GROWTH AND YIELD OF T. *AMAN* RICE AS AFFECTED BY GENOTYPES AND SUPPLEMENTAL IRRIGATION

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JUNE, 2020

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REGISTRATION NO. 13-05554

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

MASTER OF SCIENCE
IN
AGRONOMY

SEMESTER: JANUARY-JUNE, 2020

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Dedicated to my beloved parents and respected teachers

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CERTIFICATE

This is to certify that the thesis entitled **"GROWTH AND YIELD OF T. *AMAN* RICE AS AFFECTED BY GENOTYPES AND SUPPLEMENTAL IRRIGATION"** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* **MASTER OF SCIENCE (MS) in AGRONOMY** *embodies the results of a piece of bona fide research work carried out by* **MD. JAHEDUL ALAM FORHAD** *bearing Registration. No.* **13-05554** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

(Prof. Dr. Parimal Kanti Biswas)
Supervisor

ACKNOWLEDGEMENT

All the praises and gratitude to Almighty Allah Whose mercy has enabled the author to pursue the higher education and to complete the research work successfully for the degree of MS in Agronomy.

*The author expresses his deepest sense of gratitude, sincere appreciation, profound regards and indebtness to his reverend and beloved teacher and research Supervisor, **Dr. Parimal Kanti Biswas**, Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, valuable suggestions, constructive criticism, cooperation and encouragement throughout the research work and completion of this manuscript.*

*The author deems it a proud privilege to acknowledge his gratefulness, boundless gratitude and the best regards to his respectable Co-supervisor **Dr. Md. Jafar Ullah,** Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his valuable advice, constructive criticism and factual comments in upgrading the research work and this documents.*

*The author expresses his deepest respect to **Prof. Dr. Shahidul Islam**, Chairman, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his valuable suggestions and untiring effort to complete the research work smoothly.*

The author expresses his immense respect and indebtness to all the respective teachers of Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for their valuable teaching, cooperation and inspirations throughout the course of this study and research work.

The author thankfully remembers all the staffs of the Department of Agronomy and farm, Sher-e-Bangla Agricultural University, Dhaka for their cooperation during the research work.

*The author is highly thankful to the **Ministry of Science and Technology**, Govt. of the People's Republic of Bangladesh for providing National Science and Technology (NST) Fellowship to conduct this research work in the year 2018.*

Special thanks to the MS students of Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for their cooperation and encouragement in the entire period of study.

The author would like to express his gratitude to ***Mr. Moksedur Rahman****, Maintenance Engineer, Central Laboratory, Sher-e-Bangla Agricultural University, Dhaka for his technical support during the experimental period.*

The author is also thankful to ***Amalesh Sarker****,* ***Rawshanara Yeasmin*** *and* ***Asif Noor*** *for their cordial support, cooperation and encouragement.*

The author is ever indebted to his family members for their immeasurable love, continuous support, sacrifices and inspiration during the critical moment of his studies.

Eventually, omissions and discrepancies are completely up to the author.

The Author

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ABSTRACT

A field experiment was conducted at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka during the period from July to December 2018 to study the effect of supplemental irrigation on growth and yield of different *Aman* rice genotypes. The experiment comprised two factors; 1. irrigation having two levels (I_0 = no supplemental irrigation (rainfed) and I_1 = supplemental irrigation) and 2. eight rice genotypes (G_1 = SAU AGDL1, G_2 = SAU AGDL2, G3 = SAUAGDL3, G_4 = SAU AGDL12, G_5 = SAU AGDL13, G_6 = SAU AGDL14, G_7 = SAU AGDL15 and G_8 = Kataribhog (local)). The trial was setup in split plot design with irrigation in the main plot and genotypes in the sub-plot with three replications. Significant variation was recorded in terms of growth and different yield contributing characters and yield. The supplemental irrigated plots gave higher values over the non-irrigated plots in all the parameters except number of unfilled grains panicle^{-1}. At harvest, G_1 produced the tallest plant (199.23 cm), the highest leaf area index (3.36), the longest panicle (29.78 cm), the highest number of total grains panicle^{-1} (219.50), the highest weight of 1000-grains (28.95 g) and the highest grain yield (6.05 t ha^{-1}). However, G_8 (Kataribhog) produced the highest number of tillers hill^{-1} (18.50), the highest number of effective tillers m^{-2} (402.78), the lowest LAI (2.45), the shortest panicle (26.22 cm), lower number of primary branches panicle^{-1} (10.75), the lowest weight of 1000-grains (13.40 g), the lowest grain yield (5.18 t ha^{-1}) and minimum harvest index (28.37%). At harvest, the tallest plant (201.47 cm), the highest number of filled grains panicle^{-1} (192.00), the highest number of total grains panicle^{-1} (228.67), the highest weight of 1000-grains (29.10 g) and the highest grain yield (6.44 t ha^{-1}) was recorded from I_1G_1. On the contrary, the shortest plant (149.90 cm), the lowest number of tillers hill^{-1} (11.33), the lowest dry matter weight hill^{-1} (43.13 g), the lowest number of filled grains panicle^{-1} (138.33), the lowest straw yield (10.78 t ha^{-1}) and the lowest biological yield (16.02 t ha^{-1}) was recorded from I_0G_4. However, the lowest LAI (2.28), the shortest panicle (25.46 cm), the lowest number of primary branches panicle^{-1} (10.40), the highest number of unfilled grains panicle^{-1} (49.33), and the lowest weight of 1000-grains (13.29 g) was recorded in I_0G_8. The maximum harvest index (32.60%) was observed in I_0G_4, while the minimum (28.10%) from I_1G_8. However, the interaction treatments I_1G_2, I_1G_6 and I_1G_7 had grain yields (5.92 - 6.00 t ha^{-1}) which were not significantly lower than that of I_1G_1. Therefore, the genotypes SAU AGDL1, SAU AGDL2, SAU AGDL14 and SAU AGDL15 could be selected to grow further under using supplemental irrigation.

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LIST OF ACRONYMS

%	=	Percent
@	=	At the rate of
^{0}C	=	Degree Celsius
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BRRI	=	Bangladesh Rice Research Institute
cm	=	Centimeter
CV%	=	Percentage of coefficient of variance
cv.	=	Cultivar
DAT	=	Days After Transplanting
et al.	=	And others
g	=	Gram
ha^{-1}	=	Per hectare
HI	=	Harvest Index
i.e.	=	That is
IRRI	=	International Rice Research Institute
kg	=	Kilogram
LSD	=	Least Significant Difference
mm	=	Millimeter
MP	=	Muriate of Potash
N	=	Nitrogen
No.	=	Number
NPK	=	Nitrogen, Phosphorus and Potassium
NS	=	Non-significant
q	=	Quintal
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources Development Institute
t ha^{-1}	=	Ton per hectare
T. *Aman*	=	Transplanted *Aman*
TSP	=	Triple Super Phosphate
viz.	=	Videlicet (namely)
Wt.	=	Weight
Zn	=	Zinc

CHAPTER 1

INTRODUCTION

Bangladesh is mainly an agricultural country. Agriculture is the single largest producing sector of the economy and contributes about 10.98% to the total Gross Domestic Product (GDP) of the country. This sector also accommodates around 40.6% (in 2016-17) of labor force. GDP growth rate of Bangladesh mainly depends on the performance of the agriculture sector.

Rice is a major food commodity throughout the world and it is the staple food of more than half of the world's population. Worldwide, 738.2 million tons of rice (*Oryza sativa L.*) is produced from about 160.9 million hectares of land, about 90% of production comes from the Asian countries. Rice provides 30-75% of the total calories to more than 3 billion Asians. Globally rice demand is increasing and to meet up this demand, about 114 million tons of additional milled rice needs to be produced by 2035. In Bangladesh, rice contributes about 95% of the food grains consumed in the country (Rahman, 2016).

Rice crop is interwoven in the cultural, social and economic lives of millions of Bangladeshis and it holds the key for food and nutritional security of the country. It is consumed as the staple food and has been given the highest priority in meeting the demands of its ever-increasing population in Bangladesh. Being the 3rd largest rice producer of the world, Bangladesh comprises a rice growing area of 28.7 million acres with a production of 36.3 million metric tons while the average yield of rice is around 1.26 tons acre^{-1} whereas the transplanted *Aman* rice covers the largest area of 14.035 million acres (48.90% of total rice growing area) with a production of 13.99 million metric ton rice grain (38.56% of total rice production) and the average yield is about 997 kg ha^{-1} during 2017-18 (BBS, 2018). Among three growing seasons (*Aus*, *Aman* and *Boro*) *Aman* rice occupies the highest area coverage (34% of gross cropped area).

For marketing year (MY) 2019-20 (May-April), total rice area and production levels are projected to increase slightly to 11.8 million hectares (ha) and 35.3 million metric tons (MMT), assuming good weather and increased yield due to further cultivation of hybrid and high yield varieties (HYV). In MY 2018/19, total rice area and production are revised down to 11.77 million ha and 34.9 MMT, respectively (GAIN, 2019).

In *Aman* season, rice covers an area of 5.68 million hectares with a production of 13.99 million tons (AIS, 2019). BRRI has developed 102 rice varieties, among which 48 is of *Aman* varieties (BRRI, 2020). As agricultural land is decreasing day by day, it is necessary to increase hectare^{-1} yield of local T. *Aman* rice to satisfy our increasing need of food. Many researchers have worked with local T. *Aman* rice genotypes and find a considerable result in growth and yield; e.g. *Mothamota* and *Lalchicon* (Uddin *et al*., 2011).

At present, the requirement of rice in the country is 33.0 million tons which needs to be increased to 55.0 million tons by 2050 to meet up the food demand of the increased population. The possibility of expanding the area under rice in the near future is limited. Therefore, this extra rice production needed has to come from an increased productivity (Rahman, 2016).

Climate change is an extremely crucial issue in the present world and Bangladesh ranks as the most vulnerable nation to the impacts of climate change. The annual rainfall in the country ranges from 2300 to 2600 mm, but its distribution is uneven. About 70 to 80% of the total rainfall occurs during the months from June to September, leaving the most productive dry season (November to March) with inadequate rainfall for crop growth. It has been predicted that due to climate change, there will be a steady increase in temperature and change in rainfall pattern of Bangladesh (IPCC, 2007).

Variability in the amount and distribution of rainfall is one of the most important factors for limiting yield of rainfed crop like T. *Aman* in Bangladesh. If variability is associated with an untimely cessation at the reproductive or ripening stage of the rice crop, yield reduction is severe (Roy *et al*., 2010; Moomaw and Vergara, 1965). After October, rainfall was not sufficient for potential yield of rice and most of the *Aman* rice remain at flowering and grain filling stage. If water was not supplied on those farms rice yield will be reduced drastically (Sattar and Parvin, 2009).

Generally, the late-transplanted crops suffer from moisture stress when the last rainfall ceases by the first week of October. Under this situation, one timely supplemental irrigation of 60 mm could produce about 58% more yield, and the consequent benefit cost ratio of supplemental irrigation would be 5.3 to 14.5, which is highly profitable (Islam *et al.,* 1991).

Supplemental irrigation denotes the addition of limited amounts of water to essentially rainfed crops to improve and stabilize yields when rainfall fails to provide sufficient moisture for normal plant growth which is an effective response to alleviating the adverse effects of soil moisture stress on the yield of rainfed crops during dry spells. Supplemental irrigation, especially during critical crop growth stages, can improve crop yield and water productivity. Supplemental irrigation is even referred to as life-saving irrigation in some south Asian countries.

Hence, it is utmost demand to develop a correlation between growth and yield of *Aman* rice with different genotypes and supplemental irrigation. Under this circumstance, the present research work has been conducted with the following objectives:

- To determine the suitability of cultivating long grain rice genotypes,
- To determine the benefits of supplemental irrigation on yield of rice, and
- To determine the interaction effect of genotypes and supplemental irrigation on growth and yield of *Aman* rice.

CHAPTER 2

REVIEW OF LITERATURE

There are three rice-growing seasons in Bangladesh: *Aus*, *Aman*, and *Boro*. The monsoon-season rainfed rice is the *Aman*, which is the most widespread, including along the coastal areas. *Aman* is planted in two ways: direct seeding with *Aus* in March and April and transplantation between July and August. Both types are harvested from November through December. In Bangladesh, *Aman* rice is generally cultivated under rainfed condition during the period from July to December. The rainfall distribution pattern in this period is not uniform. Bangladesh receives about 95% of the total annual rainwater (203 cm) during the months from April to October. This quantity of water can support safe yield of rice crops. But the rainfall distribution pattern is such that both the crops (*Aus* and *Aman*) suffer from short duration drought, even during the monsoon. At the early part of the growing season (i.e. up to maximum tillering stage), rain water can meet the crop water demand for rice. After October, rainfall is ceased or irregular and not sufficient for potential yield of rice and most of the *Aman* rice remains at the panicle initiation to flowering stage.

Rainfall is the leading climatic event to influence crop production in particular and agriculture in general. Better crop management calls for minimization of the effects of variation of rainfall, especially in rain-fed areas. RRDI (1999) observed that rice is most susceptible to water stress during reproductive stage. The most critical stages of water stress were from panicle initiation to grain filling (Lenka and Garnayak. 1991; Sudhakar *et al*., 1989: Ramakrishnayya and Murty, 1991). Water deficit at the reproductive stage causes the reduction number of effective tillers, panicle length, number of spikelets panicle^{-1} and percentage of filled spikelets. If irrigation water is not supplied on those stages, rice yields will be reduced markedly (BRRI, 1992).

Akram *et al.* (2013) reported a higher reduction in grain yield when there was water stress at panicle initiation stage than flowering stage. Water stress at flowering stage hinder the partition of assimilate during grain filling and consequently reduced grain yield significantly.

Sarvestani *et al.* (2008) asserted that water stress at flowering stage significantly reduced grain yield. To achieve the target of self-sufficiency in food grain production in Bangladesh, it is essential to improve the productivity of rice to a greater extent. The efficient production of any crop can be obtained by manipulating basic elements of agriculture. The basic factors include variety of the crop, nutrients status of soil, climate and management practices. Growth and yield of rice are fundamentally influenced by variety and management practices. Experimental results available from home and abroad revealed that rice varieties with high yield potential and successful management of water may influence growth and yield to a greater degree.

Hence, research work related to the yield and yield contributing components of transplanted *Aman* (T. *Aman*) rice have been reviewed and discussed in this chapter.

2.1 Effect of supplemental irrigation on the yield contributing characters and yield of T. *Aman* rice

Sen *et al.* (2019) conducted a study to estimate the trend of actual crop water requirement and supplemental irrigation needed for a popular high yielding *Aman* rice variety, i.e., BR11 grown in Rajshahi and Rangpur districts of northern region of Bangladesh. After performing the analysis of probability, the supplemental irrigation (SI) was computed for BR11 in both the districts. The study revealed that the SI was required in late-stage for Rajshahi district but, for Rangpur district, it was required in both mid and late stages.

Ali (2018) conducted an experiment with cultivars: V_1 = N4/350/P-4(5), V_2 = N10/350/P-5-4, V_3 = N4/250/P-2(6)-26, V_4 = Binadhan-17, V_5 = BRRI dhan48 (as Check) and suggested that supplemental irrigation (when necessary) can facilitate good yield of most of the cultivars.

Hossain *et al*. (2017) conducted an experiment and stated that rice transplanted on 15 July required no supplemental irrigation since rainfall was adequate to meet the demand of crop. About 94 mm gross irrigation at 81 days after transplanting was needed to apply for 1 August transplanting. Delay transplanting on 15 August required one irrigation at reproductive and two irrigations at ripening phase, amounting 279 mm water. If sufficient rainfall would not occur during land preparation, supplemental irrigation would have to apply. It was revealed that no supplemental irrigation was required in T. *Aman* rice cultivation when it was transplanted before 31 July in the study region.

A study was carried out by Sen *et al*. (2017) to analyze the rainfall and evapotranspiration for successful planning of two *Aman* rice varieties i.e., BRRI dhan33 and BRRI dhan34 in Bogura and Dinajpur districts of Bangladesh. After probability analysis, the supplemental irrigation was calculated for BRRI dhan33 during mid and late stages; but for BRRI dhan34, it was calculated during development, mid and late stages in Bogura and Dinajpur districts. The study was found quite effective to assess the water availability period for *Aman* cultivation and indicated the time of supplemental irrigation.

Fahmida *et al*. (2017) performed an experiment to analyze the evapotranspiration and rainfall for beneficial planning of *Aman* rice cultivation in Dinajpur district of Bangladesh. Two popular *Aman* rice varieties i.e., BR11, and BR22 were selected. Supplemental irrigation was estimated after probability analysis. For BR11 supplemental irrigation was needed in development, mid and late stages but in case of BR22, it was needed for mid and late stages.

Amin *et al*. (2013) carried out a field experiment at Bangladesh Agricultural University (BAU), Mymensingh during *Aman* season of 2012 to study the effects of supplemental irrigation on the yield and yield contributing characters of BRRI dhan49 in *Aman* season. The treatments were T_1 (No Irrigation), T_2 (Four irrigations), T_3 (Three irrigations), T_4 (Two irrigations) and T_5 (One irrigation). Yield and yield contributing components of T. *Aman* rice variety BRRI dhan49 were greatly influenced by supplemental irrigation. From the result, it appeared that four times supplemental irrigations gave comparatively better result over other supplemental irrigation levels.

Kabir (2011) plotted field laboratory experiment at the Department of Soil Science, Bangladesh Agricultural University (BAU), Mymensingh during *Aman* season to find out the yield performance of T. *Aman* rice variety Binadhan-7 under two conditions; rainfed and supplemental irrigation. Binadhan-7 gave the minimum grain yield of 3.92 ha^{-1} under rainfed condition while the highest was obtained when irrigated four times (5.86 t ha^{-1}).

An experiment was conducted by Roy *et al*. (2010) at Bangladesh Rice Research Institute regional station, Kushtia to determine the impact of supplemental irrigation application at different growth stages on rice yield. Yield was linearly related with the amount of supplemental irrigation water. The increased yields due to supplemental irrigations over that of rainfed were as 2.2, 6.7, 11.1 and 13.3% for irrigation just after transplanting, till panicle initiation, till flowering and till harvesting, respectively. Supplemental irrigation was beneficial at any stage of rice but was most economical for transplanting to flowering period, as net profit was the highest.

Sharma *et al.* (2010) conducted a study in India and found that water used in supplemental irrigation had the highest marginal productivity and increase in rainfed production above 12% was achievable even under traditional practices. Under improved management, an average increase of 50% in total production can be achieved with a single supplemental irrigation.

A field experiment carried out by the Department of Soil Science, Bangladesh Agricultural University (BAU), Mymensingh during *Aman* season to study the yield performance of T. *Aman* rice varieties viz. V_1: BR11, V_2: BRRI dhan41, V_3: BRRI dhan31, V_4: BRRI dhan40 and V_5: BRRI dhan30 under two conditions of rainfed and supplemental irrigation. The sequence of varietals performance was $V_2>V_4>V_3>V_5>V_1$. The highest plant height (125.29 cm), grain yield (5.06 t ha^{-1}) and biological yield (11.67 t ha^{-1}) were resulted in BRRI dhan41 and harvest index (44.76%) in BRRI dhan31. The rate of increase occurred in each yield contributing components and yields especially in case of panicle length by 5.86%, grain yield by 7.67%, straw yield by 1.14%, biological yield by 3.77% and the harvest index by 3.76% in supplemental irrigated plots over the rainfed plots (Shamsuzzaman, 2007).

Bali and Uppal (2006) conducted a field trial at Ludhiana, India in the year of 2000 and 2001 in rainy seasons. Rice cv. Basmati 370 was irrigated 2 or 4 days after infiltration of previously ponded water and irrigation was withdrawn at 7, 14 or 21 days after 50% flowering. Irrigation at 2 and 4 days after infiltration of ponded water gave grain yields of 2.45 and 2.07 t ha^{-1}, total water use of 141 and 123 cm and water use efficiency of 17.4 and 16.8 kg ha^{-1} cm^{-1}, respectively. Mean yield was 1.85, 2.38 and 2.57 t ha^{-1} when irrigation was withdrawn at 7, 14 and 21 days after flowering, respectively with water consumption of 126, 131 and 139 cm.

Ilbeyi *et al.* (2006) reported that supplemental irrigation, given at early sowing, dramatically increased wheat yield and water productivity. In the highlands of Turkey, applying 50 mm of SI to wheat sown early has increased grain yield by more than 60%, adding more than 2 t ha^{-1} to the average rainfed yield of 3.2 t ha^{-1}.

Torres and Valle (2006) established a demonstration plot in southern Campeche, Mexico using supplementary irrigation from deep tubewells with the aim to increase productivity during two consecutive spring-summer cycles on 60 and 100 hectors using Campeche A-80 (non-irrigated) and Philippine Miracle (irrigated) varieties. Results of both cycles showed the superiority in yield with irrigation: 5.89 and 5.63 t ha^{-1} were harvested in the 1989 and 1990 cycles, respectively. In 1989, no yield was obtained in the non-irrigated plot due to drought while in 1990, 3.1 t ha^{-1} was obtained.

ZouGui *et al.* (2006) conducted a field study in Shanghai, China. The results showed that irrigation treatments significantly affected the growth, photosynthesis and grain yield of the 2 rice cultivars compared to those under rainfed conditions, the decrease in grain yield of Zhonghan 3 was 68.42%.

Chen *et al.* (2005) designed three levels of soil water content during grain filling stage in an irrigated field in China to study their effects on the translocation and allocation of carbohydrates in rice inter-sub specific hybrids Xieyou 9308 and Liangyoupeijiu. The results showed that in conventional flooding or non-flooding cultivation, the exported rates of stored carbohydrate from stem and photosynthate from the leaves were 60 and 90%, respectively. The exported rate of carbohydrate was decreased significantly ($P<0.01$) in the non-flooding cultivation. Grains received nearly 50% of stored carbohydrate from leaf sheath and 80% of photosynthate from leaves. At the non-flooding conditions, the absorbing capacity of grains significantly decreased by 10 and 20% from leaf sheath and from leaf photosynthate, respectively. Dry stress caused a large decrease in the absorbing capacity for inferior grains, which might be one of the main reasons for the low seed-setting rate in non-flooding cultivation.

Yang *et al*. (2005) experimented with aerobic rice varieties HD502 and HD297 and lowland rice variety JD305 under aerobic and flooded conditions. Under flooded conditions, JD305 yielded up to 8.8 t ha^{-1}, HD502 up to 6.8 t ha^{-1} and HD297 up to 5.4 t ha^{-1} compared to flooded conditions.

Bouman *et al*. (2005) stated that on average, the mean yield of all varieties was 32% lower under aerobic condition than under flooded condition in the dry season and 22% lower in the wet season. Total water input was 1240-1880 mm in flooded fields and 790-1430 mm in aerobic fields.

Boling *et al.* (2004) conducted a field experiment in six cropping seasons from 1997 to 2000 at Jakenan experiment station. Experimental treatment consists of two water supply levels (well-watered and rainfed). In one out of six seasons, yields under rainfed condition were 20-23% lower than under well-watered condition.

Spanu *et al*. (2004) compared the performance of 24 rice cultivars to non-continuous irrigation in Sardinia in 2002-03 on a rice-cultivated land for 25 years. It indicated that yields were satisfactory in both quantity and quality.

Rice plants needed adequate moisture throughout its life cycle. In tropical Asia on an average, a total of 1245 mm of water required for the complete growth cycle of rice. This total could be splitted into 40 mm for seedling nursery, 200 mm for land preparation and 1000 mm for satisfying the need during the whole growing period (Sattar, 2004).

TaoLong *et al*. (2004) studied the effects of soil water content on the physiology of the rice root system in an irrigated paddy field in China at grain filling, ripening and root senescence. There were 45 days from initial heading to harvesting and one-time irrigation was given during this period to saturate the soil. The treatment significantly improved root respiration and exudation, with little effect on gelatin content of the exudates. Thus, one-time irrigation during the tilling stage could delay senescence of the root system, reduce non-effective tillers hill^{-1} and unfilled grains panicle^{-1}.

Tomar *et al*. (2004) conducted multilocation yield trials to ascertain the degree of stability of rice genotypes suitable for rainfed condition. Nine medium duration rice genotypes (Mahamaya, Chapti, Gurmatiya, HRI 134, IET 14100, IET 15178. R1057-1632-1-1, R1097-44-1, IET 15163 and Swarna) were grown at four different locations in Raigarh, Madhya Pradesh, India in 2001. All genotypes other than Chapti, Gurmatiya and IET 15178 showed average response. Swarna with the highest mean yield, average response and significant value of S2di showed its stable behavior and suitability for that environment.

The effects of irrigation on the yield of rice cv. Jaya were studied in Davangere, Karnataka, India, during the period of 1990-91 and 1992-93. It was observed that plant height did not significantly vary with irrigation treatment during both seasons (Ganesh, 2003).

Jadhav *et al.* (2003) conducted a field experiment in Parbhani, Maharashtra, India during 1998-99 and 1999-2000 to determine the effect of irrigation and nitrogenous fertilizer on the yield and quality of rice cv. Basmati-370. The treatments comprised irrigation at critical growth stages (I_1), 0.8 (I_2), 1.2 (I_3), and 1.6 (I4). I_4 showed the highest grain yield (2.26 t ha^{-1}), kernel length (6.76 and 6.66 mm in 1998 and 1999, respectively), kernel breadth (1.79 and 1.76 mm) and cooked kernel length (13.34 and 12.92 mm). The highest amylose content (23.90 and 23.82%) was obtained with I_2 and I_1 in 1998 and 1999, respectively, while the highest head rice recovery (34.99 and 37.61%) was obtained with I_1 in 1998 and 1999, respectively.

Pandey *et al.* (2003) evaluated yield potential of rice cv. IR 36 under rainfed and irrigated conditions in Madhya Pradesh, India from 1997 to 1999. They stated that grain and straw yield were higher under irrigated condition over rainfed. Panigrahi and Panda (2003) developed a model for prediction of the optimal size of an on-farm reservoir (OFR) to provide supplemental irrigation to rice in rainfed farming system of eastern India. There was an increase of 39 and 15% in the yield of rice grain and mustard seed over rainfed conditions because of application of 84 and 45 mm of supplemental irrigation, respectively.

Sujit and Sarker (2003) conducted an experiment in Giridih, Jharkhand, India during the period of 1996-2000 to evaluate the drought tolerance of upland rice cultivars Brown Gora, RR-167-982, Kalinga-3, RR-151-3, RR-51-1, RR-50-5, RR-2-6 and Birsa-101 under rainfed condition. Among the 8 short duration cultivars, 6 were drought-tolerant with sustainable yield potentials of 10.90, 8.51, 10.90, 14.70, 10.10 and 10.80 quintal ha^{-1}, respectively during the stress drought year while the respective mean yield during the normal years were 12.75, 10.71, 15.90, 20.54, 14.46 and 17.26 q ha^{-1}, respectively.

It was found that supplemental irrigation significantly increased rice yields over rainfed condition. Moreover, it was suggested that supplemental irrigation should be supplied precisely at the peak period of crop growth which may provide better yield of this crop (Sattar, 2003).

Zeng *et al.* (2003) studied the physiological characteristics of the root and flag leaf of rice hybrids Honglianyou 6 and Liangyou 1193 after flowering under different irrigation conditions. The root densities and activities were higher under controlled damp irrigation compared to submerged irrigation. The flag leaf chlorophyll contents under controlled damp irrigation were not different at flowering stage but were significantly higher at maturity stage compared to submerged irrigation at reproductive stage. The hybrid rice combinations had high community and relative growth rate including grain yield under controlled damp irrigation.

Stanley (2002) developed a mathematical model for calculating the probabilities of the occurrence of non-rains days of different duration during the period of crop cultivation. The model was used to determine correct irrigation application durations under conditions of water scarcity for major paddy irrigation schemes in Srilanka. Water balance study showed that a soil moisture deficit existed even during the months of rainy season (ranging from 20 to 30 mm).

Babu *et al*. (2000) conducted a field study at the upland block of Hebbal tank area (Karnataka, India) during 1997 to determine the performance of rainfed lowland rice cultivars Rasi and hybrid KRH 1. The crop was raised under rainfed conditions up to 33 days after sowing and later the field was flooded with stored rain water in the Hebbal tank. KRH 1 recorded a higher yield (3.27 t ha^{-1} vs. 2.77 t ha^{-1}), longer and heavier panicles and heavier grain weight than Rasi. KRH 1 also produced a higher straw yield (6.52 t ha^{-1}) than Rasi (6.26 t ha^{-1}).

Bhandari *et al*. (2000) conducted on-farm research during 1991-94 in 127 locations (78 irrigated and 49 rainfed conditions) in 3 districts of Punjab (Kapurthala, Jalandhar and Hoshiarpur) to increase the crop productivity of different cropping sequences over a period of time. It was concluded that under irrigated conditions, it is advisable to gross rice-gobhi, mungbean/rice-wheat-maize fodder crops in sequence to get the highest economic yields while under rainfed conditions, green manure followed by wheat/raya/black gram are the only alternatives for increasing and sustaining the productivity over a longer period of time.

Islam (2001) carried out two experiments with nine rice varieties subjected to moisture stress at booting and flowering stages to observe morpho-physiological changes and identify variety for water stress to response at booting and flowering stage. Morphological characters such as number of effective tillers and number of green leaves were suppressed with the given water stress. However, different variety had shown different degrees of reduction.

Tomar *et al*. (2000) conducted a field experiment on a deep Vertisol of Jabalpur, Madhya Pradesh, India during 1979-1989. Favorable soil water regime was established during rainy season and excess runoff water was canalized to a farm pond to provide supplemental irrigation for the Rabi crops cropping. Tabulated results showed that the average yield of rice was 2.54 t ha^{-1} (average of 8 years).

Chaulian *et al*. (1999) found that two rice varieties cv. Browngara and Vandana were subjected to water stress at booting and anthesis stage. Water stress at both stages reduced plant height, total tillers and total dry matter.

RRDI (1999) observed that rice is most susceptible to water stress during reproductive stage. They found that water stress during vegetative stage reduces plant height and tiller number.

Hirasawa (1998) observed that moisture depletion caused severe injury to panicle in the critical stages. Significant differences in root system development and drought had been observed among rice cultivars. Water uptake capacity might depend on root system development and root hydraulic conductivity.

Boonfung and Fuki (1996) found that when drought occurred during grain filling of rice, the percentage of filled grains decreased to 40% and individual grain mass by 20%. The effect of stress was also related to its severity during grain filling.

Yang *et al.* (1994) reported that water deficit at the vegetative stage of the crop decreased tiller number per plant. Water deficit at the reproductive stage caused reduced number of spikelets $panicle^{-1}$, percentage of filled spikelets and weight of 1000-grains.

Islam *et al.* (1994a) conducted a pot experiment at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh to observe the growth and yield performance of 4 *Aus* rice genotypes grown under soil moisture stress. Moisture stress resulted in reduced total dry-matter. These characters also varied with the severity of stress.

Islam *et al*. (1994b) observed the effect of drought on the growth and yield of rice at tillering, booting and flowering stages in *Aus* season. They concluded that water stress showed the maximum adverse effect at tillering stage. The highest yield reduction was 68.6% due to water stress observed at booting followed by grain filling stage produced lower harvest index values than the control but the size and weight of the remained grains was higher. Stress at flowering stage produced the lowest 1000-grain weight.

Ingram *et al*. (1993) showed that yield losses resulting from moisture deficit were particularly severely stroked at the booting stage.

BRRI (1992) studied the effect of water deficits for monsoon (transplanted *Aman*) rice cultivation and reported that if rainfall continued till November there was no need for supplemental irrigation in the case of late transplanting. However, if it ceases in the first week of October, late transplanted rice will suffer from drought and percentage of filled grain will be decreased conspicuously.

BRRI (1991) conducted an experiment in monsoon (*Aman* season) at BRRI farm. Joydebpur during 1978-1987 to determine the impact and viability of supplemental irrigation. The results of 8 years of experimentation indicated that the impact of supplemental irrigation mainly depends on rainfall distribution patterns and the last precipitation of the season. Generally, the late transplanted crops suffer from moisture stress when the last rainfall ceases by the first week of October. Under this situation, one-timely supplemental irrigation of 60 mm could produce about 58% more yield and the consequent benefit-cost ratio of supplemental irrigation would be 5.3 to 14.5 which is highly profitable. The study revealed that if the last rainfall continues up to the third week of October, the supplemental irrigation is still profitable. When sufficient rainfall occurs in November, there is no need for supplemental irrigation even in late transplanting and continuous standing water is not required for rice cultivation. It was provided that rain water can be managed properly.

Lenka and Garnayak (1991) observed that the reduction in yield due to stress was relatively less during early vegetative phase of upland rice. Stress during panicle initiation to flowering was more important than flowering to maturity. This means stress during panicle development had more influence than during tittering and grain filling periods. Stress during late panicle development and early grain filling period was more critical.

Ramakrishnayya and Murty (1991) found that soil moisture stress causes reduced number of tillers.

Catalono (1989) reported that stress at heading and booting stages reduced grain yield by reducing grain size.

Sudhakar *et al*. (1989) conducted a field trial during dry season to verify the drought resistance potential at different growth stages of the early rice cv. Annapurana. CR143-2-2 and Cauvery. Moisture stress during tillering and panicle development was more harmful than during the ripening phase. Under moisture stress CR143-2-2 exhibited a higher resistance to drought and produced a higher grain yield than Annapurna and Cauvery.

Ram *et al*. (1988) conducted an experiment with two rice cultivars under water stress conditions. Water stress at the tillering stage induced maximum reduction in number of panicles plant^{-1} but yield and spikelet sterility were more adversely affected by stress at the shoot elongation stage.

Cruz *et al*. (1986) stated that a mild water stress at vegetative stage decreased leaf area and crop growth remained lower than that of unstressed plant.

Rahman and Yoshida (1985) stated that water deficit had harmful effect on the duration of grain filling. Water stress reduced root-shoot growth and duration of upland rice.

Yoshida (1981) reported that stress of water at any growth stage of rice may hamper yield. The most critical stage of water stress was from panicle initiation to flowering.

2.2 Performance of variety on the yield contributing characters and yield of T. *Aman* rice

Variety itself is the genetical factor which contributes a lot for variation in yield and yield contributing components. Different workers observed difference in the yield performance of rice varieties. Some preceding available information and literature related to the performance of variety on the yield contributing components and yield of rice are presented here:

Howlader *et al*. (2017) conducted an experiment to evaluate among the local T. *Aman* rice genotypes for obtaining the most productive genotype regarding growth and yield performance under southern region. Four local T. *Aman* rice genotypes namely Lalchicon, Lalmota, Moulata and Mothamota were used as planting materials. The genotype Moulata was produced significantly the tallest plant (155.0 cm) and number of total tillers per hill (11.80); statistically higher LAI (2.133) and TDM (16.80 g $hill^{-1}$) at vegetative stage (60 DAT). Similarly, number of maximum effective and minimum non-effective tillers per hill (10.80 and 1.333), total and filled grains $panicle^{-1}$(128.50 and 115.80), minimum unfilled grains panicle (12.67), thousand grain weight (25.35 g), grain, straw and biological yield (3.657, 6.000 and 9.657 t ha^{-1}, respectively) and HI (37.86%) also higher in Moulata at harvest. From the result, it was suggested that Moulata was the most productive genotype among the studied local T. *Aman* rice genotypes under the southern region.

Mahmud *et al*. (2017) carried out an experiment with seven short duration T. *Aman* rice varieties viz. BRRI dhan33, BRRI dhan39, BRRI dhan49, BRRI dhan56, BRRI dhan57, BRRI hybrid dhan4 and Binadhan-7. Results indicate that Binadhan-7 produced the highest grain yield (4.90 t ha^{-1}), straw yield (5.58 t ha^{-1}), biological yield (10.44 t ha^{-1}), and harvest index (47.10%). Lowest grain yield (3.27 t ha^{-1}), straw yield (3.96 t ha^{-1}) and biological yield (7.20 t ha^{-1}) were produced by BRRI dhan57.

Islam *et al*. (2017) conducted an experiment with two varieties namely, BRRI dhan28 and BRRI dhan29. Higher grain yield (5.03 t ha^{-1}) was obtained from BRRI dhan29 than from BRRI dhan28 (4.30 t ha^{-1}).

Murshida *et al.* (2017) conducted an experiment with three varieties (BRRI dhan28, BRRI dhan29 and Binadhan-14) and reported that variety had significant effect on all the crop characteristics under study except weight of 1000-grains. The highest grain yield was obtained from BRRI dhan29 and the lowest value was recorded from Binadhan-14.

Sarkar *et al*. (2016) conducted an experiment with three aromatic fine rice varieties viz. BRRI dhan34, BRRI dhan37 and BRRI dhan38. The tallest plant (142.7 cm), the highest number of effective tillers $hill^{-1}$ (10.02), number of grains $panicle^{-1}$ (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34. The highest grain protein content (8.17%) was found in BRRI dhan34 whereas the highest aroma was found in BRRI dhan37 and BRRI dhan38.

Chamely *et al.* (2015) conducted an experiment with three varieties viz., BRRI dhan28, BRRI dhan29 and BRRI dhan45. The harvest data reveal that variety had significant effect on total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, panicle length, grain yield, straw yield and harvest index. The highest grain yield (4.84 t ha^{-1}) was recorded from BRRI dhan29.

Getachew and Birhan (2015) and Garba *et al*. (2013) observed that grain yield and yield components of rice were significantly influenced by the varieties used.

Islam (2010) conducted an experiment with 14 varieties. At the time of harvest, the longest plant (123.00 cm), numbers of leaves hill^{-1} (32.65), highest number of unfilled grains panicle^{-1} (83.77) and 1000 grain weight (27.34 g) were achieved by MHR- 8, BRRI dhan32, MHR- 10 and MHR- 1, respectively. But in terms of highest tiller number hill^{-1}(12.67), dry matter weight hill^{-1} (44.92 g), number of effective tillers hill^{-1} (10.40), panicle length (28.05 cm), number of filled grains panicle^{-1} (161.10), grain yield (5.46 t ha^{-1}), straw yield (5.86 t ha^{-1}) and harvest index (48.27%) were obtained by MRH- 4 and that of second highest performance was found in MHR- 3.

An experiment conducted by Morshed (2010) with four varieties viz. V_1 (BRRI dhan48), V_2 (BRRI dhan43), V_3 (BRRI dhan42) and V_4 (ACI hybrid-2) reported that variety V_3 (BRRI dhan42) showed the highest plant height (94.95 cm) but the highest number of tillers hill^{-1} (23.62), number of leaves hill^{-1} (161.50), number of panicles hill^{-1} (16.67), number of grains panicle^{-1} (104.40), 1000- seed weight (20.82 g), grain yield (3.743 t ha^{-1}), stover yield (5.55 t ha^{-1}) and harvest index (40.13%) was obtained from V4 (ACI hybrid-2).

Zubaer *et al*. (2007) conducted an experiment with three T. *Aman* rice genotypes (Basmoti, Binadhan-4 and RD2585) and found that Binadhan-4 performed better in producing tillers, leaves, total dry matter, and yield under stress than the other two genotypes. Basmoti showed the highest plant height but medium total dry matter, 1000 grain weight and yield. RD 2585 showed the lowest total dry matter, 1000 grain weight, and yield under water stress.

Ahmed (2006) performed an experiment with Sonarbangla-1 and BRRI dhan29 and stated that variety had significant effect on all the agronomic parameters except panicle length, total grains panicle^{-1}, straw yield and biological yield. The highest grain yield (8.26 t ha^{-1}) with lowest straw yield (7.25 t ha^{-1}) was obtained from Sonarbangla-1 and BRRI dhan29 gave the lowest grain yield (7.53 t ha^{-1}) with highest straw yield (9.58 t ha^{-1}).

Bhowmick (2005) stated that the crop characters of rice were significantly influenced by different cultivars of transplant *Aman* rice except straw yield, weight of 1000-grain and biological yield.

Haque (2005) found that variety showed significant effect on the entire yield contributing characters and yield except weight of 1000-grain, straw yield and biological yield. Results revealed that BRRI dhan41 produced the highest grain yield (5.10 t ha^{-1}) while Pajam produced the lowest grain yield (3.86 t ha^{-1}).

Singh *et al*. (2004) observed that the highest number of panicles, panicle length and grains $panicle^{-1}$ were associated with Rajshree while Jallahri recorded highest test weight. They also observed that the highest grain yield (2.87 t ha^{-1}) found from Rajshree variety compared to Bhudeo and Jallari. They also reported that the highest grain yield (4.12 t ha^{-1}) was obtained from Gautam variety and Prabhat.

Uddin (2004) found that the plant height, total tillers $hill^{-1}$, effective and non-effective tillers $hill^{-1}$, panicle length and grain yield differed significantly by variety. The highest grain yield (4.71 t ha^{-1}) was obtained from BR22.

Rahman (2003) stated that effect of variety on the yield was significant. Among the test crops, BR11 produced the highest grain yield (5.35 t ha^{-1}) and Nizersail yielded the lowest.

Sarker (2003) conducted an experiment at research farm in Bangladesh Agricultural University, Mymensingh and found that variety had significant effect on growth parameters: e.g. plant height, total tillers and grain yield. The tallest plant (111.42 cm), the highest total tillers $hill^{-1}$(14.50) and grain yield 5.12 t ha^{-1}) were observed in BRRI dhan32. The shortest plant (96.11 cm), the lowest total tillers hill^{-1} (14.24) and grain yield (4.86 t ha^{-1}) were produced by BR11.

From a study with SRI, Sengthong (2002) reported that rice var. TDK 1 produced significantly higher number of tillers hill^{-1}. The average number of tillers was 23, 28 and 23 when the age of seedlings was 9, 12 and 18 days, respectively.

Kabir (2001) reported that variety had significant effect on number of sterile spikelets panicle^{-1}. BR14 produced the highest number of sterile spikelets panicle^{-1} and Binadhan-13 produced the lowest number of sterile spikelets panicle^{-1}.

Molla (2001) carried out an experiment to examine the performance of rice hybrids and HYV. The treatment consists of two hybrid rice (Pro-Agro 6201 and NRH 3) and one HYV (IET 4786). Pro-Agro 6201 had more profuse tillering habit at an early stage than the HYV, which could be due to hybrid vigor.

Uddin *et al.* (2001) conducted an experiment to find out the crop performance of hybrid, inbred and locally improved rice varieties and reported that variety had significant effect on all crop characters under study. Sonarhangla -1 ranked first in respect of weight of 1000-grains followed by Alok 6201, Habigonj VII and Habigonj IV.

Aziz and Hasan (2000) reported that in SRI practice, the average number of tillers hill^{-1} and effective tillers hill^{-1} were 11.7 and 10.3, respectively in Parija varieties at Rajshahi.

Cui *et al*. (2000) conducted a field trial and observed varietal differences in harvest index and yield were examined using 60 Japanese varieties and 20 high yielding varieties breed in Asian countries and reported that harvest index varied from 36.8% to 53.4%. Mean values of harvest index were 43.5% in the Japanese group and 48.8% in high yielding group. Yield ranged from 22.6 g plant^{-1} to 40.0 g plant^{-1}. The mean value of yield in Japanese group was 22.8 g plant^{-1} and that in the high yielding group was 34.1 g plant^{-1}. They also stated that a positive correlation was found between harvest index and yield in the high yielding group.

Patel (2000) conducted an experiment to study the varietal performance of Kranti and IR 36. The mean yield of Kranti over IR 36 was 7.1% and 10.0% higher for grain and straw, respectively. Variety Kranti showed superiority over IR 36 due to production of taller plants, a greater number of tillers and heavier grain weight as well as stiff straw.

Huang *et al*. (1999) conducted a field trial with hybrid Peiai 645/E32 in Guang Zhou in the early season and observed that this two-line hybrid rice had a plant height of 115.8 cm and a culm height 105.4 cm with thick and erect 'V' shaped leaves of deep green color.

Om *et al*. (1999) conducted a field experiment with four varieties (3 hybrids: ORI 161. PMS 2A and PMS 10A; 1 inbreed variety: HKR 126) during rainy season. They observed that hybrid ORI 161 exhibited superiority over other varieties in grain yield and straw yield.

In a trial with seven hybrid and one modern variety of rice during the *Aman* season at BAU (1998) found that the hybrid variety #93024 gave the highest grain yield (7.58 t ha^{-1}) followed by Alok 6201 (7.33 t ha^{-1}) and the control variety BR22 gave the lowest yield (4.75 t ha^{-1}). The maximum plant height was observed in BR22. On the other hand, maximum numbers of tillers hill^{-1}, panicle length and spikelets panicle^{-1} were recorded in hybrid varieties.

BINA (1998) in a field trial with seven hybrid rice varieties found that hybrid rice # 93024 gave the highest grain yield of 6.04 t ha^{-1} and the lowest yield was produced by hybrid rice # 92017. Alok 6201 gave a grain yield of 5.71 t ha^{-1}. Most of the crop parameters were found to be superior in entry # 93024.

Devaraj *et al*. (1998) in an experiment with two rice hybrid- Karnataka Rice Hybrid 1 (KRH 1) and Karnataka Rice Hybrid 2 (KRH 2) using HYV IR 20 as the check variety found that KRH 2 out yielded IR 20. In IR 20, the tiller number was higher than that of KRH 2. The increased yield of KRH 2 was mainly attributed due to the higher number of productive tillers, panicle length and number of grains panicle^{-1}.

Julfiquar *et al*. (1998) reported that in the International Hybrid Rice Observational Nursery (IRHON-96), six hybrids out yielded against check varieties of which three hybrids-IR6229A/IR29723-143-3-2-IR, IR58025A/IR34683-179-1-2-IR and IR58025A/IR21-567-18-3R gave one ton more yield than the check variety of the same duration. In International Hybrid Rice Observation Nursery (IRHON-97) seven hybrids out-yielded the check var. BRRI dhan29.

Om *et al*. (1998) found taller plants and more productive tillers in ORI 161 than in PMS 2AXIR 31802. They also found more grain and straw yield in ORI 161 than in PMS 2AXIR 31802.

Rajendra *et al*. (1998) recorded the mean grain yield of hybrid rice cultivars Pusa 834 and Pusa HR 3 was 3.3 t ha^{-1} and 5.6 t ha^{-1}, respectively.

Prabagaran and Ponnuswamy (1998) conducted an experiment to observe the seasonal influence on flowering behavior and plant growth characters in parental lines of hybrid rice. The A lines were found late for first flowering, 50% flowering and to have higher duration of flowering in a panicle and productive tillers than their respective maintainers.

Singh *et al*. (1998) evaluated the productivity of two rice hybrids- TNH 1 and TNH 2 using Rasi and Jaya as standard checks during Kharif season of 1992 and found that Jaya produced significantly highest grain yield (5.12 t ha^{-1}). Rasi and TNH 1 were at par in grain yield but TNH 2 recorded the lowest grain yield of 3.06 t ha^{-1}.

Tae *et al*. (1998) conducted an experiment with two rice varieties- Akitakomachi and Hitombore in Tohoku region of Japan. It was found that Hitombore yielded the highest (710 g m^{-2}) and Akitakomachi yielded the lowest (660 g m^{-2}).

BRRI (1997) reported that three modern upland rice varieties, namely BR20, BR21 and BR24 were suitable for high rainfall belts in Bangladesh under proper management. The grain yield was 3.5 t ha^{-1} for BR21 and 3.8 t ha^{-1} for BR24.

Dwivedi (1997) found that scented genotypes Kamini and Sugandha produced higher grain and straw yields than other cultivars- RP 615, Harbans, Basmati and Kasturi in Agwanpur (Bihar), India.

DRR (1996) evaluated the performance of 11 hybrids in India developed for irrigated ecosystem and found that plant height differed significantly by variety. The highest plant height (128 cm) was found in the hybrid rice cultivar 2RI 075 followed by the cultivars PMS 8A/IR46 (120 cm) and IR13025A/RP 1057 (117 cm). The lowest plant height of 82 cm was observed with hybrid rice cultivar IR62829A. In a preliminary evaluation of six hybrids the plant height was found to vary- from 88 cm to 151 cm and it was 101 cm of the check variety Jaya. They also evaluated 44, 33 and 33 hybrids in International Hybrid Rice Observation Nursery (IRHON) in consecutive 3 years 1994, 1995 and 1996, respectively. They reported that the hybrid gave (1.7 to 3.7 t ha^{-1}) more yield than their corresponding check varieties. In observation of yield, they found that all the rice hybrids out-yielded the local highest yielding check varieties.

Guok *et al*. (1996) conducted an experiment with hybrid rice cultivar MS IR 62829A/IR and MR 84 and observed that cultivar MS IR62829A/IR significantly out-yielded MR 84 by 26%. In another experiment they found that out of two hybrid cultivars, MH 841- IA/MR 167 62829 A/IR significantly out-yielded MR 167 by 24%.

Munoz *et al*. (1996) reported that the highest yielding hybrid rice cultivar was IR8025A, which produced an average yield of 7.1 t ha^{-1} which was 16% higher than the commercial variety Oryzica Yacu-9.

Radhakrishna *et al*. (1996) conducted 15 trials at Mandya, Karnataka from 1992-1995 and found that hybrid cultivar KRH 2 gave an average yield of 9.3 t ha^{-1} with a yield advantage of 1.51 t ha^{-1} over the best check variety- Jaya.

Sitaramaiah *et al*. (1996) evaluated six promising rice hybrids with two check varieties and found that hybrids MTUHR 2033, MTUHR 2020 and MTUHR 2037 gave higher grain yields, greater biomass production and harvest index than other varieties.

BRRI (1995) conducted an experiment to find out the yield performance of BR4. BR10, BR11, BR22, BR23 and BR25 cultivars including two local check cultivars Challish and Nizersail. Experimental results indicated that BR4, BR10, BR11, Challish and Nizersail produced grain yield of 4.38, 3.12, 3.12, 3.12 and 2.70 t ha^{-1}, respectively. Challish cultivar flowered earlier than all other varieties. BR22 and BR23 showed poor performance.

Islam (1995) performed an experiment with four modern cultivars- BR10, BR11, BR22 and BR23 and found distinct variation in straw yield among the varieties studied.

LiuXinhua (1995) conducted a field trial with a new indica hybrid rice cv.11-You 92 and found an average yield of 7.5 t ha^{-1} which was 10% higher than that of standard hybrid cv. Shanyou 64.

BRRI (1994) studied the performance of BR14, Pajam, BR5 and Tulsimala. They stated that Tulsimala produced the highest number of filled grains $panicle^{-1}$ and BR14 produced the lowest number of filled grains $panicle^{-1}$.

Ali and Murship (1993) conducted an experiment during July to December, 1989 to find out suitable variety for late transplanted *Aman* rice. Cultivar Kumragoir statistically out-yielded two modern cultivars- BR23 and BR11.

BINA (1993) evaluated the yield performance of four varieties/advanced lines IRATOM-24, BR14, Binadhan-13 and Binadhan-19. They found that varieties/advanced lines differed significantly in terms of plant height, number of effective and ineffective tillers, panicle length and unfilled grains panicle^{-1}.

Chowdhury *et al*. (1993) observed that the cv. BR23 showed superior performance over cv. Paiam in respect of number of effective tillers hill^{-1}, length of panicle, weight of 1000-grains, grain yield and straw yield but cv. Pajam produced significantly taller plants, more number of total spikelets panicle^{-1}, grains panicle^{-1} and sterile spikelets panicle^{-1}.

Leenakumari *et al*. (1993) evaluated eleven hybrids against standard check varieties- Jaya, Rasi, IR 20 and Margala. They concluded that hybrid cultivar OR 1002 gave the highest yield of 7.9 t ha^{-1} followed by the hybrid cultivar OR 1001 (6.2 t ha^{-1}). Among the control varieties, Jaya gave the highest yield of 8.4 t ha^{-1}.

Chandra *et al*. (1992) carried out an experiment with two hybrid cultivars and three control varieties and observed that the hybrid cultivar IR62829A out-yielded the hybrid cultivar IR58025A and all other control varieties.

Suprihatno and Sutaryo (1992) evaluated the performance of seven IRRI hybrids and 13 Indonesian hybrids using IR 64 and Way-Seputih as check varieties. They found that the check varieties were high yielding than the hybrids. IR 64 was highest yielding significantly out-yielded IR6461H, IR64610H and IR621329A/IR54 which in turn out-yielded Way-Seputih.

BRRI (1991) reported that the filled grains panicle^{-1} of different modern varieties were 95-100 in BR3, 125 in BR4, 120-130 in BR22 and 110-120 in BR23 when they were cultivated in *Aman* season. They also reported that plant height differedamong the varieties.

Gu *et al*. (1991) recorded that hybrid rice cv. Yayou No. 2 had a strong tillering ability and high harvest index than cv. Shanyou No. 6.

Hossain and Alam (1991) reported that the growth characters like plant height, number of total tillers hill^{-1} and number of grains panicle^{-1} differed significantly among BR3, BR11, BR4, Pajam and Jaguli varieties in *Aman* season.

Idris and Matin (1990) conducted an experiment with different rice cultivars and concluded that panicle length differed among the varieties. They also reported that the rice varieties BAU 29, BAU 92, BAU 110, BAU 128 and IR 8 gave different yield values.

Hussain *et al*. (1989) observed in an experiment with nine cultivars and concluded that the number of total tillers hill^{-1} differed among the varieties.

Rafey *et al*. (1989) conducted an experiment with three different rice cultivars and reported that weight of 1000-grains differed among the cultivars studied.

Singh and Gangwer (1989) found that the grain number panicle^{-1}, weight of 1000-grains and biological yield were the highest in c-14-8 than in CR-1009, IET-5656 and IET-6314 varieties.

Shamsuddin *et al*. (1988) stated that plant height and weight of 1000-grains differed significantly among the nine varieties studied.

So, this research review's purpose is to help the reader understand variation in growth, yield and yield-contributing parameters' pattern of different *aman* rice genotypes due to the effect of supplemental irrigation posed by research in rice growing countries. The study of past years revealed that world has been undergoing through climate change and change in rainfall pattern. Variability in the amount and distribution of rainfall is one of the most important factors for limiting yield of rainfed crop like T. *Aman* in Bangladesh. Therefore, it is important to explore the potentiality of supplemental irrigation and conduct more studies to find out potential local rice cultivars of *aman* rice germplasm.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from July to December 2018.

3.1 Description of the experimental site

3.1.1 Geographical location

The experimental area was situated at 23°77′N latitude and 90°33′E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of “The Madhupur Tract”, AEZ-28 (Anon., 1988). This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as ‘islands’ surrounded by floodplain. The experimental site has been shown in the map of AEZ of Bangladesh in Appendix I.

3.1.3 Climate

The climate of the area is sub-tropical, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the October-December.

3.1.4 Soil

The soil of the experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish-brown mottles. Soil pH was 5.6 and had organic matter 0.78% (Appendix II). The experimental area was flat having available irrigation and drainage system and above flood level.

3.2 Details of the experiment

3.2.1 Treatments

Two factor experiment was conducted to study the effect of supplemental irrigation on *Aman* rice genotypes.

Treatments included in the experiment were as follows:

Treatments

Factor A (Main factor): **Supplemental Irrigation**: **2**

i. No supplemental irrigation (I_0)
ii. Supplemental irrigation as and when needed (I_1)

Factor B (Sub factor): **Genotypes/Cultivar**: **8**

i. SAU AGDL1 (G_1)
ii. SAU AGDL2 (G_2)
iii. SAU AGDL3 (G_3)
iv. SAU AGDL12 (G_4)
v. SAU AGDL13 (G_5)
vi. SAU AGDL14 (G_6)
vii. SAU AGDL15 (G_7)
viii. Kataribhog (G_8)

No. of treatments: 16

3.2.2 Experimental design

The experiment was laid out in a Split-plot design with three replications. All of the eight rice genotypes were planted in irrigated and non-irrigated plots. There were sixteen treatments. The total numbers of unit plots were 48. The size of unit plot was 2.8 m by 2.0 m. The distances between plot to plot and replication to replication were 0.75 m and 1.0 m, respectively. The layout of the experiment has been shown in Appendix IV.

3.3 Planting material

Seven rice genotypes along with Kataribhog were used as planting material.

3.3.1 Description of Kataribhog

Kataribhog is a local cultivar of aromatic rice grown in *Aman* season. It is a tall stature, photosensitive cultivar and lodged with higher management package. It takes around 140 days to mature. It is considered as a low yield potential aromatic cultivar.

3.3.2 Description of other cultivars

SAU AGDL1, SAU AGDL2, SAU AGDL3, SAU AGDL12, SAU AGDL13, SAU AGDL14 and SAU AGDL15 are rice line of *Aman* season provided by an NGO named Suranjana. Paul (2016) reported that the genotypes require about 125-140 days to mature.

3.4 Crop management

3.4.1 Raising of seedling

3.4.1.1 Seed collection

Seeds of specific lines were selected from the lot through various field observations by the Agronomy department of Sher-e-Bangla Agricultural University. The selected materials were named as SAU AGDL (Sher-e-Bangla Agricultural University Agronomy Department Line) having chronological numerical as SAU AGDL1, SAU AGDL2, SAU AGDL3, SAU AGDL12, SAU AGDL13, SAU AGDL14 and SAU AGDL15. The seeds of Kataribhog was used from personal collection.

3.4.1.2 Seed sprouting

Seeds were selected by following specific gravity method. Seeds were immersed into water in a bucket for 24 hours. These were then taken out of water and kept tightly in gunny bags. The seeds started sprouting after 48 hours which were suitable for sowing in nursery bed within 72 hours.

3.4.1.3 Preparation of seedling nursery

A common procedure was followed in raising seedlings in the seedbed. The seedbed was prepared by puddling with repeated ploughing followed by laddering. Weeds were removed and irrigation was provided to the bed as and when necessary. No fertilizer was applied in the nursery bed.

3.4.1.4 Seed sowing

Sprouted seeds were sown on the seedbed on 12th July 2018 for raising nursery seedlings. The sprouted seeds were sown uniformly.

3.4.2 Preparation of experimental land

The experimental field was first ploughed on 29th July 2018 with the help of a tractor drawn disc plough. Later on 10th August 2018 the land was irrigated and prepared by three successive ploughings and cross ploughings with a tractor drawn plough and subsequently leveled by laddering. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was performed on 11th August 2018 according to experimental specification. Individual plots were cleaned and finally leveled with the help of wooden plank so that no water pocket could remain in the puddled field.

3.4.3 Application of fertilizer

The experimental area was fertilized with 120, 80, 80 and 20 kg ha^{-1} of N, P_2O_5, K_2O and S applied in the form of urea, triple super phosphate (TSP), muriate of potash (MP) and gypsum, respectively. The entire amounts of triple super phosphate, muriate of potash and gypsum were applied as basal dose at final land preparation. Urea was top-dressed in three equal installments, first after seedling recovery, then during the vegetation stage and finally at 7 days before panicle initiation.

3.4.4 Transplanting of seedlings

For nursery seedlings 30 days old seedlings were uprooted carefully on 11th August, 2018 and kept in soft mud in shade. The seedbeds were kept wet by application of water in previous day before uprooting the seedlings to minimize mechanical injury of roots. Seedlings were then transplanted with 20 cm × 20 cm spacing on the well-puddled plots. In each plot, there were 10 rows, each row contains 14 hills of rice seedlings.

3.4.5 Intercultural operations

3.4.5.1 Weeding

The early stage of crop establishment is the most vulnerable period for weed infestation. Three hand weeding were done for every method, first weeding was done at 10 days after transplanting followed by second weeding at 15 days after first weeding. Third weeding was done 15 days after second weeding.

3.4.5.2 Plant protection measures

Plants were infested with rice stem borer (*Scirphophaga incertulus*) and leaf hopper (*Nephotettix nigropictus*) to some extent which were successfully controlled by applying Furadan 5G @ 10 kg ha^{-1} and Actara on 6^{th} September and Furadan 5G @ 10 kg ha^{-1} and Diazinon 60EC @ 1 ml $liter^{-1}$ of water for 5 decimal lands on 25^{th} September. Crop was protected from birds and rats during the grain filling stage. Field trap and phostoxin poisonous bait were used to control the rat. For controlling the birds watching was done properly, especially during morning and afternoon and netting of research plot was done before panicle initiation.

3.5 Harvesting and post-harvest operations

The rice plant was harvested depending upon the maturity of plant. Harvesting was done manually from each plot. Harvesting was started at 138 days and continued up to 145 days. Maturity of crop was determined when 80% of the grains become matured.

Ten preselected hills $plot^{-1}$ from which different data were collected and $1m^2$ areas from middle portion of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yield. Threshing was done using pedal thresher. The grains were cleaned and sun dried to a moisture content of 12%. Straw was also sun dried properly. Finally, grain and straw yields $plot^{-1}$ were calculated and converted to ton ha^{-1}.

3.6 Recording of data

Experimental data were recorded from 20 days of growth duration and continued until harvest. The following data were recorded during the experiment.

A. Crop growth characters

i. Plant height at 20 days interval and at harvest

ii. Number of tillers hill^{-1} at 20 days interval and at harvest

iii. Leaf area index at 20 days interval and at harvest

iv. Dry weight of plant at 30 days interval

B. Yield and other crop characters

i. Number of tillers hill^{-1}

ii. Length of panicle

iii. Number of primary branches panicle^{-1}

iv. Number of filled grains panicle^{-1}

v. Number of unfilled grains panicle^{-1}

vi. Number of total grains panicle^{-1}

vii. Weight of 1000-grains

viii. Grain yield

ix. Straw yield

x. Biological yield

xi. Harvest index

3.7 Detailed procedures of recording data

A brief outline of the data recording procedure followed during the study is given below:

A. Crop growth characters

i. Plant height (cm)

Plant height was measured at 20, 40, 60, 80, 100 DAT and at harvest. The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf height before heading and to the tip of panicle after heading.

ii. Number of tillers hill^{-1}

Number of tillers hill^{-1} were counted at 20, 40, 60, 80, 100 DAT and at harvest from ten randomly preselected hills and expressed as number hill^{-1}. Only those tillers having three or more leaves were used for counting.

iii. Leaf Area Index (LAI)

Leaf area index were estimated measuring the length and average breadth of leaf (at 20, 40, 60, 80, 100 DAT and at harvest) and multiplying by a factor of 0.75 followed by Yoshida (1981).

iv. Dry weight of plant at 30 days interval

Dry weight of plant was measured at transplanting, 30, 60, 90 DAT and at harvest.

B. Yield and other crop characters

i. Effective tillers m^{-2}

The panicles which had at least one grain were considered as effective tillers. The number of effective tillers of 10 hills was recorded and expressed as effective tillers number m^{-2}.

ii. Ineffective tiller m^{-2}

The tillers having no panicle were regarded as ineffective tillers. The number of ineffective tillers of 10 hills were recorded and was expressed as ineffective tiller number m^{-2}.

iii. Panicle length

Measurement of panicle length was taken from basal node of the rachis to apex of each panicle. Each observation was an average of 10 panicles.

iv. Primary branches of panicle

Primary branches of 10 panicles were recorded and averaged.

vi. Filled grains panicle^{-1}

Grain was considered to be filled if any kernel was present therein. The number of total filled grain present on 10 panicles were recorded and finally averaged.

vii. Unfilled grains panicle^{-1}

Unfilled grain means the absence of any kernel inside spikelet and such grain present on each of 10 panicles were counted and finally averaged.

viii. Total grains panicle^{-1}

The total number of grains panicle^{-1} was calculated by adding number of filled panicle^{-1} with the number of unfilled grains panicle^{-1}.

ix. Sterility percentage

At harvesting, 10 panicles were harvested at maturity from five randomly chosen plants in each of the hybrids and the no. of filled, unfilled and total grain was counted. Spikelets fertility percentage was then computed as following:

$$\text{Sterility percentage} = \frac{\text{No. of unfilled grains in the panicle}}{\text{Total no. of grains in the panicle}} \text{x } 100$$

x. Weight of 1000-grains

One thousand cleaned dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage the grain retained 12% moisture and the mean weight were expressed in gram.

xi. Grain yield

Grain yield was determined from the central $1m^2$ area of each plot and expressed as t ha^{-1} and adjusted with 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

xii. Straw yield

Straw yield was determined from the central $1m^2$ area of each plot. After separating of grains, the sub-samples were sun dried to a constant weight and finally converted to t ha^{-1}.

xiii. Biological yield

Grain yield and straw yield were all together regarded as biological yield. Biological yield was calculated with the following formula:

$$\text{Biological yield (t ha}^{-1}) = \text{Grain yield (t ha}^{-1}) + \text{Straw yield (t ha}^{-1})$$

xiv. Harvest index

Harvest index denotes the ratio of economic yield (grain yield) to biological yield and was calculated using following formula (Donald, 1963; Gardner *et al.*, 1985):

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \text{x} 100$$

3.8 Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique using CropStat package and the mean differences were adjudged by LSD technique (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Growth parameters

4.1.1 Plant height

4.1.1.1 Effect of irrigation

The plant height of aromatic rice genotypes was influenced by different level of irrigations (Figure 1). At 20 DAT, plant height of irrigated treatments was higher than non-irrigated ones (62.24 cm and 62.14 cm, respectively) but there was no significant difference. At 40 DAT, plant height of irrigated plots was higher than non-irrigated ones (124.43 cm and 121.86 cm, respectively) but there was no significant difference.

At 60 DAT, plant height of irrigated plots was higher than non-irrigated ones (146.30 cm and 142.03 cm, respectively) but there was no significant difference. At 80 DAT, plant height of irrigated plots was higher than non-irrigated ones (165.55 cm and 160.21 cm, respectively) but there was no significant difference.

At 100 DAT, plant height of irrigated plots was significantly higher than non-irrigated ones (180.05 cm and 171.80 cm, respectively). At harvest, plant height of irrigated plots was significantly higher than non-irrigated ones (186.65 cm and 177.83 cm, respectively).

The plant height of supplemental irrigated treatment at 20, 40, 60, 80, 100 DAT and at harvest was 0.16, 2.13, 3.03, 3.31, 4.77 and 4.95% higher, respectively; compared to that of no supplemental irrigation. Shamsuzzaman (2007) also reported higher plant height due to supplemental irrigation on T. *Aman*.

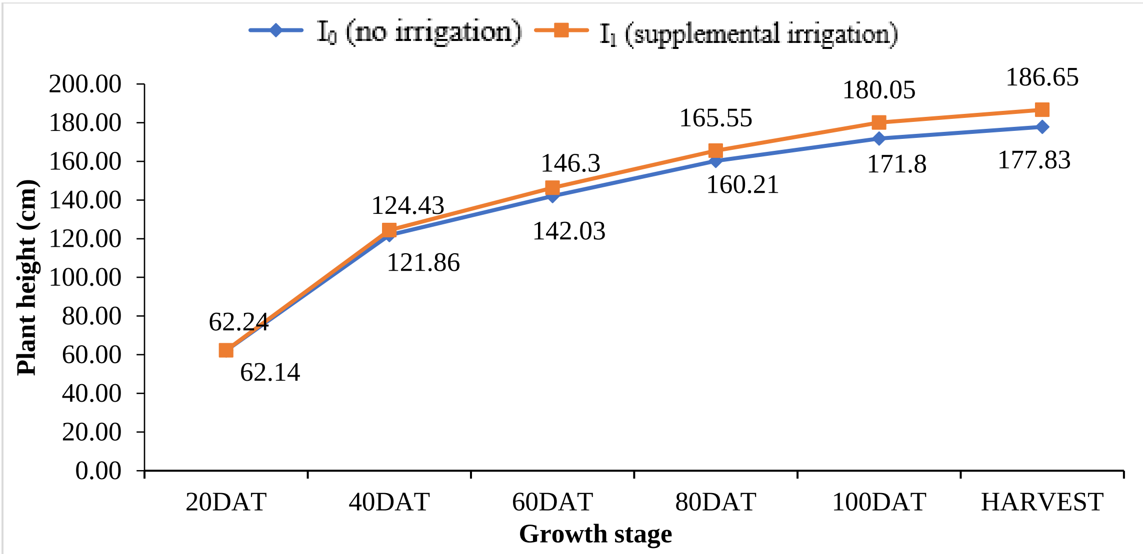

Figure 1. Effect of supplemental irrigation on plant height of T. *Aman* rice at different crop growth stages [$LSD_{(0.05)}$ = 3.882, 10.398, 11.913, 5.643, 5.094 and 5.727, respectively]

4.1.1.2 Effect of Genotypes

Genotypes had significant influence on plant height of T. *Aman* rice at transplanting, 20, 40, 60, 80, 100 days after transplanting (DAT) and at harvest (Table 1).

At transplanting, the genotype SAU AGDL14 produced the tallest plant (47.12 cm) and the shortest plant (28.05 cm) was observed in SAU AGDL12. SAU AGDL2 produced the second tallest plant (46.21 cm). Kataribhog produced plants of 30.78 cm.

At 20 DAT, SAU AGDL1 produced the tallest plant (66.88 cm), which was statistically similar with SAU AGDL13, SAU AGDL15, and SAU AGDL2. The shortest plant (58.15 cm) was observed in SAU AGDL3, which was statistically similar with Kataribhog, SAU AGDL12 and SAU AGDL14.

At 40 DAT, SAU AGDL1 produced the tallest plant (138.32 cm), which was statistically similar with SAU AGDL15 (133.62 cm). The shortest plant (105.38 cm) was observed in Kataribhog, which was statistically similar with SAU AGDL12 (105.48 cm).

At 60 DAT, SAU AGDL15 produced the tallest plant (159.87 cm), which was statistically similar with SAU AGDL1 (159.48 cm) and SAU AGDL14 (155.49 cm). The shortest plant (122.95 cm) was observed in SAU AGDL12, which was statistically similar with Kataribhog (124.08 cm).

At 80 DAT, SAU AGDL1 produced the tallest plant (179.27 cm), which was statistically similar with SAU AGDL15 (176.67 cm) and SAU AGDL14 (172.45 cm). The shortest plant (140.32 cm) was observed in SAU AGDL12, which was statistically similar with Kataribhog (143.38 cm).

At 100 DAT, SAU AGDL1 produced the tallest plant (192.34 cm), which was statistically similar with SAU AGDL15 (187.81 cm) and SAU AGDL14 (185.10 cm). The shortest plant (153.67 cm) was observed in SAU AGDL12, which was statistically similar with Kataribhog (158.29 cm).

At harvest, SAU AGDL1 produced the tallest plant (199.23 cm), which was statistically similar with SAU AGDL15 (193.94 cm) and SAU AGDL14 (191.02 cm). The shortest plant (160.15 cm) was observed in SAU AGDL12, which was statistically similar with Kataribhog (164.66 cm).

Variation in plant height might be due to the differences in their genetic make-up. The highest plant height recorded at transplanting, 20, 40, 60, 80, 100 DAT and at harvest was 53.09, 13.94, 31.26, 28.84, 25.03, 21.51 and 20.99% higher, respectively; compared to that of Kataribhog. Similar result was reported by Shamsuddin *et al.* (1988), Hossain *et al.* (1991) and Khatun (2001) who also observed differences in plant heights among the varieties.

Table 1. Effect of genotypes on plant height of T. *Aman* rice at different crop growth stages

Genotype	Plant height (cm) at						
	Transplanting	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Harvest
G_1	39.20 f	66.88 a	138.32 a	159.48 a	179.27 a	192.34 a	199.23 a
G_2	46.21 b	63.32 a-c	130.42 b	145.91 b	164.89 bc	175.37 cd	181.57 cd
G_3	42.95 c	58.15 d	116.40 c	142.61 b	160.09 c	171.83 d	178.12 d
G_4	28.05 h	60.06 cd	105.48 d	122.95 c	140.32 d	153.67 e	160.15 e
G_5	40.26 e	65.78 ab	126.12 b	142.92 b	165.98 bc	182.98 bc	189.25 bc
G_6	47.12 a	60.99 b-d	129.43 b	155.49 a	172.45 ab	185.10 ab	191.02 ab
G_7	42.61 d	63.67 a-c	133.62 ab	159.87 a	176.67 a	187.81 ab	193.94 ab
G_8	30.78 g	58.70 cd	105.38 d	124.08 c	143.38 d	158.29 e	164.66 e
$LSD_{(0.05)}$	0.0004	5.008	7.590	7.795	9.467	8.955	8.450
CV (%)	0.01	6.81	5.21	4.57	4.91	4.30	3.92

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,
G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.1.1.3 Interaction effect of supplemental irrigation and genotypes

Due to interaction effect of supplemental irrigation and genotypes, plant height varied significantly (Appendix V and Table 2).

At 20 DAT, SAU AGDL13 with no irrigation produced the tallest plant (67.50 cm), which was statistically similar with SAU AGDL1 with irrigation and SAU AGDL1 with no irrigation, SAU AGDL2 with no irrigation, SAU AGDL15 with irrigation, SAU AGDL13 with irrigation, SAU AGDL15 with no irrigation, SAU AGDL14 with irrigation, SAU AGDL2 with irrigation and SAU AGDL12 with irrigation.

SAU AGDL3 with no irrigation produced the shortest plant (56.57 cm), which was statistically similar with Kataribhog with irrigation, SAU AGDL12 with no irrigation, Kataribhog with no irrigation, SAU AGDL3 with irrigation, SAU AGDL14 with no irrigation, SAU AGDL12 with no irrigation, SAU AGDL2 with irrigation, SAU AGDL14 with irrigation and SAU AGDL15 with irrigation.

At 40 DAT, SAU AGDL1 with irrigation produced the tallest plant (139.87 cm) which was statistically similar with SAU AGDL1 with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL2 with no irrigation, SAU AGDL14 with irrigation, and SAU AGDL15 with irrigation. SAU AGDL12 with no irrigation produced the shortest plant (101.49 cm), which was statistically similar with Kataribhog with irrigation, Kataribhog with no irrigation, SAU AGDL12 with irrigation and SAU AGDL3 with no irrigation.

At 60 DAT, SAU AGDL14 with irrigation produced the tallest plant (162.81 cm) that was statistically similar with SAU AGDL15 with irrigation, SAU AGDL1 with irrigation, SAU AGDL15 with no irrigation, SAU AGDL1 with no irrigation, SAU AGDL2 with no irrigation and SAU AGDL13 with no irrigation. SAU AGDL12 with no irrigation gave the shortest plant (118.49 cm) and that was statistically similar with the variety Kataribhog with irrigation, Kataribhog with no irrigation and SAU AGDL12 with irrigation.

At 80 DAT, SAU AGDL14 with irrigation produced the tallest plant (179.40 cm) that was statistically similar with SAU AGDL1 with irrigation, SAU AGDL1 with no irrigation, SAU AGDL15 with irrigation, SAU AGDL15 with no irrigation, SAU AGDL13 with irrigation and SAU AGDL2 with no irrigation. SAU AGDL12 with no irrigation gave the shortest plant (133.51 cm) and that was statistically similar with the variety Kataribhog with no irrigation and Kataribhog with irrigation.

At 100 DAT, SAU AGDL1 with irrigation produced the tallest plant (194.15 cm) that was statistically similar with SAU AGDL14 with irrigation, SAU AGDL15 with irrigation, SAU AGDL1 with no irrigation, SAU AGDL13 with irrigation and SAU AGDL15 with no irrigation. The shortest plant (144.93 cm) was recorded in SAU AGDL12 with no irrigation, which was statistically similar with Kataribhog with no irrigation.

At harvest, SAU AGDL1 with irrigation produced the tallest plant (201.47 cm) that was statistically similar with SAU AGDL14 with irrigation, SAU AGDL15 with irrigation, SAU AGDL1 with no irrigation, SAU AGDL13 with irrigation and SAU AGDL15 with no irrigation. The shortest plant (149.90 cm) was observed in SAU AGDL12 with no irrigation

The highest plant height recorded at transplanting, 20, 40, 60, 80, 100 DAT and at harvest was 14.27, 31.33, 29.80, 26.34, 24.75 and 23.85% higher, respectively; compared to that of Kataribhog with no irrigation. Shamsuzzaman (2007) also reported higher plant height due to interaction effect of supplemental irrigation and genotypes on T. *Aman*.

Table 2. Interaction effect of supplemental irrigation and genotypes on plant height of T. *Aman* rice at different crop growth stages

Treatments	Plant height (cm) at					
	20DAT	40DAT	60DAT	80DAT	100DAT	Harvest
I_0G_1	67.05 ab	136.77 ab	158.47 ab	179.23 a	190.53 ab	196.99 ab
I_0G_2	65.14 a-c	133.57 a-d	148.89 a-c	169.33 a-d	176.27 cd	181.73 c-e
I_0G_3	56.57 d	112.10 ef	139.99 c-e	155.30 e-g	167.47 d-f	173.60 d-f
I_0G_4	58.89 cd	101.49 f	118.49 f	133.51 h	144.93 g	149.90 g
I_0G_5	67.50 a	123.93 d	137.71 de	161.85 c-e	179.21 b-d	185.34 b-d
I_0G_6	59.97 b-d	125.37 cd	148.17 a-d	165.50 b-e	176.80 cd	182.36 c-e
I_0G_7	62.95 a-d	135.17 a-c	159.07 ab	174.94 a-c	183.55 a-c	190.09 a-c
I_0G_8	59.07 cd	106.50 f	125.43 f	142.00 gh	155.63 fg	162.67 f
I_1G_1	66.71 ab	139.87 a	160.49 a	179.30 a	194.15 a	201.47 a
I_1G_2	61.49 a-d	127.27 b-d	142.92 cd	160.45 d-f	174.47 c-e	181.40 c-e
I_1G_3	59.72 b-d	120.70 de	145.23 b-d	164.87 c-e	176.20 cd	182.64 cd
I_1G_4	61.23 a-d	109.47 f	127.41 ef	147.13 fg	162.40 ef	170.40 ef
I_1G_5	64.06 a-c	128.30 b-d	148.13 b-d	170.10 a-d	186.75 a-c	193.16 a-c
I_1G_6	61.99 a-d	133.50 a-d	162.81 a	179.40 a	193.40 a	199.67 a
I_1G_7	64.39 a-c	132.07 a-d	160.67 a	178.40 ab	192.07 a	197.78 a
I_1G_8	58.33 cd	104.27 f	122.73 f	144.77 gh	160.95 f	166.65 f
LSD (0.05)	7.424	13.604	14.776	13.429	12.627	12.218
CV (%)	6.81	5.21	4.57	4.91	4.30	3.92

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.1.2 Number of total tillers hill^{-1}

4.1.2.1 Effect of irrigation

Total number of tillers hill^{-1} varied significantly among *Aman* rice genotypes due to different level of irrigation (Figure 2). At 20 DAT, the maximum number of tillers hill^{-1} was observed in the irrigated plots (7.17), which was statistically higher than the non-irrigated plots (6.83). At 40, 60 and 80 DAT, the maximum number of tillers hill^{-1} was observed in the irrigated plots (10.42, 12.21 and 14.00, respectively), which was statistically similar with the non-irrigated plots (9.00, 11.17 and 12.79, respectively). At 100 DAT and harvest, the maximum number of tillers hill^{-1} was observed in the irrigated plots (14.38 and 14.29, respectively), which was statistically higher than the non-irrigated plots (13.08 and 12.75, respectively).

The total number of tillers hill^{-1} of supplemental irrigated treatment at 20, 40, 60, 80, 100 DAT and at harvest was 4.98, 15.78, 9.31, 9.46, 9.94 and 12.08% higher, respectively; compared to that of no supplemental irrigation. Chaulian *et al.* (1999) also reported higher total number of tillers hill^{-1} due to supplemental irrigation on T. *Aman*.

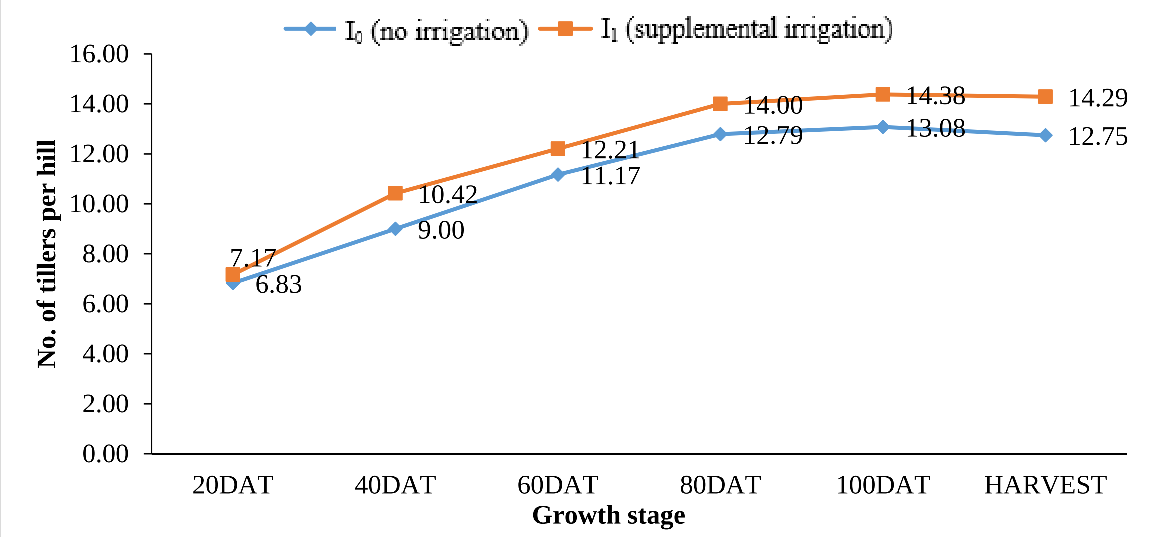

Figure 2. Effect of supplemental irrigation on no. of tillers hill^{-1} of T. *Aman* rice at different crop growth stages [$LSD_{(0.05)}$ = 0.179, 1.563, 2.068, 1.293, 0.474 and 0.987, respectively]

4.1.2.2 Effect of genotypes

Rice genotypes varied for growth and number of tillers throughout the life span. Total number of tillers hill^{-1} varied significantly among *Aman* rice genotypes at 20, 40, 60, 80, 100 DAT and at harvest (Table 3). Variable effect of variety on number of total tillers hill^{-1} was also reported by Roy *et al.* (2014) and BINA (1998) noticed that number of total tillers hill^{-1} differed among the varieties. Shahidullah *et al.* (2009a) reported that tillering patterns in aromatic rice genotypes exhibited wide range of variations without showing any major influence on grain yield.

At 20 DAT, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (8.67), which was statistically similar with SAU AGDL1 and the minimum number of tillers hill^{-1} was obtained from SAU AGDL14 (5.50), which was statistically similar with SAU AGDL13 and SAU AGDL2.

At 40 DAT, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (13.17) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL2 (8.33), which was statistically similar with SAU AGDL15, SAU AGDL3 and SAU AGDL13.

At 60 DAT, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (15.67) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL13 (10.33), which was statistically similar with SAU AGDL2, SAU AGDL15, SAU AGDL14, SAU AGDL12 and SAU AGDL3.

At 80 DAT, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (17.67) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 (11.67), which was statistically similar with SAU AGDL3, SAU AGDL13, SAU AGDL2, SAU AGDL15 and SAU AGDL14.

At 100 DAT, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (19.00) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 (12.00), which was statistically similar with SAU AGDL15, SAU AGDL13, SAU AGDL3 and SAU AGDL2.

At harvest, the maximum number of tillers hill^{-1} was observed in the local aromatic rice genotype Kataribhog (18.50) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 (12.17), which was statistically similar with SAU AGDL2, SAU AGDL3, SAU AGDL15, SAU AGDL13 and SAU AGDL1.

Result revealed that aromatic rice variety Kataribhog produced maximum tiller hill^{-1} at harvest. The variation in number of total tillers hill^{-1} might be due to varietal character as reported by Jisan *et al.* (2014).

Table 3. Effect of genotypes on number of total tillers hill^{-1} of T. *Aman* rice at different crop growth stages

Genotype	Number of total tillers hill^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Harvest
G_1	7.83 ab	10.67 b	13.33 b	15.17 b	14.17 b	13.00 bc
G_2	6.33 c-e	8.33 d	10.50 c	12.83 c	13.00 b-d	12.17 c
G_3	6.83 b-d	8.83 cd	11.17 c	12.00 c	12.67 cd	12.67 bc
G_4	7.33 bc	9.50 c	11.17 c	11.67 c	12.00 d	12.17 c
G_5	6.17 de	9.00 cd	10.33 c	12.17 c	12.67 cd	13.00 bc
G_6	5.50 e	9.33 c	10.67 c	12.83 c	13.67 bc	13.67 b
G_7	7.33 bc	8.83 cd	10.67 c	12.83 c	12.67 cd	13.00 bc
G_8	8.67 a	13.17 a	15.67 a	17.67 a	19.00 a	18.50 a
$LSD_{(0.05)}$	1.032	0.970	1.440	1.176	1.344	1.080
CV (%)	12.47	8.45	10.42	7.42	8.28	6.75

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.1.2.3 Interaction effect of supplemental irrigation and genotypes

Due to interaction effect of irrigation and genotype, number of tillers hill^{-1} varied significantly (Appendix VI and Table 4).

At 20 DAT, maximum number of tillers hill^{-1} was observed in Kataribhog with irrigation (9.00), which was statistically similar with Kataribhog with no irrigation, SAU AGDL1 with no irrigation and SAU AGDL1 with irrigation. Minimum number of tillers hill^{-1} was recorded in SAU AGDL14 with no irrigation (5.33), which was statistically similar with SAU AGDL14 with irrigation, SAU AGDL13 with no irrigation, SAU AGDL2 with no irrigation SAU AGDL13 with irrigation SAU AGDL3 with no irrigation and SAU AGDL2 with irrigation.

At 40 DAT, maximum number of tillers hill^{-1} was observed in Kataribhog with irrigation (14.33) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL2 with no irrigation (7.33), which was statistically similar with SAU AGDL15 with no irrigation, SAU AGDL13 with no irrigation and SAU AGDL3 with no irrigation.

At 60 DAT, maximum tiller numbers hill^{-1} was observed in Kataribhog with irrigation (16.67), which was statistically similar with Kataribhog with no irrigation. The minimum number of tillers hill^{-1} was obtained from SAU AGDL13 with no irrigation (9.33), which was statistically similar with SAU AGDL2 with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL14 with no irrigation, SAU AGDL3 with no irrigation, SAU AGDL15 with irrigation, SAU AGDL14 with irrigation, SAU AGDL2 with irrigation, SAU AGDL12 with no irrigation, SAU AGDL13 with irrigation, SAU AGDL12 with irrigation and SAU AGDL3 with irrigation.

At 80 DAT, maximum number of tillers hill^{-1} was observed in Kataribhog with irrigation (18.67) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 with no irrigation (11.00), which was statistically similar with SAU AGDL13 with no irrigation, SAU AGDL3 with no irrigation, SAU AGDL14 with no irrigation, SAU AGDL12 with irrigation, SAU AGDL3 with irrigation and SAU AGDL15 with no irrigation.

At 100 DAT, maximum number of tillers hill^{-1} was observed in Kataribhog with irrigation (20.33) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 with no irrigation (11.33), which was statistically similar with SAU AGDL3 with no irrigation, SAU AGDL2 with no irrigation, SAU AGDL12 with irrigation, SAU AGDL3 with irrigation and SAU AGDL14 with no irrigation.

At harvest, maximum number of tillers hill^{-1} was observed in Kataribhog with irrigation (19.33) and the minimum number of tillers hill^{-1} was obtained from SAU AGDL12 with no irrigation (11.33), which was statistically similar with SAU AGDL2 with no irrigation, SAU AGDL3 with no irrigation, SAU AGDL1 with no irrigation, SAU AGDL15 with no irrigation and SAU AGDL13 with no irrigation.

The highest number of tillers hill^{-1} obtained due to interaction effect of supplemental irrigation and genotypes at 20, 40, 60, 80, 100 DAT and at harvest was 8.04, 19.42, 13.63, 12.00, 15.05 and 9.39% higher, respectively; compared to that of Kataribhog with no irrigation. Chaulian *et al.* (1999) also reported higher number of tillers hill^{-1} due to interaction effect of supplemental irrigation and genotypes on T. *Aman*.

Table 4. Interaction effect of supplemental irrigation and genotypes on number of total tillers hill^{-1} of T. *Aman* rice at different crop growth stages

Treatments	Number of total tillers hill^{-1} at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Harvest
I_0G_1	8.00 a-c	10.00 cd	13.00 b-d	14.67 cd	13.67 c-e	12.00 ef
I_0G_2	6.00 ef	7.33 g	10.00 e	12.66 e-g	12.67 d-f	11.33 f
I_0G_3	6.33 d-f	8.33 e-g	10.67 e	11.67 f-h	12.33 ef	12.00 ef
I_0G_4	7.33 b-e	9.00 d-f	11.00 de	11.00 h	11.33 f	11.33 f
I_0G_5	6.00 ef	8.33 e-g	9.33 e	11.33 gh	12.00 ef	12.33 d-f
I_0G_6	5.33 f	9.00 d-f	10.33 e	12.00 e-h	13.00 c-f	13.00 c-e
I_0G_7	7.33 b-e	8.00 fg	10.33 e	12.33 e-h	12.00 ef	12.33 d-f
I_0G_8	8.33 ab	12.00 b	14.67 ab	16.67 b	17.67 b	17.67 b
I_1G_1	7.67 a-d	11.33 bc	13.67 bc	15.67 bc	14.67 c	14.00 c
I_1G_2	6.67 c-f	9.33 d-f	11.00 de	13.00 d-g	13.33 c-e	13.00 c-e
I_1G_3	7.33 b-e	9.33 d-f	11.67 c-e	12.33 e-h	13.00 c-f	13.33 c-e
I_1G_4	7.33 b-e	10.00 c-e	11.33 de	12.33 e-h	12.67 d-f	13.00 c-e
I_1G_5	6.33 d-f	9.67 d-f	11.33 de	13.00 d-g	13.33 c-e	13.67 cd
I_1G_6	5.67 f	9.67 d-f	11.00 de	13.67 de	14.33 cd	14.33 c
I_1G_7	7.33 b-e	9.67 d-f	11.00 de	13.33 d-f	13.33 c-e	13.67 cd
I_1G_8	9.00 a	14.33 a	16.67 a	18.67 a	20.33 a	19.33 a
LSD (0.05)	1.374	1.894	2.036	1.922	1.824	1.648
CV%	12.47	8.45	10.42	7.42	8.28	6.75

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.1.3 Leaf Area Index (LAI)

The leaf area of plant is one of the major determinants of its growth. It is the ratio of leaf area to its ground area (Radford, 1967) and it is the functional size of the standing crop on unit land area (Hunt, 1978). It depends on the growth, number of leaves plant^{-1}, population density and leaf senescence (Khan, 1981). The higher productivity of a crop depends on the persistence of higher LAI over a greater part of its vegetative phase. The rate of crop photosynthesis depends on the LAI. After germination, LAI increases and reaches the peak levels after that it declines due to increased senescence.

4.1.3.1 Effect of supplemental irrigation

Different irrigation levels had affected LAI significantly (Figure 3).

At 20 DAT, the highest leaf area index (LAI) was observed in the irrigated plots (1.37), which was statistically similar with the non-irrigated plots (1.27). At 40, 60, 80, 100 DAT and harvest, the highest leaf area index (LAI) was observed in the irrigated plots (3.79, 5.20, 4.80, 4.39 and 3.06, respectively), which was statistically higher than the non-irrigated plots (3.71, 4.90, 4.46, 3.99 and 2.73, respectively).

The LAI of supplemental irrigated treatment at 20, 40, 60, 80, 100 DAT and at harvest was 7.87, 2.16, 5.16, 7.74, 10.04 and 12.11% higher, respectively compared to that of no supplemental irrigation. Kikuta *et al.* (2019) also reported higher LAI due to supplemental irrigation.

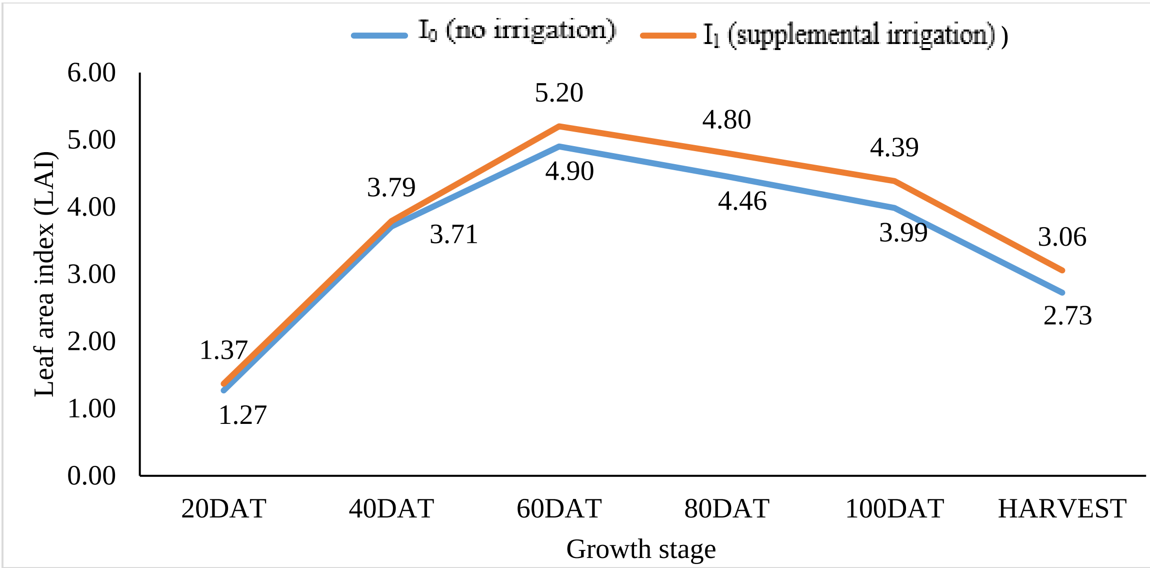

Figure 3. Effect of supplemental irrigation on Leaf Area Index (LAI) of T. *Aman* rice at different crop growth stage [LSD$_{(0.05)}$ = 0.130, 0.032, 0.073, 0.020, 0.012 and 0.126, respectively]

4.1.3.2 Effect of genotypes

The significant difference of LAI was observed among local aromatic *Aman* rice genotypes and Kataribhog at 20, 40, 60, 80, 100 DAT and harvest (Table 5).

At 20 DAT, the highest leaf area index (LAI) was observed in the local rice genotype SAU AGDL1 (1.79) which was similar with SAU AGDL15 and the lowest leaf area index (LAI) was recorded in SAU AGDL14 (1.00).

At 40 DAT, the highest leaf area index (LAI) was observed in the local rice genotype SAU AGDL1 (5.17) and the lowest leaf area index (LAI) was observed in SAU AGDL14 (3.23).

At 60, 80, 100 DAT and at harvest, the highest leaf area index (LAI) was observed in the local rice genotype SAU AGDL1 (6.81, 5.92, 4.89 and 3.36, respectively) and the lowest leaf area index (LAI) was recorded in Kataribhog (4.29, 4.02, 3.48 and 2.45, respectively).

Variation in LAI might be due to the differences in their genetic make-up. The highest LAI obtained from SAU AGDL1 at transplanting, 20, 40, 60, 80, 100 DAT and at harvest was 42.06, 41.64, 58.81, 47.32, 40.52 and 37.22% higher, respectively compared to that of Kataribhog. Mia and Shamsuddin (2011) also found lowest LAI in Kataribhog.

Shahidullah *et al.* (2009a) stated that different aromatic rice genotypes exhibited significant variations for leaf area index (LAI). Results revealed that leaf area index (LAI) increased after transplantation and it decreases at harvest due to senescence which was also reported by Katiya (1980).

Table 5. Effect of genotypes on LAI of T. *Aman* rice at different crop growth stages

Genotype	Leaf Area Index (LAI) at					
	20 DAT	**40 DAT**	**60 DAT**	**80 DAT**	**100 DAT**	**Harvest**
G_1	1.79 a	5.17 a	6.81 a	5.92 a	4.89 a	3.36 a
G_2	1.27 b	4.05 b	5.02 bc	4.93 b	4.55 b	3.13 b
G_3	1.23 b	3.31 e	4.92 c	4.63 c	4.24 c	2.88 c
G_4	1.21 b	3.44 d	4.71 e	4.17 g	3.77 e	2.61 d
G_5	1.25 b	3.49 d	5.05 b	4.56 d	4.19 d	2.94 c
G_6	1.00 c	3.23 f	4.99 bc	4.50 e	4.20 d	2.91 c
G_7	1.57 a	3.67 c	4.83 d	4.31 f	4.17 d	2.87 c
G_8	1.26 b	3.65 c	4.29 f	4.02 h	3.48 f	2.45 e
$LSD_{(0.05)}$	0.209	0.069	0.092	0.039	0.033	0.113
CV (%)	13.39	1.56	1.54	0.72	0.66	3.31

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.1.3.1 Interaction effect of supplemental irrigation and genotypes

Due to interaction effect of irrigation and genotype, leaf area index (LAI) varied significantly (Appendix VII and Table 6).

At 20 DAT, the highest leaf area index (LAI) was observed in SAU AGDL1 with irrigation (1.86), which was statistically similar with SAU AGDL1 with no irrigation, SAU AGDL15 with irrigation and the lowest leaf area index (LAI) was obtained from SAU AGDL14 with no irrigation (0.96), which was statistically similar with SAU AGDL14 with irrigation, SAU AGDL3 with no irrigation, SAU AGDL12 with no irrigation, SAU AGDL13 with no irrigation, SAU AGDL2 with no irrigation and Kataribhog with no irrigation.

At 40 DAT, the highest leaf area index (LAI) was observed in SAU AGDL1 with irrigation (5.22), which was statistically similar with SAU AGDL1 with no irrigation and the lowest leaf area index (LAI) was obtained from SAU AGDL14 with no irrigation (3.19), which was statistically similar with SAU AGDL14 with irrigation and SAU AGDL3 with no irrigation.

At 60, 80 and 100 DAT, the highest leaf area index (LAI) was observed in SAU AGDL1 with irrigation (6.93, 6.15 and 5.20, respectively) and at harvest the highest leaf area index (LAI) was observed in SAU AGDL2 with irrigation (3.55). The lowest leaf area index (LAI) was obtained from Kataribhog with no irrigation (4.15, 3.85, 3.28 and 2.28, respectively).

The highest LAI obtained due to interaction effect of supplemental irrigation and genotypes at transplanting, 20, 40, 60, 80, 100 DAT and at harvest was 93.75, 63.64, 58.04, 52.47, 43.60 and 43.81% higher, respectively compared to that of Kataribhog with no irrigation.

Table 6. Interaction effect of supplemental irrigation and genotypes on LAI of T. *Aman* rice at different crop growth stages

Treatments	Leaf Area Index (LAI) at					
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	Harvest
I_0G_1	1.70 ab	5.13 a	6.65 b	5.65 b	4.55 d	3.17 bc
I_0G_2	1.22 ef	3.96 c	4.85 e	4.75 d	4.25 e	2.91 d-f
I_0G_3	1.14 ef	3.28 hi	4.79 e-g	4.45 f	3.75 j	2.60 h-j
I_0G_4	1.16 ef	3.38 fg	4.65 g	4.05 k	3.60 k	2.47 j
I_0G_5	1.20 ef	3.46 ef	4.80 ef	4.25 h	4.05 h	2.83 e-g
I_0G_6	0.96 f	3.19 i	4.81 ef	4.3 h	4.1 g	2.80 fg
I_0G_7	1.54 b-d	3.64 d	4.74 fg	4.2 i	4.15fg	2.745-i
I_0G_8	1.24 ef	3.62 d	4.15 i	3.85 l	3.28 l	2.28 k
I_1G_1	1.86 a	5.22 a	6.93 a	6.15 a	5.20 a	3.34 b
I_1G_2	1.31 c-e	4.14 b	5.14 cd	5.05 c	4.80 b	3.55 a
I_1G_3	1.33 c-e	3.34 gh	5.05 d	4.8 d	4.70 c	3.165 c
I_1G_4	1.27 de	3.49 e	4.75 fg	4.28 hi	3.90 i	2.76 f-h
I_1G_5	1.29 de	3.52 e	5.27 c	4.8 d	4.25 e	3.04 cd
I_1G_6	1.05 ef	3.26 hi	5.17 cd	4.65 e	4.25 e	3.02 c-e
I_1G_7	1.60 a-c	3.70 d	4.91 e	4.35 g	4.15 f	2.99 c-e
I_1G_8	1.29 de	3.67 d	4.39 h	4.15 j	3.65 k	2.60 ij
LSD $_{(0.05)}$	0.299	0.096	0.140	0.055	0.045	0.186
CV%	13.39	1.56	1.54	0.72	0.66	3.31

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.1.4 Dry matter content hill^{-1}

4.1.4.1 Effect of supplemental irrigation

Dry weight of *Aman* rice genotypes varied significantly at transplanting, 30, 60, 90 days after transplanting (DAT) and at harvest due to the effect of supplemental irrigation (Figure 4)

At 30 and 60 DAT, the highest dry weight hill^{-1} was recorded in the irrigated plots (14.20 g and 32.13 g, respectively), which was statistically higher than the non-irrigated plots (12.30 g and 30.75 g, respectively).

At 90 DAT, the highest dry weight hill^{-1} was recorded in the irrigated plots (43.84 g), which was statistically similar with the non-irrigated plots (42.08 g).

At harvest, the highest dry weight hill^{-1} was recorded in the irrigated plots (53.87 g), which was statistically higher than the non-irrigated plots (51.30 g).

The dry weight hill^{-1} of supplemental irrigated treatment at 30, 60, 90 DAT and at harvest was 15.45, 4.49, 4.18 and 5.01% higher, respectively compared to that of no supplemental irrigation.

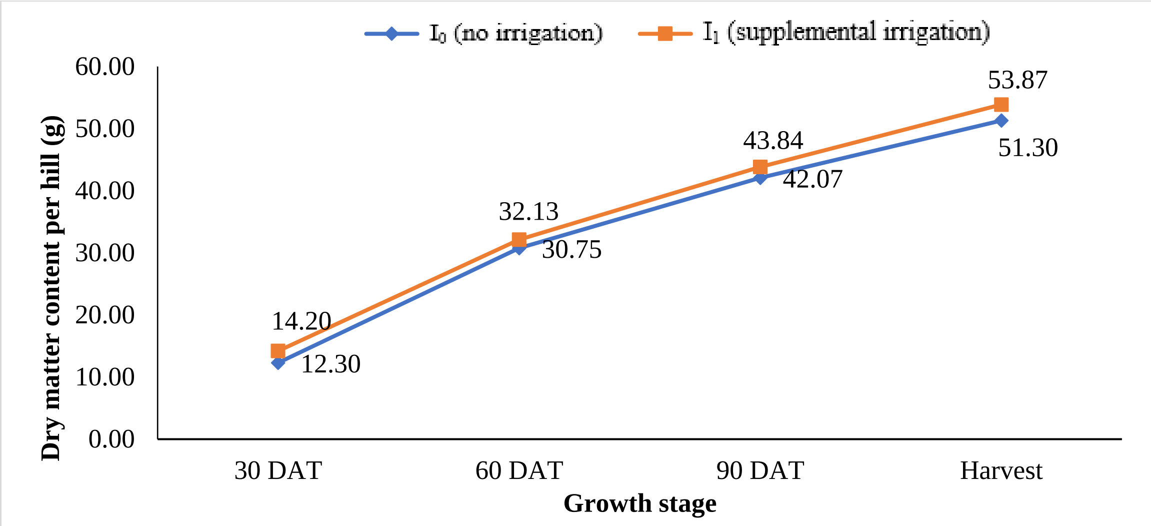

Figure 4. Effect of supplemental irrigation on dry matter content hill^{-1} of T. *Aman* rice at different crop growth stages [LSD$_{(0.05)}$ = 0.298, 0.799, 3.008 and 2.036, respectively]

4.1.4.1 Effect of genotypes

Dry weight of *Aman* rice genotypes varied significantly at transplanting, 30, 60, 90 days after transplanting (DAT) and at harvest (Table 7).

At transplanting, the genotype SAU AGDL3 produced the highest dry matter content hill^{-1} (0.25 g) and the lowest dry weight hill^{-1} (0.10 g) was recorded in SAU AGDL12. Kataribhog produced the second lowest dry weight hill^{-1} (0.13 g).

At 30 DAT, the highest dry matter content hill^{-1} (13.66 g) was produced in the local rice genotype SAU AGDL15, which was statistically similar with SAU AGDL1, Kataribhog, SAU AGDL14, SAU AGDL12, SAU AGDL2 and SAU AGDL3. The lowest dry matter content hill^{-1} (12.42 g) was observed in SAU AGDL13, which was statistically similar with SAU AGDL3, SAU AGDL2, SAU AGDL12, SAU AGDL14, Kataribhog and SAU AGDL1.

At 60 DAT, the highest dry matter content hill^{-1} (33.36 g) was produced in the local rice genotype SAU AGDL1, which was statistically similar with SAU AGDL3, Kataribhog and SAU AGDL13. The lowest dry matter content hill^{-1} (29.21 g) was recorded in SAU AGDL14, which was statistically similar with SAU AGDL15 and SAU AGDL12.

At 90 DAT, the highest dry matter content hill^{-1} (46.97 g) was produced in the local rice genotype SAU AGDL1, which was statistically similar with SAU AGDL14 and the lowest dry matter content hill^{-1} (40.07 g) was observed in SAU AGDL2, which was statistically similar with SAU AGDL12, SAU AGDL3 and SAU AGDL13.

At Harvest, the highest dry matter content hill^{-1} (57.33 g) was produced in the local rice genotype SAU AGDL13, which was statistically similar with SAU AGDL1 and the lowest dry matter content hill^{-1} (44.43 g) was recorded in SAU AGDL12. Dry matter content hill^{-1} of Kataribhog was 52.31 g.

Variation in dry weight hill^{-1} might be due to the differences in their genetic make-up. The highest dry weight hill^{-1} obtained at transplanting, 30, 60, 90 DAT and at harvest was 92.31, 1.49, 3.06, 7.53 and 9.60% higher, respectively compared to that of Kataribhog. Islam (2010) also reported higher dry weight hill^{-1} due to varietal effect on T. *Aman*.

Table 7. Effect of genotype on Dry matter content hill^{-1} of T. *Aman* rice genotypes at different crop growth stages

Genotypes	Dry matter content hill^{-1} (g) at				
	Transplanting	30 DAT	60 DAT	90 DAT	Harvest
G_1	0.16 f	13.53 ab	33.36 a	46.97 a	54.81 ab
G_2	0.22 d	13.20 ab	31.58 bc	40.07 c	52.76 b
G_3	0.25 a	13.04 ab	32.74 ab	41.69 bc	52.85 b
G_4	0.10 h	13.27 ab	30.41 cd	40.59 c	44.43 c
G_5	0.23 b	12.42 b	31.98 ab	42.36 bc	57.33 a
G_6	0.22 c	13.40 ab	29.21 d	44.58 ab	52.46 b
G_7	0.19 e	13.66 a	29.89 d	43.75 b	53.73 b
G_8	0.13 g	13.46 ab	32.37 ab	43.68 b	52.31 b
$LSD_{(0.05)}$	2.957E-04	1.193	1.398	2.897	2.669
CV (%)	0.13	7.61	3.76	5.70	4.29

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.1.3.1 Interaction effect of supplemental irrigation and genotypes

Due to interaction effect of irrigation and genotype, dry matter content hill^{-1} varied significantly (Appendix VIII and Table 8).

At 30 DAT, the highest dry matter content hill^{-1} (15.08 g) was recorded in SAU AGDL1 with irrigation, which was statistically similar with SAU AGDL2 with irrigation, SAU AGDL14 with irrigation, SAU AGDL3 with irrigation, SAU AGDL15 with irrigation, SAU AGDL12 with irrigation and Kataribhog with irrigation. The lowest dry matter content hill^{-1} (11.47 g) was obtained from SAU AGDL2 with no irrigation, which was statistically similar with SAU AGDL3 with no irrigation, SAU AGDL1 with no irrigation, SAU AGDL13 with no irrigation, SAU AGDL14 with no irrigation, SAU AGDL12 with no irrigation, SAU AGDL13 with irrigation, Kataribhog with no irrigation and SAU AGDL14 with no irrigation.

At 60 DAT, the highest dry matter content hill^{-1} (33.80 g) was observed in SAU AGDL1 with irrigation, which was statistically similar with SAU AGDL3 with irrigation, SAU AGDL13 with irrigation, SAU AGDL1 with no irrigation, Kataribhog with irrigation, SAU AGDL2 with irrigation, SAU AGDL3 with no irrigation and Kataribhog with no irrigation. The lowest dry matter content hill^{-1} (28.22 g) was recorded in SAU AGDL14 with no irrigation, which was statistically similar with SAU AGDL15 with no irrigation and SAU AGDL12 with no irrigation.

At 90 DAT, the highest dry matter content hill^{-1} (49.46 g) was recorded in SAU AGDL1 with irrigation, which was statistically similar with SAU AGDL14 with no irrigation and SAU AGDL15 with irrigation. The lowest dry matter content hill^{-1} (39.19 g) was obtained from SAU AGDL2 with no irrigation, which was statistically similar with SAU AGDL12 with no irrigation, SAU AGDL3 with no irrigation, SAU AGDL2 with irrigation, SAU AGDL12 with irrigation, SAU AGDL13 with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL13 with irrigation, Kataribhog with no irrigation, SAU AGDL3 with irrigation and SAU AGDL14 with irrigation.

At harvest, the highest dry matter content hill^{-1} (61.41 g) was recorded in SAU AGDL13 with irrigation. The lowest dry matter content hill^{-1} (43.13 g) was recorded in SAU AGDL12 with no irrigation, which was statistically similar with SAU AGDL12 with irrigation.

The highest dry weight hill^{-1} obtained due to interaction effect of supplemental irrigation and genotypes at 30, 60, 90 DAT and at harvest was 16.81, 5.89, 15.78 and 19.27% higher, respectively compared to that of Kataribhog with no irrigation.

Anning *et al.* (2018) reported that dry matter accumulation at harvest were significantly ($p<0.05$) influenced by the main effects of both variety and irrigation management method in both seasons.

Table 8. Interaction effect of supplemental irrigation and genotypes on dry matter content hill^{-1} of T. *Aman* rice at different crop growth stages

Treatments	Dry matter content hill^{-1} (g) at			
	30 DAT	60 DAT	90 DAT	Harvest
I_0G_1	11.98 e	32.91 a	44.48 bc	53.89 bc
I_0G_2	11.47 e	30.70 c-e	39.19 d	52.11 bc
I_0G_3	11.79 e	31.97 a-d	40.58 cd	51.48 c
I_0G_4	12.48 c-e	29.93 ef	39.73 d	43.13 d
I_0G_5	12.16 e	30.89 b-e	42.09 b-d	53.25 bc
I_0G_6	12.44 de	28.22 f	45.72 ab	51.88 bc
I_0G_7	13.16 b-e	29.45 ef	42.11 b-d	53.21 bc
I_0G_8	12.91 b-e	31.92 a-d	42.72 b-d	51.49 c
I_1G_1	15.08 a	33.80 a	49.46 a	55.72 b
I_1G_2	14.93 a	32.47 a-c	40.96 cd	53.42 bc
I_1G_3	14.29 ab	33.50 a	42.80 b-d	54.22 bc
I_1G_4	14.05 a-c	30.89 b-e	41.44 b-d	45.74 d
I_1G_5	12.69 b-e	33.07 a	42.63 b-d	61.41 a
I_1G_6	14.36 ab	30.20 de	43.45 b-d	53.04 bc
I_1G_7	14.16 ab	30.33 de	45.38 ab	54.25 bc
I_1G_8	14.01 a-d	32.81 ab	44.65 bc	53.13 bc
$LSD_{(0.05)}$	1.598	1.973	4.643	3.944
CV (%)	7.61	3.76	5.70	4.29

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.2 Yield and yield contributing characters

4.2.1 Number of effective and ineffective tillers m^{-2}

The number of panicles is the result of the number of tillers produced and the proportion of effective tillers, which survived to produce panicle, thereby contributing to the yield. Higher number of effective tillers hill^{-1} and higher number of grains panicle^{-1} also showed higher grain yield in rice (Kusutani *et al.*, 2000).

4.2.1.1 Effect of supplemental irrigation

The maximum number of effective tillers m^{-2} (306.25) was recorded in the irrigated plots. On the contrary, least number of effective tillers m^{-2} (262.15) were recorded in the non-irrigated plots (Figure 5).

Number of ineffective tillers m^{-2} varied numerically between the irrigated and non-irrigated plots. The maximum number of ineffective tillers m^{-2} (56.60) was produced in the irrigated plots. On the contrary, least number of ineffective tillers m^{-2} (51.04) were recorded in the non-irrigated plots.

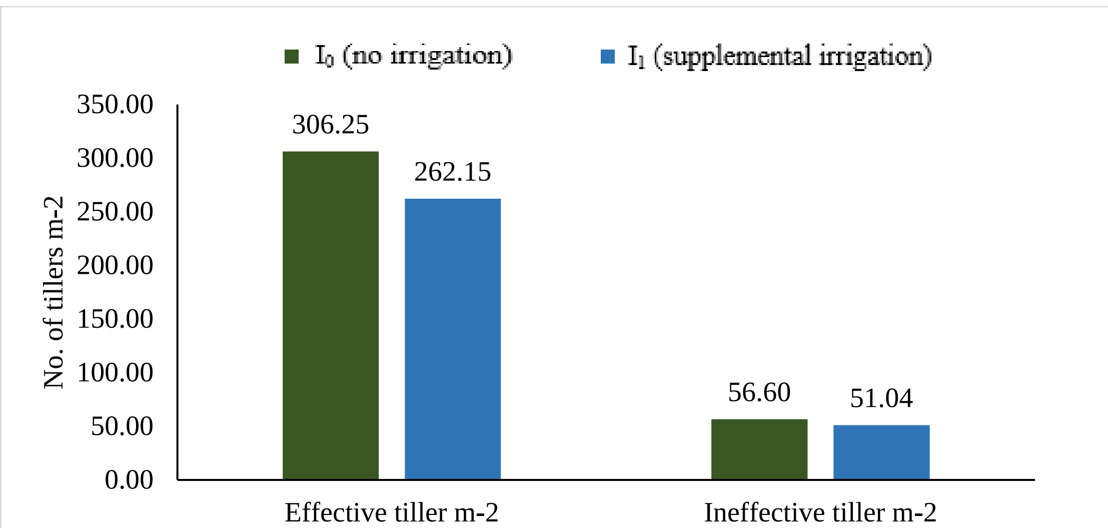

Figure 5. Effect of supplemental irrigation on number of effective and ineffective tillers m^{-2} of T. *Aman* rice [LSD$_{(0.05)}$ = 12.229 and 14.714, respectively]

Number of effective tillers m^{-2} of supplemental irrigated treatment was 16.82 % higher compared to that of no supplemental irrigation and number of ineffective tillers m^{-2} of supplemental irrigated treatment was 10.89 % higher compared to that of no supplemental irrigation. TaoLong *et al*. (2004) reported that one-time irrigation during the tillering stage could reduce non-effective tillers $hill^{-1}$.

4.2.1.2 Effect of genotypes

Significant variation was observed among the local rice genotypes in terms of number of effective and ineffective tillers per square meter (Table 9) and maximum number of effective tillers m^{-2} (402.78) was recorded for Kataribhog. On the contrary, least number of effective tillers m^{-2} (252.78) was recorded in SAU AGDL2, which was statistically similar with SAU AGDL3, with SAU AGDL12, SAU AGDL15 and SAU AGDL1. The highest number of ineffective tillers m^{-2} (61.11) was recorded for SAU AGDL14, which was statistically similar with Kataribhog, SAU AGDL3, SAU AGDL1, SAU AGDL15 and SAU AGDL2. On the contrary, lowest number of ineffective tillers m^{-2} (41.67) was recorded in SAU AGDL12 which was statistically similar with SAU AGDL13 and SAU AGDL2.

The reason of difference in effective tillers $hill^{-1}$ might be due to the genetic makeup of the variety. The results were in agreement with Chowdhury *et al.* (1993) and Islam *et al.* (2013) who stated that effective tillers $hill^{-1}$ was the genetic makeup of the variety, which was primarily influenced by heredity.

Table 9. Effect of genotypes on number of effective and ineffective tillers m^{-2}, panicle length (cm) and number of primary branches $panicle^{-1}$ of T. *Aman* rice

Genotypes	Effective tillers m^{-2} (No.)	Ineffective tillers m^{-2} (No.)	Panicle length (cm)	Primary branches $panicle^{-1}$ (No.)
G_1	269.44 bc	55.56 ab	29.78 a	11.87 bc
G_2	252.78 c	51.39 a-c	27.95 b	12.42 ab
G_3	256.94 c	59.72 a	26.81 bc	13.15 a
G_4	262.50 bc	41.67 c	27.47 b	11.05 cd
G_5	279.17 b	45.83 bc	29.28 a	12.02 b
G_6	280.56 b	61.11 a	29.40 a	12.36 ab
G_7	269.44 bc	55.56 ab	27.55 b	12.42 ab
G_8	402.78 a	59.72 a	26.22 c	10.75 d
$LSD_{(0.05)}$	21.168	10.015	1.210	0.869
CV (%)	6.30	15.74	3.65	6.12

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.2.1.3 Interaction effect of supplemental irrigation and genotypes

Significant variation was observed in terms of number of effective and ineffective tillers m^{-2} due to interaction effect of supplemental irrigation and genotypes (Appendix IX and Table 10).

Kataribhog with irrigation produced maximum number of effective tillers m^{-2} (427.78) followed by Kataribhog with no irrigation (377.78). The least number of effective tillers m^{-2} (230.56) was observed in SAU AGDL2 with no irrigation, which was statistically similar with SAU AGDL3 with no irrigation, SAU AGDL12 with no irrigation, SAU AGDL1 with no irrigation and SAU AGDL15 with no irrigation.

SAU AGDL14 with no irrigation produced maximum number of ineffective tillers m^{-2} (63.89), which was similar with kataribhog with no irrigation and SAU AGDL3 with no irrigation. The least number of ineffective tillers m^{-2} (38.89) was observed in SAU AGDL12 with irrigation, which was statistically similar with SAU AGDL13 with irrigation, SAU AGDL12 with no irrigation, SAU AGDL13 with no irrigation, SAU AGDL2 with irrigation, SAU AGDL15 with irrigation, SAU AGDL1 with irrigation and SAU AGDL2 with no irrigation.

Table 10. Interaction effect of supplemental irrigation and genotypes on number of effective and ineffective tillers m^{-2}, panicle length and primary branches panicle^{-1} of T. *Aman* rice

Treatments	Effective tiller m^{-2}	Ineffective tiller m^{-2}	Panicle length (cm)	Primary branches panicle^{-1}
I_0G_1	241.67 fg	58.33 ab	29.85 ab	11.67 c-f
I_0G_2	230.56 g	52.78 a-c	27.86 de	12.70 a-c
I_0G_3	236.11 fg	63.89 a	26.03 fg	13.30 a
I_0G_4	238.89 fg	44.44 bc	27.17 ef	10.74 fg
I_0G_5	261.11 d-f	47.22 bc	29.00 a-d	12.23 a-e
I_0G_6	261.11 d-f	63.89 a	28.53 b-e	11.90 b-f
I_0G_7	250.00 e-g	58.33 ab	27.48 d-f	12.47 a-d
I_0G_8	377.78 b	63.89 a	26.98 e-g	10.40 g
I_1G_1	297.22 c	52.78 a-c	29.71 a-c	12.07 b-e
I_1G_2	275.00 c-e	50.00 a-c	28.05 c-e	12.13 b-e
I_1G_3	277.78 c-e	55.56 ab	27.59 d-f	13.00 ab
I_1G_4	286.11 cd	38.89 c	27.76 de	11.37 d-g
I_1G_5	297.22 c	44.44 bc	29.55 a-c	11.80 b-f
I_1G_6	300.00 c	58.33 ab	30.27 a	12.82 a-c
I_1G_7	288.89 cd	52.78 a-c	27.62 d-f	12.37 a-d
I_1G_8	427.78 a	55.56 ab	25.46 g	11.10 e-g
LSD $_{(0.05)}$	29.905	18.590	1.691	1.154
CV%	6.30	15.74	3.65	6.12

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.2.2 Panicle length

The panicle length had a positive effect on yield. Panicle size had the most consistent and closest positive correlation with grain yield (Laza *et al.*, 2004).

4.2.2.1 Effect of supplemental irrigation

The highest panicle length (28.25 cm) was recorded in the irrigated plots which was statistically similar with the panicle length recorded in the non-irrigated plots (27.86 cm) (Figure 6).

Panicle length of supplemental irrigated treatment was 1.40 % higher compared to that of no supplemental irrigation. Shamsuzzaman (2007) also reported higher panicle length due to supplemental irrigation on T. *Aman*.

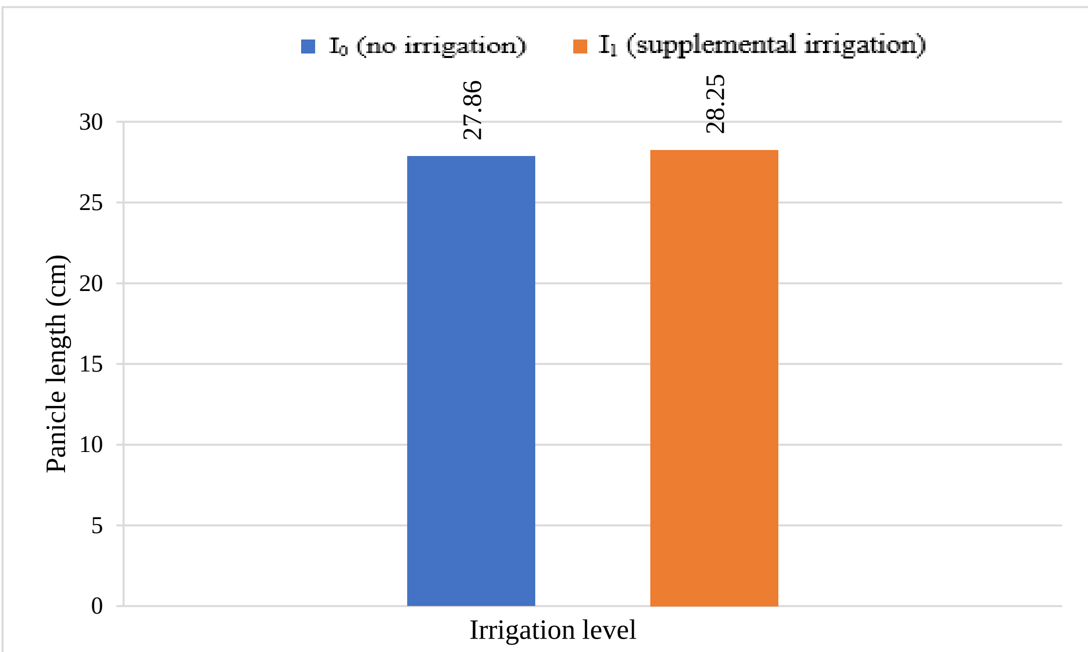

Figure 6. Effect of supplemental irrigation on panicle length of T. *Aman* rice [LSD$_{(0.05)}$ = 0.64]

4.2.2.2 Effect of genotype

There was significant difference among the rice genotypes in terms of panicle length (Table 9) and highest panicle length (29.78 cm) was recorded for SAU AGDL1 that was statistically similar with SAU AGDL14 and SAU AGDL13. On contrary, lowest panicle length was recorded in Kataribhog (26.22 cm) which was statistically similar with SAU AGDL3.

Such variations might be due to the genetic make-up of the varieties. The highest panicle length obtained from SAU AGDL1 was 13.58 % higher compared to that of Kataribhog. Babiker (1986) explained that panicle length differed due to the varietal variation. Singh and Singh (2000), Sharma (2002) and Ashrafuzzaman *et al.* (2009) also reported similar results.

4.2.2.3 Interaction effect of supplemental irrigation and genotypes

Significant variation was observed in terms of panicle length due to the interaction effect of supplemental irrigation and genotypes (Appendix IX and Table 10). The highest panicle length (30.27 cm) was recorded in SAU AGDL14 with irrigation, which was statistically similar with SAU AGDL1 with no irrigation, SAU AGDL1 with irrigation, SAU AGDL13 with irrigation and SAU AGDL13 with no irrigation. The lowest panicle length (25.46 cm) was recorded in Kataribhog with irrigation, which was statistically similar with SAU AGDL3 with no irrigation and Kataribhog with no irrigation.

The highest panicle length recorded in SAU AGDL14 with irrigation was 12.19 % higher compared to that of Kataribhog with no irrigation. Similar higher panicle length due to interaction effect of irrigation and genotypes on T. *Aman* was also reported by Shamsuzzaman (2007).

4.2.3 Primary branches panicle^{-1}

Rachis branching system i.e. primary and secondary branching is one of the important factors for determining yield. Yamagishi *et al.* (2003) found high yielding variety to have a relatively large number of primary rachis-branches as compared with the secondary rachis-branches.

4.2.3.1 Effect of supplemental irrigation

Significant variation was observed in terms of primary branches panicle^{-1} between the irrigated and the non-irrigated plots (Figure 7). The highest number of primary branches panicle^{-1} (12.08) was recorded in the irrigated plots, which was statistically higher than the number of primary branches panicle^{-1} recorded in the non-irrigated plots (11.93).

Number of primary branches panicle^{-1} of supplemental irrigated treatment was 1.26 % higher compared to that of no supplemental irrigation. Similar higher number of primary branches panicle^{-1} due to supplemental irrigation was also reported by Kato *et al.* (2009).

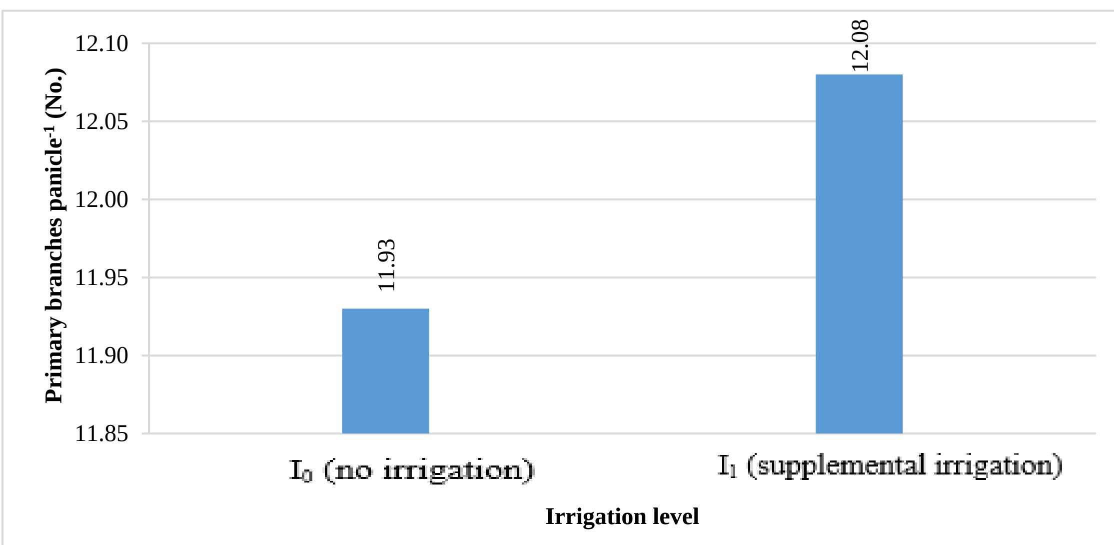

Figure 7. Effect of supplemental irrigation on primary branches panicle^{-1} of T. *Aman* rice [LSD$_{(0.05)}$ = 0.12]

4.2.3.2 Effect of genotypes

Significant variation was observed in terms of number of primary branches panicle^{-1} among the screened genotypes (Table 9). The highest number of primary branches panicle^{-1} (13.15) was recorded in SAU AGDL3, which was statistically similar with SAU AGDL2, SAU AGDL15 and SAU AGDL14. The lowest number of primary branches panicle^{-1} (10.75) was recorded from Kataribhog, which was statistically similar with SAU AGDL12 (11.05).

The highest number of primary branches panicle^{-1} obtained from SAU AGDL3, which was 22.33 % higher compared to that of Kataribhog. Mia and Shamsuddin (2011) reported that number of primary branches revealed significant difference among the varieties.

4.2.3.3 Interaction effect of supplemental irrigation and genotypes

Interaction effect of irrigation and genotype showed significant differences regarding number of primary branches panicle^{-1} (Appendix IX and Table 10). SAU AGDL3 with no irrigation produced highest number of primary branches panicle^{-1} (13.30) that was statistically similar with SAU AGDL3 with irrigation, SAU AGDL14 with irrigation, SAU AGDL2 with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL15 with irrigation and SAU AGDL13 with no irrigation. The lowest number of primary branches panicle^{-1} (10.40) was recorded in Kataribhog with no irrigation that was statistically similar with SAU AGDL12 with no irrigation, Kataribhog with irrigation and SAU AGDL12 with irrigation.

The highest number of primary branches panicle^{-1} obtained due to interaction effect of supplemental irrigation and genotypes was 27.88 % higher compared to that of Kataribhog with no irrigation. Kato *et al.* (2009) also reported similar higher number of primary branches panicle^{-1} due to interaction effect of supplemental irrigation and genotypes.

4.2.4 Filled grains panicle^{-1}

Number of filled grains panicle^{-1}, 1000-grain weight, spikelets sterility had positive direct effects on grain yield (Padmavathi *et al.*, 1996).

4.2.4.1 Effect of supplemental irrigation

Significant variation was observed in terms of number of filled grains panicle^{-1} between the irrigated and the non-irrigated plots (Figure 8). The highest number of filled grains panicle^{-1} (173.25) was recorded in the irrigated plots, which was statistically higher than number of filled grains panicle^{-1} recorded in the non-irrigated plots (160.25).

Number of filled grains panicle^{-1} of supplemental irrigated treatment was 8.11 % higher compared to that of no supplemental irrigation. Boonfung and Fuki (1996) also reported similar higher number of filled grains panicle^{-1} due to supplemental irrigation.

4.2.4.2 Effect of genotypes

Number of filled grains panicle^{-1} showed significant difference among the screened genotypes (Table 11). The maximum number of filled grains panicle^{-1} was found in SAU AGDL3 (181.17) which was statistically similar with SAU AGDL1 (179.33). The minimum number of filled grains panicle^{-1} was recorded from SAU AGDL12 (143.17). Kataribhog produced 158.67 filled grains panicle^{-1}.

This variation might be due to genetic characteristics of the varieties. The highest number of filled grains panicle^{-1} obtained from SAU AGDL3, which was 14.18 % higher compared to that of Kataribhog. These results were in consistent to those of Anonymous (1994), Singh and Gangwer (1989) who reported that the number of filled grains panicle^{-1} influenced significantly due to variety.

Table11. Effect of genotypes on filled grains panicle^{-1}, unfilled grains panicle^{-1}, total grains panicle^{-1}, sterility percentage and 1000-grains weight of T. *Aman* rice

Genotypes	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	Total grains panicle^{-1}	Sterility percentage	1000 grain weight (g)
G_1	179.33 a	40.17 b	219.50 a	18.40 d	28.95 a
G_2	164.83 d	44.33 a	209.17 bc	21.15 b	25.86 b
G_3	181.17 a	19.00 d	200.17 d	9.52 f	28.11 a
G_4	143.17 f	40.67 b	183.83 e	22.10 a	22.48 c
G_5	166.33 cd	40.17 b	206.50 c	19.40 c	21.34 c
G_6	171.83 b	39.83 b	211.67 b	18.92 cd	26.59 b
G_7	168.67 bc	33.67 c	202.33 d	16.69 e	28.56 a
G_8	158.67 e	43.00 a	201.67 d	21.32 ab	13.40 d
$LSD_{(0.05)}$	3.667	1.729	3.757	0.808	1.255
CV (%)	1.86	3.89	1.55	4.35	3.71

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.2.2.3 Interaction effect of supplemental irrigation and genotypes

Significant variation was recorded regarding number of filled grains panicle^{-1} due to the interaction effect of supplemental irrigation and genotypes (Appendix X and Table 12). SAU AGDL1 with irrigation produced highest number of filled grains panicle^{-1} (192.00), which was statistically similar with SAU AGDL3 with irrigation (187.33). The lowest number of filled grains panicle^{-1} (138.33) was recorded in SAU AGDL12 with no irrigation. The second lowest number of filled grains panicle^{-1} (148.00) was recorded in SAU AGDL12 with irrigation, which was statistically similar with Kataribhog with no irrigation (152.67).

The highest number of filled grains panicle^{-1} recorded in SAU AGDL1 with irrigation was 25.76 % higher compared to that of Kataribhog with no irrigation. Anning *et al.* (2018) found that the interaction between variety and irrigation management method affected percentage of filled grains significantly ($p<0.05$).

4.2.5 Unfilled grains panicle^{-1}

Among the undesirable traits, number of unfilled grains panicle^{-1} was important one and played a vital role in yield reduction. Grain yield was negatively correlated with false (unfilled) grains panicle^{-1} (Paul and Sarmah, 1997).

4.2.5.1 Effect of supplemental irrigation

The maximum number of unfilled grains panicle^{-1} (42.29) was recorded in the non-irrigated plots which was statistically higher than number of unfilled grains panicle^{-1} recorded in the irrigated plots (32.92) (Figure 8). Number of filled grains panicle^{-1} of supplemental irrigated treatment was 19.79 % lower compared to that of no supplemental irrigation. TaoLong *et al.* (2004) also reported similar lower number of unfilled grains panicle^{-1} due to supplemental irrigation.

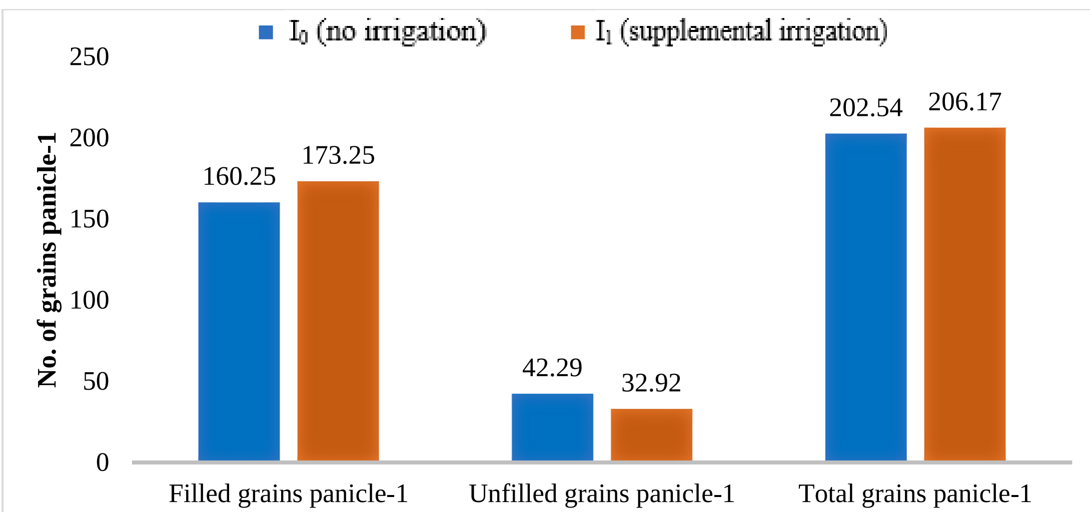

Figure 8. Effect of supplemental irrigation on filled, unfilled and total grains panicle^{-1} of T. *Aman* rice [$LSD_{(0.05)}$ = 3.29, 1.12 and 3.42, respectively]

4.2.5.2 Effect of genotypes

Significant variation in terms of number of unfilled grains panicle^{-1} was observed among the screened genotypes (Table 11). The maximum number of unfilled grains panicle^{-1} (44.33) was recorded in SAU AGDL2, which was statistically similar with Kataribhog (43.00). The minimum number of unfilled grains panicle^{-1} (19.00) was recorded from SAU AGDL3.

This variation in number of unfilled grains panicle^{-1} might be due to genetic characteristics of the varieties. The highest number of unfilled grains panicle^{-1} obtained from SAU AGDL2, which was 3.09 % higher compared to that of Kataribhog. This result was also supported by Chowdhury *et al.* (1993), Murthy *et al.* (2004) and BINA (1993) who reported differences in number of sterile spikelets panicle^{-1} due to varietal differences.

4.2.5.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding number of unfilled grains panicle^{-1} was observed due to interaction effect of supplemental irrigation and genotypes (Appendix X and Table 12). Kataribhog with no irrigation produced the highest number of unfilled grains panicle^{-1} (49.33), which was statistically similar with SAU AGDL2 with no irrigation, SAU AGDL13 with no irrigation and SAU AGDL12 with no irrigation. The lowest number of unfilled grains panicle^{-1} (15.00) was recorded in SAU AGDL3 with irrigation. The second lowest number of filled grains panicle^{-1} (23.00) was recorded in SAU AGDL3 with no irrigation.

The highest number of unfilled grains panicle^{-1} recorded in Kataribhog with no irrigation, which was 228.87 % higher than that of SAU AGDL3 with irrigation. Shamsuzzaman (2007) also reported that interaction effect of irrigation and genotypes have significant effect on number of unfilled grains panicle^{-1}.

4.2.6 Total number of grains panicle^{-1}

The total number of grains panicle^{-1} is an important factor, which contributes towards grain yield. The number of grains panicle^{-1} is the most important criteria of high yield in rice cultivars (Venkateswaslu *et al.*, 1986). Spikelets panicle^{-1} contributed more to the yield and this study confirms the views of Patel *et al.* (2010), Fageria and Baligar (2001) who reported that the sink size is the most important factor responsible for yield.

4.2.6.1 Effect of supplemental irrigation

The maximum number of total grains panicle^{-1} (206.17) was recorded in the irrigated plots, which was statistically higher than number of total grains panicle^{-1} recorded in the non-irrigated plots (202.54) (Figure 8).

Total number of grains panicle^{-1} of supplemental irrigated treatment was 1.79 % higher compared to that of no supplemental irrigation. Yang *et al.* (1994) reported that water deficit at the reproductive stage caused reduced number of spikelets panicle^{-1}.

4.2.6.2 Effect of genotypes

Significant variation regarding number of total grains panicle^{-1} was observed among the screened genotypes (Table 11). The maximum number of total grains panicle^{-1} (219.50) was recorded in SAU AGDL1 and the minimum number of total grains panicle^{-1} (183.83) was recorded in SAU AGDL12. Total grains panicle^{-1} recorded in Kataribhog (201.67) was statistically similar with SAU AGDL1 and SAU AGDL15.

The variation might be mainly due to genetic background of the variety. The highest number of grains panicle^{-1} obtained from SAU AGDL1 was 8.84 % higher compared to that of Kataribhog. This result was also recorded by Tahir *et al.* (2002) who reported highly significant variation for the grains panicle^{-1} for different genotypes.

4.2.6.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding number of total grains panicle^{-1} was observed due to interaction effect of supplemental irrigation and genotypes (Appendix X and Table 12). SAU AGDL1 with irrigation produced highest number of total grains panicle^{-1} (228.67), which was statistically similar with SAU AGDL14 with irrigation (223.67). The lowest number of total grains panicle^{-1} (182.33) was recorded in SAU AGDL12 with irrigation, which was statistically similar with SAU AGDL12 with no irrigation (185.33).

The highest number of total grains panicle^{-1} obtained from SAU AGDL1 with irrigation due to interaction effect of supplemental irrigation and genotypes was 13.20 % higher compared to that of Kataribhog with no irrigation. Anning *et al.* (2018) stated that the interaction between variety and irrigation management method significantly ($p<0.05$) influenced spikelets panicle^{-1} in both seasons.

Table 12. Interaction effect of supplemental irrigation and genotypes on filled grains panicle^{-1}, unfilled grains panicle^{-1}, total grains panicle^{-1}, sterility percentage and 1000-grain weight of T. *Aman* rice

Treatments	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	Total grains panicle^{-1}	Sterility percentage	1000 grain weight (g)
I_0G_1	166.67 ef	44.33 b	211.00 bc	21.01 c	28.80 a
I_0G_2	167.00 ef	48.67 a	215.67 b	22.57 b	25.78 d
I_0G_3	175.00 cd	23.00 i	198.00 e	11.62 k	27.98 a-c
I_0G_4	138.33 j	47.00 a	185.33 f	25.37 a	22.12 ef
I_0G_5	163.00 f-h	47.33 a	210.33 c	22.51 b	20.53 f
I_0G_6	158.33 h	41.33 c	199.67 e	20.69 cd	26.90 b-d
I_0G_7	161.00 gh	37.33 e	198.33 e	18.83 ef	28.60 ab
I_0G_8	152.67 i	49.33 a	202.00 de	24.42 a	13.29 g
I_1G_1	192.00 a	36.00 ef	228.00 a	15.79 i	29.10 a
I_1G_2	162.67 f-h	40.00 cd	202.67 de	19.74 de	25.94 d
I_1G_3	187.33 ab	15.00 j	202.33 de	7.41 l	28.24 ab
I_1G_4	148.00 i	34.33 fg	182.33 f	18.82 ef	22.85 e
I_1G_5	169.67 de	33.00 g	202.67 de	16.28 hi	22.15 ef
I_1G_6	185.33 b	38.33 de	223.67 a	17.14 gh	26.28 cd
I_1G_7	176.33 c	30.00 h	206.33 cd	14.55 j	28.52 ab
I_1G_8	164.67 e-g	36.67 ef	201.33 de	18.22 fg	13.51 g
$LSD_{(0.05)}$	5.625	2.481	5.786	1.136	1.792
CV (%)	1.86	3.89	1.55	4.35	3.71

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

4.2.7 Sterility percentage (%)

4.2.7.1 Effect of supplemental irrigation

Sterility percentage has direct effect on grain yield. Different level of irrigation had significant effect on sterility percentage of *Aman* rice genotypes (Figure 9).

The highest sterility percentage (20.88) was recorded in the non-irrigated plots, which was statistically higher than sterility percentage recorded in the irrigated plots (15.99).

Sterility percentage of supplemental irrigated treatment was 23.42 % lower compared to that of no supplemental irrigation. Boonfung and Fuki (1996) found that when drought occurred during grain filling of rice, the percentage of filled grains decreased to 40%.

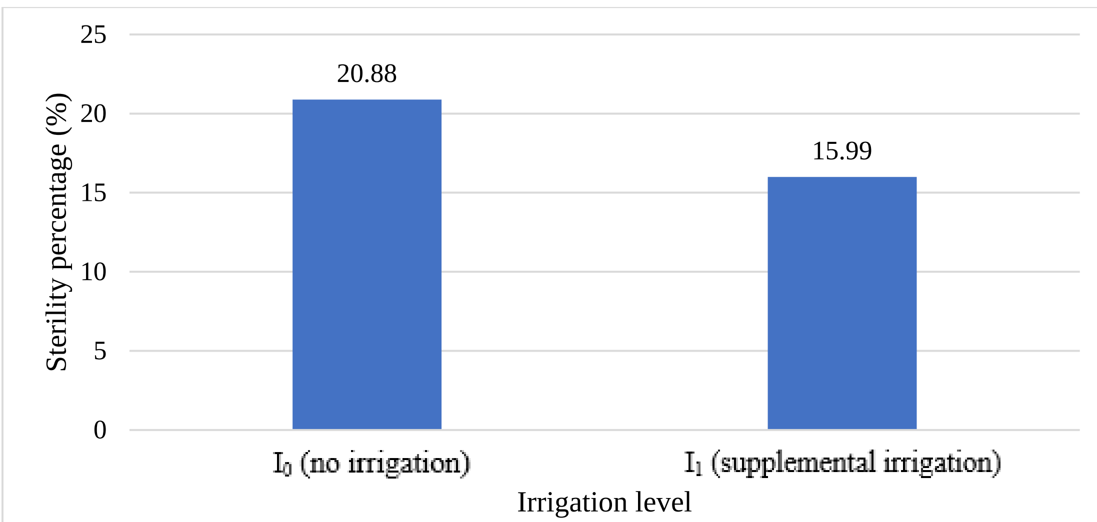

Figure 9. Effect of supplemental irrigation on sterility percentage of T. *Aman* rice [$LSD_{(0.05)}$ = 0.45]

4.2.7.2 Effect of genotypes

Significant variation regarding sterility percentage was observed among the screened genotypes (Table 11). The highest sterility percentage (22.10) was recorded in SAU AGDL12, which was statistically similar with Kataribhog (21.32). The lowest sterility percentage (9.52) was recorded in SAU AGDL3.

The highest sterility percentage observed in SAU AGDL12 was 3.66 % higher compared to that of Kataribhog. Kabir *et al*. (2001) reported that variety had significant effect on sterile spikelets panicle^{-1}.

4.2.7.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding sterility percentage was observed due to interaction effect of irrigation and genotypes (Appendix X and Table 12). SAU AGDL12 with no irrigation produced highest sterility percentage (25.37), which was statistically similar with Kataribhog with no irrigation (24.42). The lowest sterility percentage (7.41) was recorded in SAU AGDL3 with irrigation.

The highest sterility percentage recorded in SAU AGDL12 with no irrigation was 3.89 % higher compared to that of Kataribhog with no irrigation.

4.2.8 Weight of 1000-grains

The weight of 1000-grains, an important yield-determining component, is a genetic character least influenced by environment (Ashraf *et al.*, 1999). Yoshida (1981) reported that under most conditions, 1000 grains of filled crop is a very stable character. Mondal *et al.* (2005) reported significant correlation between 1000-grain weight and grain yield plant^{-1}.

4.2.8.1 Effect of supplemental irrigation

The highest weight of 1000-grains (24.57 g) was recorded in the irrigated plots, which was statistically similar with the weight of 1000-grains recorded in the non-irrigated plots (24.25 g) (Figure 10). The weight of 1000-grains of supplemental irrigated treatment was 4.18 % higher compared to that of no supplemental irrigation. Similar higher weight of 1000-grains due to supplemental irrigation on T. *Aman* was also reported by Shamsuzzaman (2007).

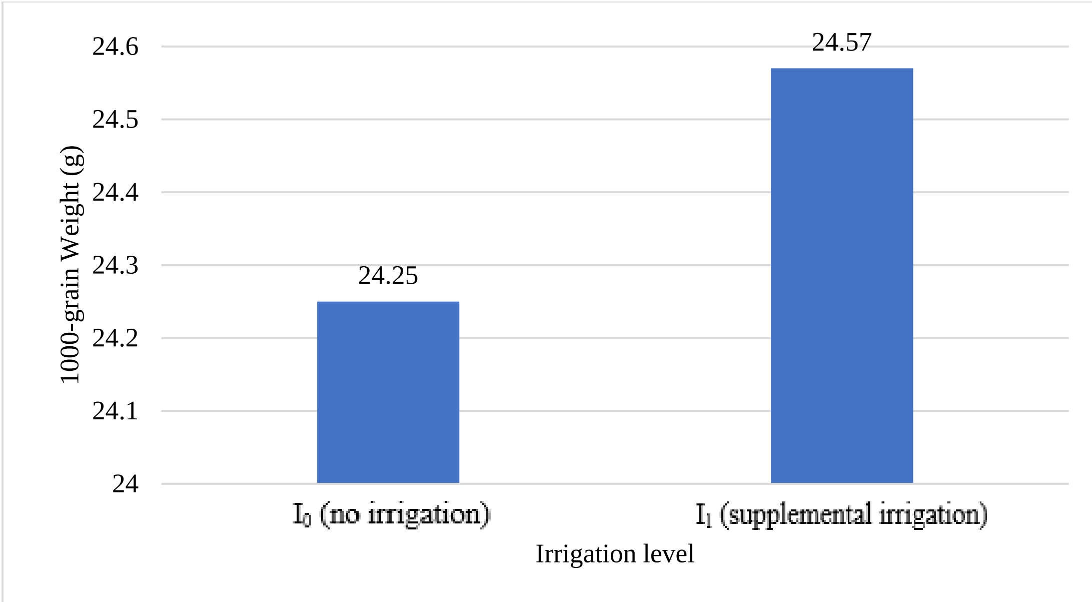

Figure 10. Effect of supplemental irrigation on 1000-grains weight of T. *Aman* rice [$LSD_{(0.05)}$ = 0.78]

4.2.8.2 Effect of genotypes

Significant variation regarding weight of 1000-grains was observed among the screened genotypes (Table 11). The highest weight of 1000-grains (28.95 g) was recorded in SAU AGDL1, which was statistically similar with SAU AGDL15 and SAU AGDL3 and the lowest weight of 1000-grains (13.40 g) was recorded from Kataribhog. This minimum grain weight might be due to short medium grain. Hoque *et al.* (2013) observed that the weight of 1000-grains of Kataribhog was 14.83 g whereas Hossain *et al.* (2005) found 16.47 g.

The variation of 1000-grains weight among varieties might be due to genetic constituents. The highest weight of 1000-grains was obtained from SAU AGDL1 which was 116.04 % higher compared to that of Kataribhog. Shamsuddin *et al.* (1988) and Chowdhury *et al.* (1993) reported that weight of 1000-grains differed among the varieties.

4.2.8.3 Interaction effect of supplemental irrigation and genotypes

Significant differences regarding weight of 1000-grains was observed due to interaction effect of irrigation and genotypes (Appendix X and Table 12). SAU AGDL1 with irrigation produced the highest weight of 1000-grains (29.10 g), which was statistically similar with SAU AGDL1 with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL15 with irrigation, SAU AGDL3 with irrigation and SAU AGDL3 with no irrigation. The lowest weight of 1000-grains (13.29 g) was recorded in Kataribhog with no irrigation, which was statistically similar with Kataribhog with irrigation (13.51 g).

The highest weight of recorded in SAU AGDL1 with irrigation, which was 119.96 % higher, compared to that of Kataribhog with no irrigation. Similar result was also reported by Shamsuzzaman (2007).

4.2.9 Grain yield

Grain yield of rice mainly depends on the number of effective tillers per unit area, panicle length, filled grains panicle^{-1} and 1000-grain weight (Islam *et al.*, 2013a). Weather conditions, cultural management and nutrient supply greatly influence each yield component (Yoshida, 1981). Hassan *et al.* (2003) also stated that grain yield is a function of interplay of various yield components such as number of productive tillers, spikelets panicle^{-1} and weight of 1000-grains.

4.2.9.1 Effect of supplemental irrigation

Grain yield of T. *Aman* rice genotypes varied significantly due to different irrigation levels (Figure 11). At harvest, highest grain yield (5.83 t ha^{-1}) was recorded in the irrigated plots, which was statistically higher than the grain yield recorded in the non-irrigated plots (5.37 t ha^{-1}).

The grain yield of supplemental irrigated treatment was 8.57 % higher compared to that of no supplemental irrigation. Similar higher grain yield due to supplemental irrigation on T. *Aman* was also reported by Kabir (2011).

4.2.9.2 Effect of genotypes

Significant variation in terms of grain yield was observed among the screened genotypes (Table 13). The highest grain yield (6.05 t ha^{-1}) was recorded in SAU AGDL1, which was statistically similar with SAU AGDL13, SAU AGDL14, SAU AGDL2 and SAU AGDL15. The lowest grain yield (5.18 t ha^{-1}) was recorded in Kataribhog, which was statistically similar with SAU AGDL3, SAU AGDL12 and SAU AGDL15.

Difference in grain yield among screened *Aman* rice genotypes might be due to their different yield potential. The highest grain yield was obtained from SAU AGDL1 was 16.80 % higher compared to that of Kataribhog. This result also supported by Tyeb *et al.* (2013), Islam *et al.* (2012) and Biswas *et al.* (1998) who reported that variety exerted variable effect on yield and yield contributing characters of rice.

4.2.9.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding grain yield was observed due to interaction effect of supplemental irrigation and genotypes (Appendix XI and Table 14).The highest grain yield (6.44 t ha^{-1}) was recorded in SAU AGDL1 with irrigation, which was statistically similar with SAU AGDL13 with irrigation, SAU AGDL2 with irrigation, SAU AGDL14 with irrigation and SAU AGDL15 with irrigation. The lowest grain yield (5.10 t ha^{-1}) was recorded in SAU AGDL3 with no irrigation, which was statistically similar with Kataribhog with no irrigation, Kataribhog with irrigation, SAU AGDL12 with no irrigation, SAU AGDL15 with no irrigation and SAU AGDL2 with no irrigation, SAU AGDL12 with irrigation, SAU AGDL14 with no irrigation, SAU AGDL3 with irrigation, SAU AGDL13 with no irrigation and SAU AGDL1 with no irrigation.

The highest grain yield recorded in SAU AGDL1 with irrigation was 24.56 % higher compared to that of Kataribhog with no irrigation. Murshida *et al.* (2017) reported that variety and water management system had significant effect on grain yield.

4.2.10 Straw yield

4.2.10.1 Effect of supplemental irrigation

Straw yield of T. *Aman* rice genotypes varied significantly due to different irrigation levels (Figure 11). At harvest, highest straw yield (13.47 t ha^{-1}) was recorded in the irrigated plots which was statistically higher than the straw yield recorded in the non-irrigated plots (12.83 t ha^{-1}).

The straw yield of supplemental irrigated treatment was 4.99 % higher compared to that of no supplemental irrigation. Similar higher straw yield due to supplemental irrigation on T. *Aman* was also reported by Shamsuzzaman (2007).

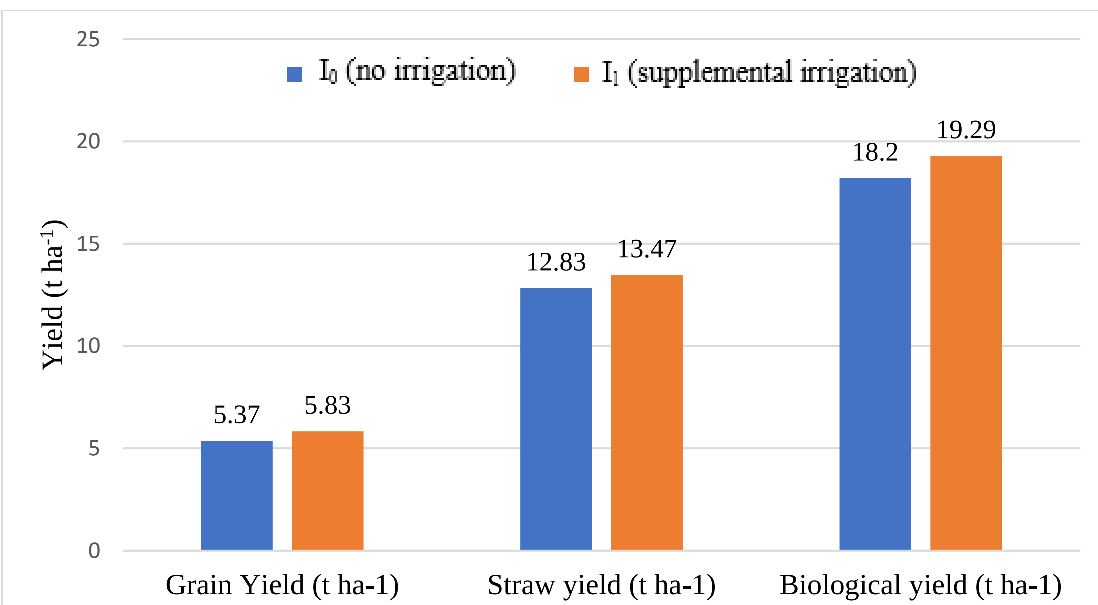

Figure 11. Effect of supplemental irrigation on grain yield, straw yield and biological yield of T. *Aman* rice [$LSD_{(0.05)}$ = 0.26, 0.51 and 0.56, respectively]

4.2.10.2 Effect of genotypes

Straw yield showed significant difference among the screened genotypes (Table 13). The highest straw yield was observed in SAU AGDL13 (14.33 t ha^{-1}) which was statistically similar with SAU AGDL1 (13.70 t ha^{-1}). The lowest straw yield (11.11 t ha^{-1}) was recorded in SAU AGDL12. The second lowest straw yield (13.08 t ha^{-1}) was recorded in Kataribhog.

The differences in straw yield among the varieties might be attributed to the genetic make-up of the varieties. The highest grain yield was obtained from SAU AGDL13 which was 9.56 % higher compared to that of Kataribhog. These results uphold with the findings of Patel (2000) and Om *et al.* (1999) where they concluded that straw yield differed significantly among the varieties.

Table 13. Effect of genotypes on grain yield, straw yield, biological yield and harvest index of T. *Aman* rice

Genotypes	Grain Yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
G_1	6.05 a	13.70 ab	19.75 ab	30.56 b
G_2	5.71 a-c	13.19 b	18.90 bc	30.17 b-d
G_3	5.30 cd	13.21 b	18.52 c	28.59 cd
G_4	5.35 b-d	11.11 c	16.46 d	32.49 a
G_5	5.83 ab	14.33 a	20.16 a	28.98 b-d
G_6	5.73 a-c	13.12 b	18.84 c	30.38 bc
G_7	5.64 a-d	13.43 b	19.07 bc	29.52 b-d
G_8	5.18 d	13.08 b	18.26 c	28.37 d
$LSD_{(0.05)}$	0.481	0.667	0.902	1.875
CV (%)	7.27	4.29	4.07	5.31

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

G_1 = SAU AGDL1, G_3 = SAU AGDL3, G_5 = SAU AGDL13, G_7 = SAU AGDL15,

G_2 = SAU AGDL2, G_4 = SAU AGDL12, G_6 = SAU AGDL14, G_8 = Kataribhog

4.2.2.3 Interaction effect of supplemental irrigation and genotypes

Straw yield varied significantly due to the interaction effect of supplemental irrigation and genotypes (Appendix XI and Table 14). SAU AGDL13 with irrigation produced highest straw yield (15.35 t ha^{-1}). The lowest straw yield (10.78 t ha^{-1}) was recorded in SAU AGDL12 with no irrigation, which was statistically similar with SAU AGDL12 with irrigation (11.43 t ha^{-1}).

Table 14. Interaction effect of supplemental irrigation and genotypes on grain yield, straw yield, biological yield and harvest index of T. *Aman* rice

Treatments	Grain Yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
I_0G_1	5.65 b-d	13.47 bc	19.13 b-d	29.54 c-f
I_0G_2	5.42 b-d	13.03 bc	18.45 cd	29.37 c-f
I_0G_3	5.10 d	12.87 c	17.97 de	28.29 ef
I_0G_4	5.24 d	10.78 d	16.02 f	32.60 a
I_0G_5	5.57 b-d	13.31 bc	18.89 cd	29.51 c-f
I_0G_6	5.47 b-d	12.97 bc	18.44 cd	29.68 b-f
I_0G_7	5.35 cd	13.30 bc	18.65 cd	28.66 d-f
I_0G_8	5.17 d	12.87 c	18.04 de	28.63 d-f
I_1G_1	6.44 a	13.93 b	20.37 ab	31.58 a-c
I_1G_2	6.00 a-c	13.35 bc	19.36 bc	30.98 a-e
I_1G_3	5.51 b-d	13.56 bc	19.06 cd	28.89 d-f
I_1G_4	5.47 b-d	11.43 d	16.91 ef	32.37 ab
I_1G_5	6.08 ab	15.35 a	21.43 a	28.46 d-f
I_1G_6	5.99 a-c	13.26 bc	19.25 b-d	31.08 a-d
I_1G_7	5.92 a-c	13.56 bc	19.49 bc	30.39 a-f
I_1G_8	5.19 d	13.28 bc	18.48 cd	28.10 f
$LSD_{(0.05)}$	0.676	0.986	1.289	2.720
CV%	7.27	4.29	4.07	5.31

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

I_0G_1 = SAU AGDL1 with no irrigation
I_0G_2 = SAU AGDL2 with no irrigation
I_0G_3 = SAU AGDL3 with no irrigation
I_0G_4 = SAU AGDL12 with no irrigation
I_0G_5 = SAU AGDL13 with no irrigation
I_0G_6 = SAU AGDL14 with no irrigation
I_0G_7 = SAU AGDL15 with no irrigation
I_0G_8 = Kataribhog with no irrigation
I_1G_1 = SAU AGDL1 with irrigation
I_1G_2 = SAU AGDL2 with irrigation
I_1G_3 = SAU AGDL3 with irrigation
I_1G_4 = SAU AGDL12 with irrigation
I_1G_5 = SAU AGDL13 with irrigation
I_1G_6 = SAU AGDL14 with irrigation
I_1G_7 = SAU AGDL15 with irrigation
I_1G_8 = Kataribhog with irrigation

The highest straw yield recorded in SAU AGDL1 with irrigation was 19.27 % higher compared to that of Kataribhog with no irrigation. Shamsuzzaman (2007) also reported similar higher straw yield due to interaction effect of supplemental irrigation and genotypes on T. *Aman*.

4.2.11 Biological yield

4.2.11.1 Effect of supplemental irrigation

Biological yield of T. *Aman* rice genotypes varied significantly due to different levels of irrigation (Figure 11). At harvest, highest biological yield (19.29 t ha^{-1}) was recorded in the irrigated plots, which was statistically higher than the biological yield recorded in the non-irrigated plots (18.20 t ha^{-1}).

The biological yield of supplemental irrigated treatment was 5.99 % higher compared to that of no supplemental irrigation. Shamsuzzaman (2007) also reported similar higher biological yield due to supplemental irrigation on T. *Aman*.

4.2.11.2 Effect of genotypes

Significant variation regarding biological yield was observed among the screened genotypes (Table 13). The highest biological yield (20.16 t ha^{-1}) was produced in SAU AGDL13, which was statistically similar with SAU AGDL1 (19.75t ha^{-1}). The lowest biological yield (16.46 t ha^{-1}) was recorded in SAU AGDL12. The second lowest biological yield (18.26 t ha^{-1}) was recorded in Kataribhog.

The highest biological yield observed in SAU AGDL13 was 10.41 % higher compared to that of Kataribhog. Islam *et al.* (2016a) also reported that biological yield varied due to varietal effect.

4.2.2.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding biological yield was observed due to interaction effect of supplemental irrigation and genotypes (Appendix XI and Table 14). SAU AGDL13 with irrigation produced highest biological yield (21.43 t ha^{-1}), which was statistically similar with SAU AGDL1 with irrigation (20.37 t ha^{-1}). The lowest biological yield (16.02 t ha^{-1}) was recorded in SAU AGDL12 with no irrigation, which was statistically similar with SAU AGDL12 with irrigation (16.91 t ha^{-1}).

The highest straw yield recorded in SAU AGDL1 with irrigation was 19.27 % higher compared to that of Kataribhog with no irrigation. Shamsuzzaman (2007) also reported similar higher straw yield due to interaction effect of supplemental irrigation and genotypes on T. *Aman*.

4.2.12 Harvest index

Harvest index is a vital character having physiological importance. It reflects translocation on alternatively dry matter partitioning of a given genotype to the economic parts. Harvest index of traditional tall varieties is about 0.3 and 0.5 for improved short varieties (Yoshida, 1981). Murshida *et al.* (2017) reported that the effect of interaction between variety and water management system was significant for plant height, panicle length, number of grains $panicle^{-1}$, grain yield, straw yield and biological yield of rice.

4.2.12.1 Effect of supplemental irrigation

Biological yield of T. *Aman* rice genotypes varied due to different levels of irrigation (Figure 12). The highest harvest index (30.23%) was recorded in the irrigated plots, which was statistically similar with the harvest index recorded in the non-irrigated plots (29.53%).

The harvest index of supplemental irrigated treatment was 2.37 % higher compared to that of no supplemental irrigation. Similar higher harvest index due to supplemental irrigation on T. *Aman* was also reported by Shamsuzzaman (2007).

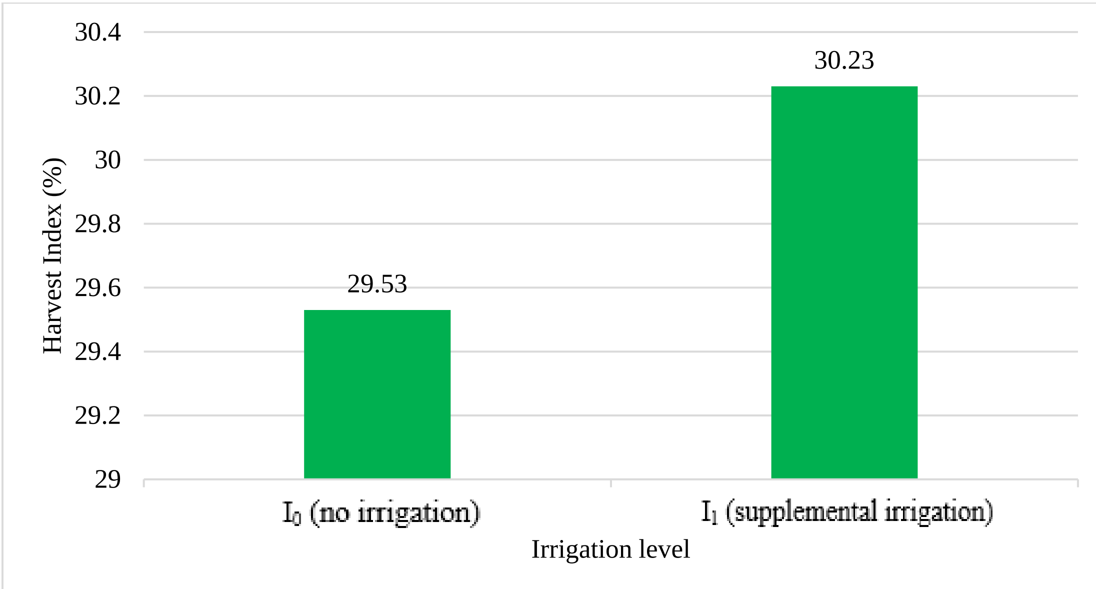

Figure 12. Effect of supplemental irrigation on harvest index of T. *Aman* rice [$LSD_{(0.05)}$ = 1.30]

4.2.12.2 Effect of genotypes

Significant variation regarding harvest index was observed among the screened genotypes (Table 13). The highest harvest index (32.49%) was recoded in SAU AGDL12. The second highest harvest index (30.56%) recorded in SAU AGDL1, which was statistically similar to SAU AGDL14 (30.38%), SAU AGDL2 (30.17%), SAU AGDL15 (29.52%) and SAU AGDL13 (28.98%). The lowest harvest index (28.37%) was recorded in Kataribhog, which was statistically similar to SAU AGDL3 (29.59%), SAU AGDL13 (28.98%), SAU AGDL15 (29.52%) and SAU AGDL2 (30.17%).

The highest harvest index was recorded in SAU AGDL12 was 14.52 % higher compared to that of Kataribhog. Sokoto and Muhammad (2014) also found the similar results in case of harvest index due to varietal variations.

4.2.12.3 Interaction effect of supplemental irrigation and genotypes

Significant variation regarding harvest index was observed due to interaction effect of supplemental irrigation and genotypes (Appendix XI and Table 14). The highest harvest index (32.60%) was recorded in SAU AGDL12 with no irrigation, which was statistically similar with SAU AGDL12 with irrigation, SAU AGDL1 with irrigation, SAU AGDL14 with irrigation, SAU AGDL2 with irrigation and SAU AGDL15 with irrigation. The lowest harvest index (28.10%) was recorded in Kataribhog with irrigation, which was statistically similar with SAU AGDL3 with no irrigation, SAU AGDL13 with irrigation, Kataribhog with no irrigation, SAU AGDL15 with no irrigation, SAU AGDL3 with irrigation and SAU AGDL2 with no irrigation, SAU AGDL13 with no irrigation, SAU AGDL1 with no irrigation, SAU AGDL14 with no irrigation and SAU AGDL15 with irrigation.

The highest harvest recorded in SAU AGDL12 with no irrigation was 13.87 % higher compared to that of Kataribhog with no irrigation. Shamsuzzaman (2007) also reported similar higher harvest index due to interaction effect of supplemental irrigation and genotypes on T. *Aman*.

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was conducted at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka during the period from July to December 2018 to study the effect of supplemental irrigation on growth and yield of different *Aman* rice genotypes. The experiment comprised two factors; 1. irrigation having two levels (I_0 = no supplemental irrigation (rainfed) and I_1 = supplemental irrigation) and 2. eight rice genotypes (G_1 = SAU AGDL1, G_2 = SAU AGDL2, G3 = SAUAGDL3, G_4 = SAU AGDL12, G_5 = SAU AGDL13, G_6 = SAU AGDL14, G_7 = SAU AGDL15 and G_8 = Kataribhog (local)). The trial was setup in split plot design with irrigation in the main plot and genotypes in the sub-plot with three replications. Significant variation was recorded in terms of data on growth, different yield contributing characters and yield of T. *Aman* rice genotypes.

At 20, 40, 60, 80, 100 DAT and harvest the taller plant (62.24 cm, 124.43 cm, 146.30 cm, 165.55 cm, 180.05 cm and 186.65 cm, respectively) was recorded in I_1, whereas the shorter plant (62.14 cm, 121.86 cm, 142.03 cm, 160.21 cm, 171.80 cm and 177.83 cm) in I_0.

At 20, 40, 60, 80, 100 DAT and at harvest the higher number of tillers hill^{-1} (7.17, 10.42, 12.21, 14.00, 14.38 and 14.29, respectively) was recorded in I_1, whereas the lower number (6.83, 9.00, 11.17, 12.79, 13.08 and 12.75, respectively) in I_0. At 20, 40, 60, 80, 100 DAT and at harvest, the higher Leaf Area Index (LAI) (1.37, 3.79, 5.20, 4.80, 4.39 and 3.06, respectively) was recorded in I_1, whereas the lower (1.27, 3.71, 4.90, 4.46, 3.99 and 2.73, respectively) in I_0. At 30, 60, 90 DAS and harvest the higher dry matter weight hill^{-1} (14.20 g, 32.13 g, 43.84 g, 53.84 g, respectively) was recorded in I_1, whereas the lower (12.30 g, 30.75 g, 42.07 g and 51.30 g) in I_0. The higher number of effective tillers m^{-2} (204.17) was recorded in I_1, whereas the lower number (148.96) in I_0. The higher number of in-effective tillers m^{-2} (169.79) was recorded from I_0, whereas the lower number (153.13) from I_1. The longer panicle (28.25 cm) was recorded in I_1, whereas the shorter (27.86 cm) in I_0. The higher number of primary branches panicle^{-1} (12.08) was recorded in I_1, whereas the lower number (11.93) in I_0. The higher number of filled grains panicle^{-1} (173.25) was recorded in I_1, whereas the lower number (160.25) in I_0. The lower number of unfilled grains panicle^{-1}was recorded (32.92) in I_1, whereas the higher number (42.29) in I_0. The higher number of total grains panicle^{-1} (206.17) was recorded in I_1, whereas the lower number (202.54) in I_0. The higher weight of 1000 grains (24.57 g) was recorded in I_1, whereas the lower weight (24.25 g) in I_0. The higher grain yield (5.83 t ha^{-1}) was recorded in I_1, whereas the lower yield (5.37 t ha^{-1}) in I_0. The higher straw yield (13.47 t ha^{-1}) was recorded in I_1, whereas the lower yield (12.83 t ha^{-1}) in I_0. The higher biological yield (19.29 t ha^{-1}) was recorded in I_1, whereas the lower yield (18.20 t ha^{-1}) in I_0. The maximum harvest index (30.23%) was recorded in I_1, whereas the minimum (29.53%) in I_0.

At transplanting, 20, 40, 60, 80, 100 DAT and at harvest, the tallest plant (47.12 cm, 66.88 cm, 138.32 cm, 155.49 cm, 179.27 cm, 192.34 cm and 199.23 cm, respectively) was observed in G_6, G_1, G_7, G_7, G_1, G_1, G_1, respectively; while the shortest plant (47.12 cm, 58.15 cm, 105.38 cm, 122.95 cm, 140.32 cm, 153.67 cm and 160.15 cm, respectively) in G_4, G_3, G_8, G_4, G_4, G_4, G_4, respectively. At 20, 40, 60, 80, 100 DAT and at harvest, the highest number of tillers hill^{-1} (8.67, 13.17 and 15.67, 17.67, 19.00 and 18.50, respectively) was observed in G_8, while the lowest number (5.50, 8.33, 10.33, 11.67, 12.00, and 12.17, respectively) in G_6,G_2, G_5, G_4, G_4, G_4, respectively. At 20, 40, 60, 80, 100 DAT and at harvest, the highest leaf area index (LAI) (1.79, 5.17, 6.81, 5.92, 4.89 and 3.36, respectively) was recorded from G_1, whereas the lowest (1.00, 3.23, 4.29, 4.02, 3.48 and 2.45, respectively) from G_6, G_6, G_8, G_8, G_8, G_8, respectively. At transplanting, 30, 60, 90 DAT and at harvest, the highest dry matter content hill^{-1} (0.25 g, 13.66 g, 33.36 g, 46.97 g and 57.33 g, respectively) was recorded in G_3, G_7, G_1, G_1, G_5, respectively; while the lowest dry matter content hill^{-1} (0.10 g, 12.42 g, 29.21 g, 40.07 g and 44.43 g, respectively) was recorded in G_4, G_5, G_6, G_2, G_4, respectively. The highest number of effective tillers m^{-2} (402.78) was observed from G_8, while the lowest number (252.78) was recorded in G_2. The highest number of in-effective tillers m^{-2} (61.11) was observed in G_6, while the lowest number (41.67) was recorded in G_4. The longest panicle (29.78 cm) was observed in G_1, whereas the shortest (26.22 cm) was recorded in G_8. The higher number of primary branches panicle^{-1} (14.20) was recorded in G_3, whereas the lower number (10.75) in G_8. The highest number of filled grains panicle^{-1} (181.17) was observed in G_3, while the lowest number (143.17) was recorded in G_4. The lowest number of unfilled grains panicle^{-1} (19.00) was observed in G_3, while the highest number (44.33) was recorded in G_2. The highest number of total grains panicle^{-1} (219.50) was observed in G_1, while the lowest number (183.83) was recorded in G_4. The highest weight of 1000-grains (28.95 g) was observed in G_1, while the lowest weight (13.40 g) was recorded in G_8. The highest grain yield (6.05 t ha^{-1}) was observed in G_1, while the lowest grain yield (5.18 t ha^{-1}) was recorded in G_8. The highest straw yield (14.33 t ha^{-1}) was observed in G_5, while the lowest straw yield (11.11 t ha^{-1}) was recorded in G_4. The highest biological yield (20.16 t ha^{-1}) was observed in G_5, while the lowest biological yield (16.46 t ha^{-1}) was recorded in G_4. The maximum harvest index (32.49%) was observed in G_4, while the minimum harvest index (28.37%) was recorded in G_8.

At 20, 40, 60, 80, 100 DAT and at harvest, the tallest plant (67.50 cm, 139.87 cm, 162.81 cm, 179.40 cm, 194.15 cm and 201.47 cm, respectively) was observed in I_0G_5, I_1G_1, I_1G_6, I_1G_6, I_1G_1, I_1G_1, respectively; while the shortest plant (56.57 cm, 101.49 cm, 118.49 cm, 133.51 cm, 144.93 cm and 149.90 cm, respectively) in I_0G_3, I_0G_4, I_0G_4, I_0G_4, I_0G_4, I_0G_4, respectively. At 20, 40, 60, 80, 100 DAT and at harvest, the highest number of tillers hill^{-1} (9.00, 14.33 and 16.67, 18.67, 20.33 and 19.33, respectively) was observed in I_1G_8, while the lowest number (5.33, 7.33, 9.33, 11.00, 11.33 and 11.33, respectively) in I_0G_6, I_0G_2, I_0G_5, I_0G_4, I_0G_4, I_0G_4, respectively. At 20, 40, 60, 80, 100 DAT and at harvest, the highest Leaf Area Index (LAI) (1.86, 5.22, 6.93, 6.15, 5.20 and 3.55, respectively) was recorded in I_1G_1, whereas the lowest (0.96, 3.19, 4.15, 3.85, 3.28 and 2.28, respectively) in I_0G_6, I_0G_6, I_0G_8, I_0G_8, I_0G_8, I_0G_8, respectively. At 30, 60, 90 DAT and at harvest, the highest dry matter content hill^{-1} (15.08 g, 33.80 g, 49.46 g and 61.41 g, respectively) was observed in I_1G_1, I_1G_1, I_1G_1, I_1G_5, respectively, while the lowest dry matter content hill^{-1} (11.47 g, 28.22 g, 39.19 g and 43.13 g, respectively) was recorded in I_2G_2, I_0G_6,I_0G_2, I_0G_4, respectively. The highest number of effective tillers m^{-2} (427.78) was observed in I_1G_8 (Kataribhog with irrigation), while the lowest number (230.56) was recorded in I_0G_2 (SAU AGDL2 with no irrigation). The highest number of in-effective tillers m^{-2} (63.89) was observed in I_0G_6 (SAU AGDL14 with no irrigation), while the lowest number (38.89) was recorded in I_1G_4 (SAU AGDL12 with irrigation). The longest panicle (30.27 cm) was observed in I_1G_6 (SAU AGDL14 with irrigation), whereas the shortest (25.46 cm) was recorded in I_1G_8 (Kataribhog with irrigation). The highest number of primary branches panicle^{-1} (13.30) was recorded in I_0G_3 (SAU AGDL3 with no irrigation), whereas the lowest number (10.40) in I_0G_8 (Kataribhog with no irrigation). The highest number of filled grains panicle^{-1} (192.00) was observed in I_1G_1 (SAU AGDL1 with irrigation), while the lowest number (138.33) was recorded in I_0G_4 (SAU AGDL12 with no irrigation). The lowest number of unfilled grains panicle^{-1} (15.00) was observed in I_1G_3 (SAU AGDL3 with irrigation), while the highest number (49.33) was recorded in I_0G_8 (Kataribhog with no irrigation). The highest number of total grains panicle^{-1} (228.67) was observed in I_1G_1 (SAU AGDL1 with irrigation), while the lowest number (182.33) was recorded in I_1G_4 (SAU AGDL12 with irrigation). The highest weight of 1000-grains (29.10 g) was observed in I_1G_1 (SAU AGDL1 with irrigation), while the lowest weight (13.29 g) was recorded in I_0G_8 (Kataribhog with no irrigation). The highest grain yield (6.44 t ha^{-1}) was observed in I_1G_1 (SAU AGDL1 with irrigation), while the lowest grain yield (5.10 t ha^{-1}) was recorded in I_0G_3 (SAU AGDL3 with no irrigation). The highest straw yield (15.35 t ha^{-1}) was observed in I_1G_5 (SAU AGDL13 with irrigation), while the lowest straw yield (10.78 t ha^{-1}) was recorded in I_0G_4 (SAU AGDL12 with no irrigation). The highest biological yield (21.43 t ha^{-1}) was observed in I_1G_5 (SAU AGDL13 with irrigation), while the lowest biological yield (16.02 t ha^{-1}) was recorded in I_0G_4 (SAU AGDL12 with no irrigation). The maximum harvest index (32.60%) was observed in I_0G_4 (SAU AGDL12 with no irrigation), while the minimum (28.10%) in I_1G_8 (Kataribhog with irrigation).

The following conclusion can be drawn regarding the findings of the current study:

1. The irrigated plots have given higher results in terms of all the desirable characters.
2. SAU AGDL1 has given the highest grain yield among all the varieties and Kataribhog yielded the lowest.
3. Among the treatments, SAU AGDL1 with irrigation has given the maximum grain yield.
4. Nevertheless, the same experiment needs to be repeated in order to draw a clear conclusion and recommendation, and further research work should be undertaken throughout various agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performances.

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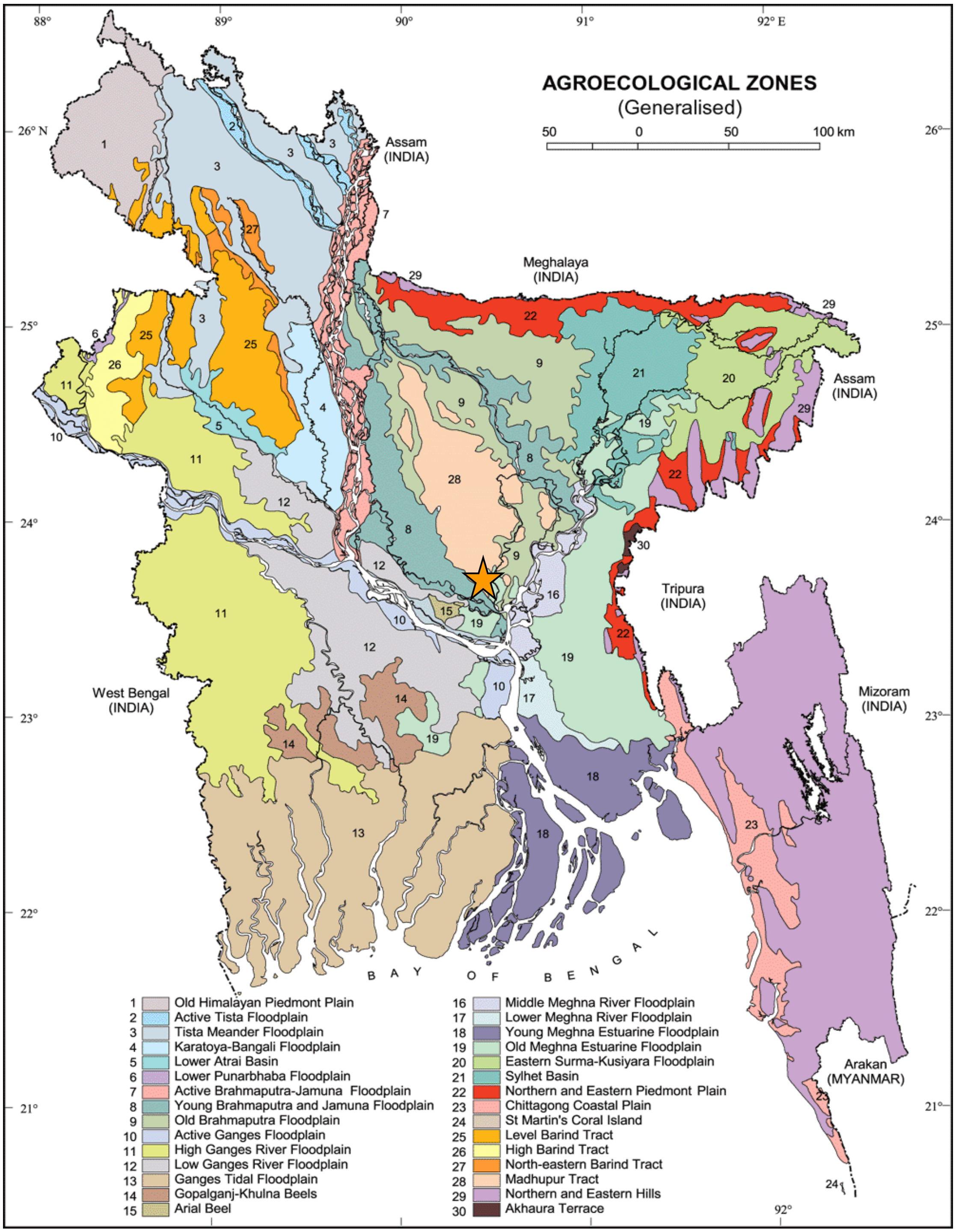
APPENDICES

Appendix I. Map showing the experimental site under study



★ The experimental site under study

Appendix II. Morphological, physical and chemical characteristics of experimental soil

A. Morphological characteristics

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

B. Physical and chemical properties of the initial soil

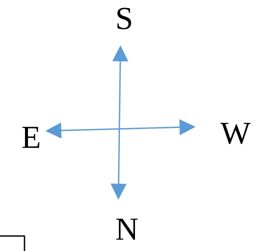
Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

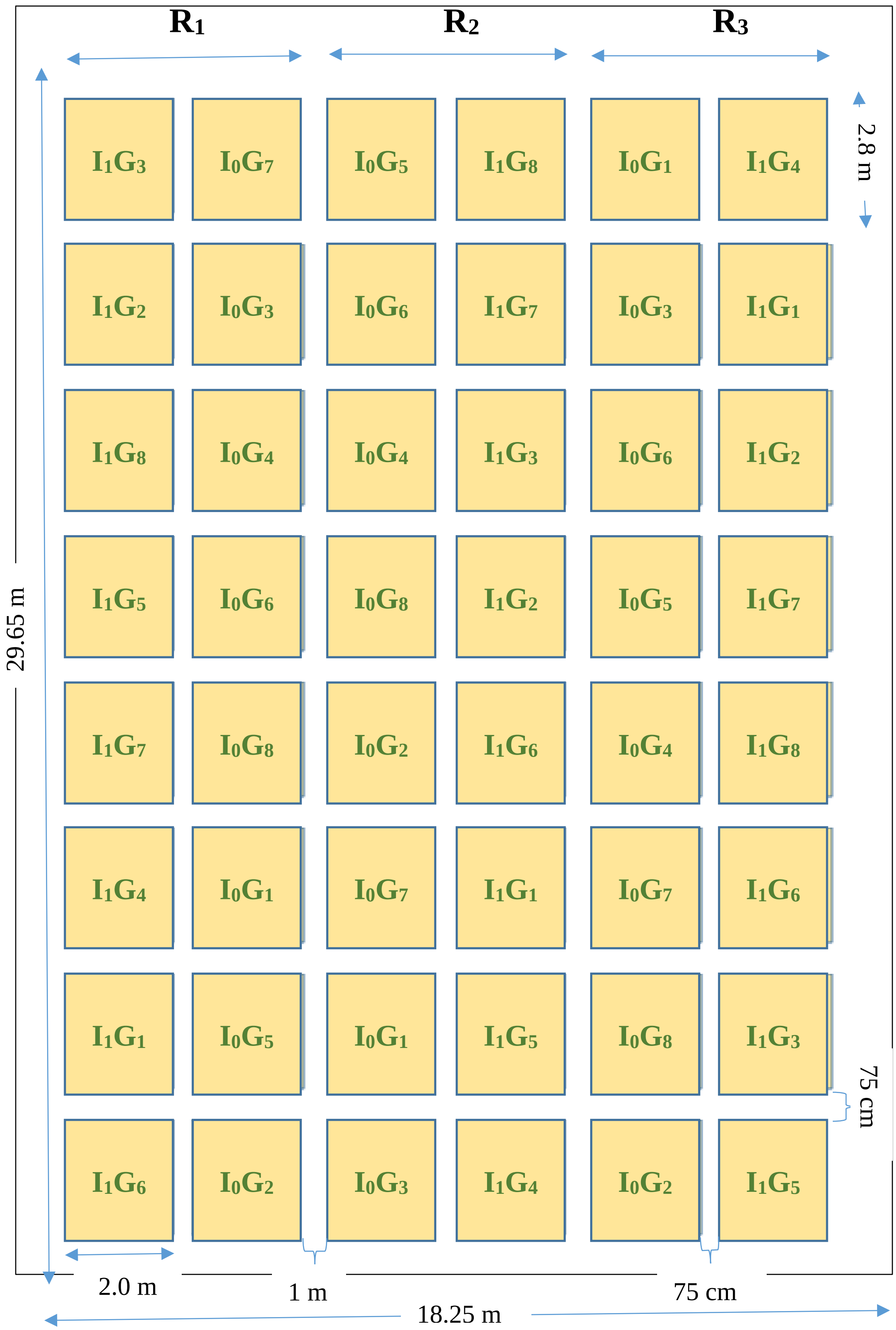
Appendix III. Monthly record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period from July to December 2018

Month (Year 2018)	*Air temperature (ºC)		*Relative humidity (%)	*Total Rainfall (mm)	*Total Sunshine (hr)
	Maximum	Minimum			
July	37	25	81%	46.53	268.00
August	36	26	77%	66.92	302.00
September	36	25	76%	64.14	292.50
October	36	21	69%	33.00	238.00
November	31	18	63%	12.30	210.5
December	28	16	61%	51.70	206.00

* Monthly total rainfall,
Source: https://www.timeanddate.com/weather/bangladesh/dhaka/
https://www.worldweatheronline.com/dhaka-weather-history/bd.aspx



Appendix IV. Field layout of the Experiment in Split-plot Design



Appendix V. Mean square values of plant height of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values at different days after transplanting					
		20	40	60	80	100	At harvest
Replication	2	2.95	90.38	224.93	399.45	329.27	328.81
Irrigation (A)	1	0.12^{NS}	79.11^{NS}	218.88^{NS}	342.83^{NS}	816.09*	931.57*
Error I	2	9.77	70.09	92.00	20.64	16.82	21.26
Variety (B)	7	62.44**	954.95**	1259.94**	1252.09**	1172.65**	1170.86**
Interaction (A x B)	7	10.16^{NS}	50.12^{NS}	71.46^{NS}	87.56^{NS}	61.44^{NS}	72.19^{NS}
Error II	28	17.93	41.19	43.44	64.08	57.33	51.06

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix VI. Mean square values of number of tillers hill^{-1} of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values at different days after transplanting					
		20	40	60	80	100	At harvest
Replication	2	1.31	4.33	3.81	0.08	0.77	6.08
Irrigation (A)	1	1.33*	24.08^{NS}	13.02^{NS}	17.52^{NS}	20.02**	28.52*
Error I	2	0.02	1.58	2.77	1.08	0.15	0.58
Variety (B)	7	6.10**	14.56**	20.93**	24.66**	29.90**	25.74**
Interaction (A x B)	7	0.29^{NS}	0.46^{NS}	0.59^{NS}	0.47^{NS}	0.59^{NS}	0.09^{NS}
Error II	28	0.77	0.67	1.48	0.99	1.29	0.83

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix VII. Mean square values of Leaf Area Index (LAI) of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values at different days after transplanting					
		20	40	60	80	100	At harvest
Replication	2	0.002	0.023	0.035	0.001	0.001	0.270
Irrigation (A)	1	0.129^{NS}	0.090**	3.164^{NS}	5.709**	7.733**	5.221**
Error I	2	0.011	0.001	0.0137	0.001	0.0004	0.041
Variety (B)	7	0.345**	2.372**	13.199**	8.444**	4.458**	1.899**
Interaction (A x B)	7	0.004^{NS}	0.003^{NS}	0.080*	0.111**	0.555**	0.082^{NS}
Error II	28	0.031	0.003	0.024	0.004	0.003	0.037

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix VIII. Mean square values of dry weight hill^{-1} of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values at different days after transplanting			
		30	60	90	At harvest
Replication	2	1.67	2.85	4.84	4.52
Irrigation (A)	1	43.18**	23.05*	37.38^{NS}	78.75*
Error I	2	0.06	0.41	5.87	2.69
Variety (B)	7	0.90^{NS}	12.83**	30.69**	81.80**
Interaction (A x B)	7	1.65^{NS}	0.45^{NS}	6.56^{NS}	8.27^{NS}
Error II	28	1.02	1.40	6.00	5.09

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix IX. Mean square values of number of effective tillers m^{-2}, number of ineffective tillers m^{-2}, panicle length and number of primary branches panicle^{-1} of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values			
		Effective tillers m^{-2}	Ineffective tillers m^{-2}	Panicle length	Primary branches panicle^{-1}
Replication	2	2154.20	313.95	0.43	0.24
Irrigation (A)	1	23334.80**	370.37^{NS}	1.80^{NS}	0.29*
Error I	2	96.90	140.34	0.26	0.01
Variety (B)	7	14345.00**	296.79**	10.11**	3.67**
Interaction (A x B)	7	64.30^{NS}	6.61^{NS}	1.56^{NS}	0.49^{NS}
Error II	28	320.40	71.72	1.05	0.54

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix X. Mean square values of number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, number of total grains panicle^{-1}, sterility percentage and 1000-grain weight of T. *Aman* rice as affected by supplemental irrigation and genotypes

Source of variation	DF	Mean square values				
		Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	Total grains panicle^{-1}	Sterility percentage	1000-grains weight (g)
Replication	2	16.75	1.27	27.15	0.01	2.28
Irrigation (A)	1	2028.00**	1054.69**	157.69*	285.97**	1.24^{NS}
Error I	2	7.00	0.81	7.56	0.13	0.40
Variety (B)	7	875.19**	397.28**	651.93**	96.72**	165.25**
Interaction (A x B)	7	151.43**	20.26**	231.40**	2.84**	0.63^{NS}
Error II	28	9.61	2.14	10.09	0.47	1.13

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant

Appendix XI. Mean square values of yield characters of T. *Aman* rice as affected by genotypes and supplemental irrigation

Source of variation	DF	Mean square values			
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	0.73	0.28	1.85	6.77
Irrigation (A)	1	2.47*	4.92*	14.37*	5.81^{NS}
Error I	2	0.05	0.17	0.21	1.09
Variety (B)	7	0.52**	5.11*	7.41**	10.70**
Interaction (A x B)	7	0.08^{NS}	0.52^{NS}	0.60^{NS}	2.06^{NS}
Error II	28	0.17	0.32	0.58	2.51

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability: ^{NS}: Non significant