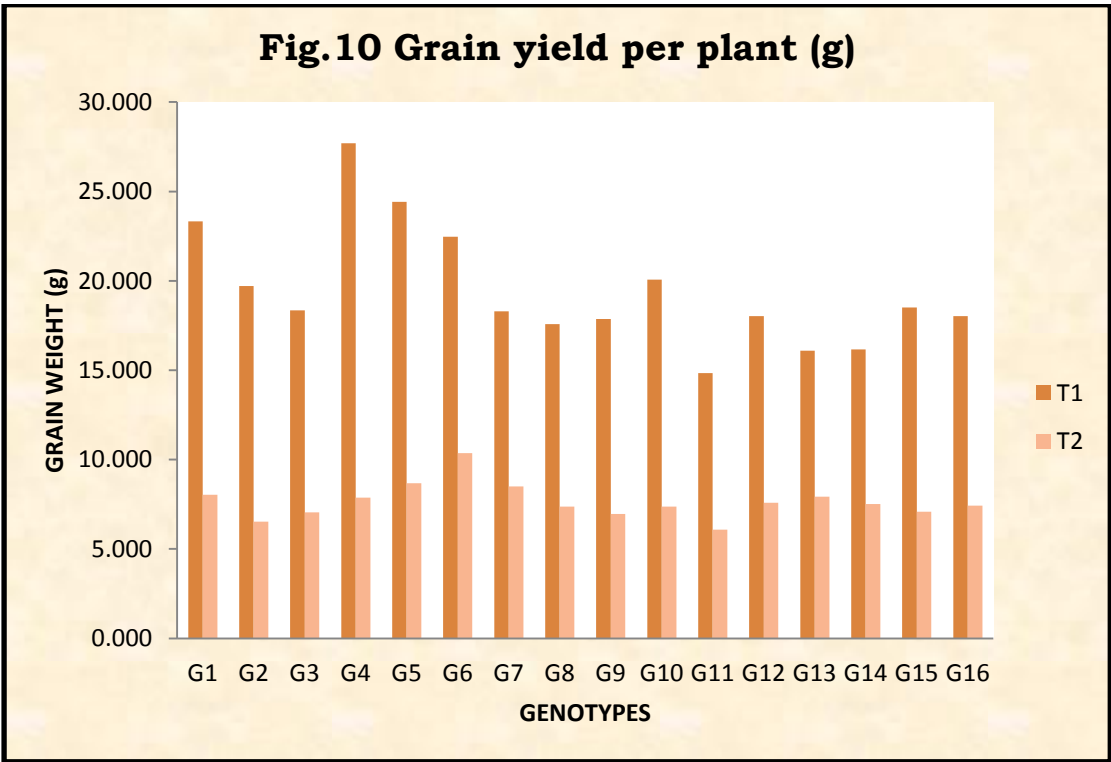
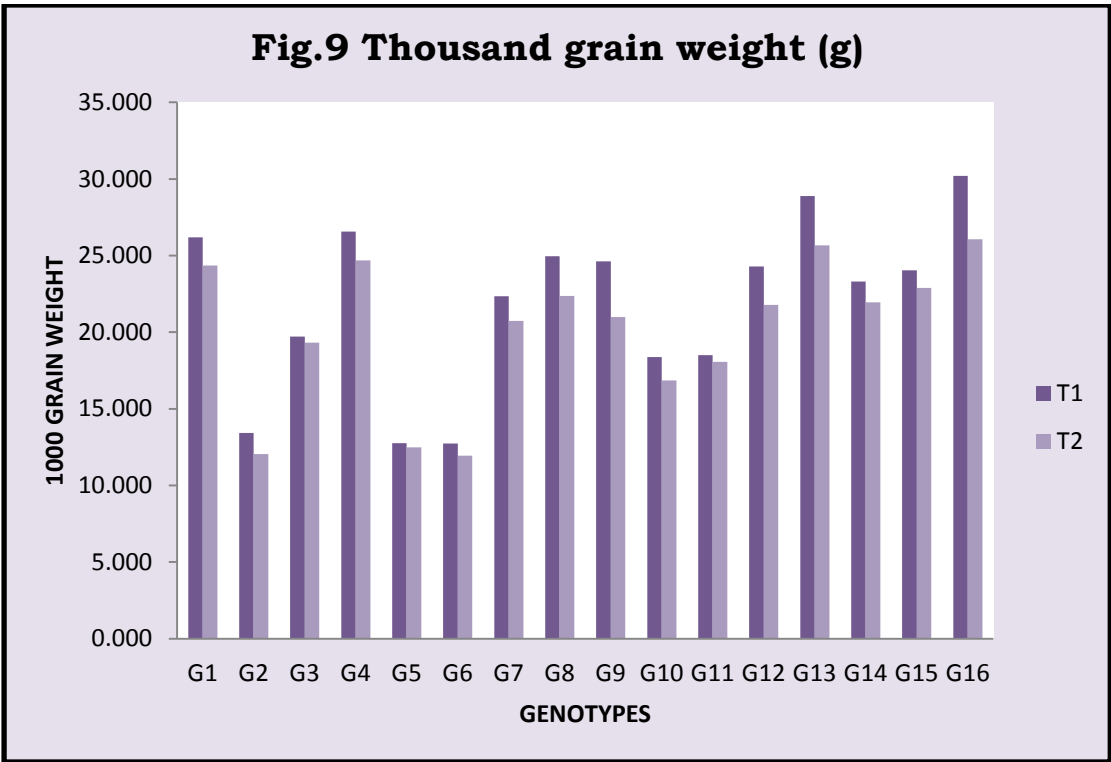


Fig.8 Panicle length (cm)





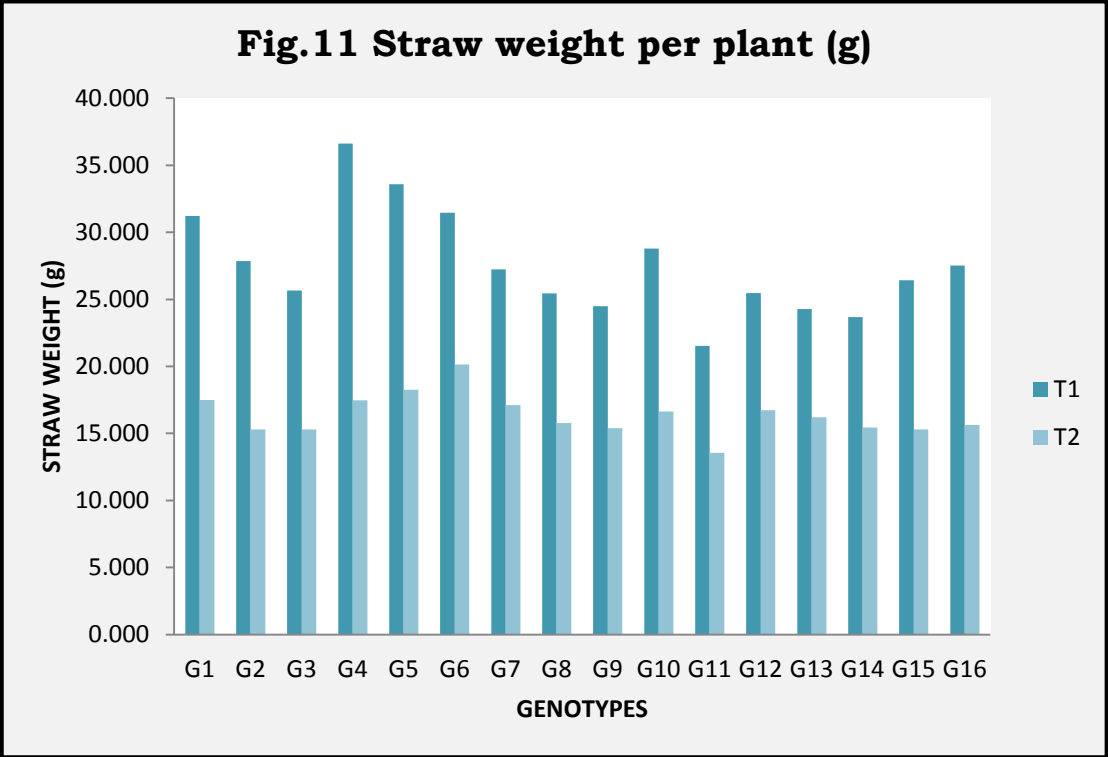




Plate 1 : A view of field experiment of rice at without shade net



Plate 2 : A view of field experiment of rice at shade net



Plate 3 : Variation in number of tillers per plant

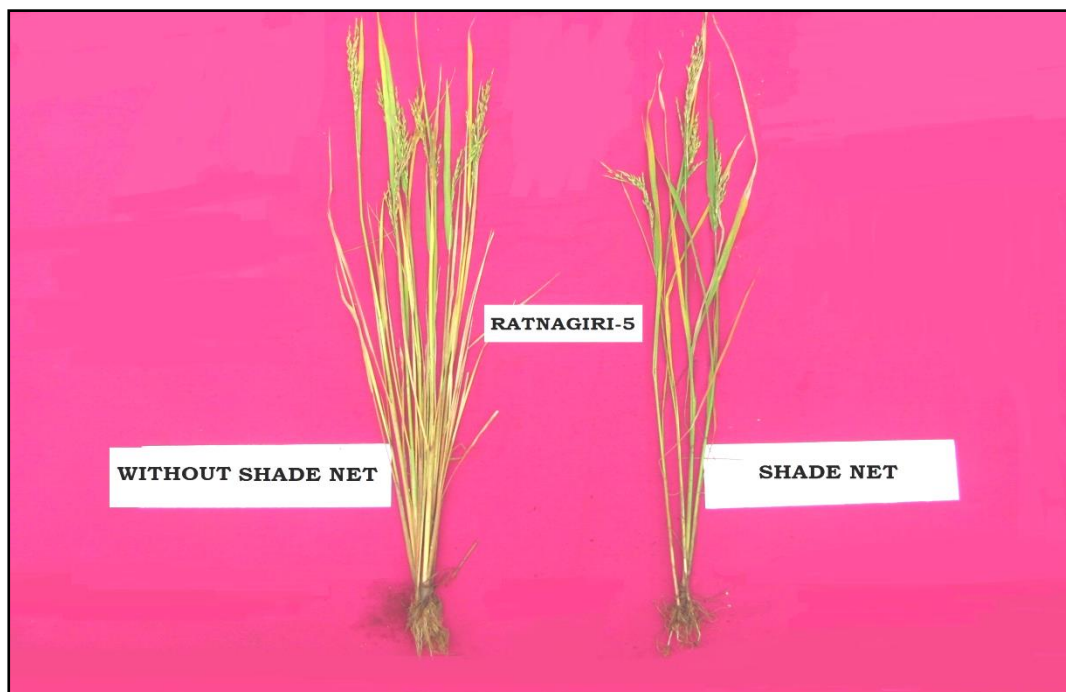


Plate 4 : Variation in number of productive tillers per plant

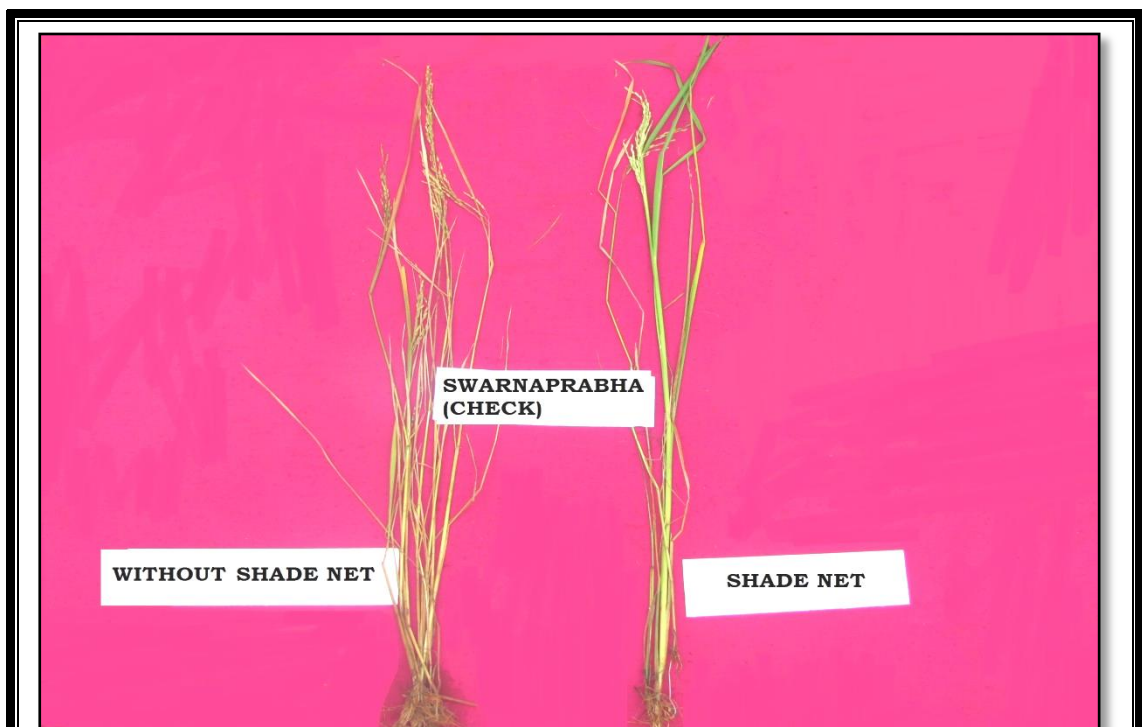


Plate 5 : Variation in plant height



Plate 6 : Variation in number of leaves

