EFFECT OF ALTERNATE FURROW IRRIGATION ON WHITE MAIZE VARIETIES

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It is a fact that the remembrance of Allah brings peace in the heart. It is better to ponder over the verses to bring us even closer to Allah(SWT).

DEDICATED TO-

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CERTIFICATE

This is to certify that the thesis entitled ***"EFFECT OF ALTERNATE FURROW IRRIGATION ON WHITE MAIZE VARIETIES"*** *submitted to the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in AGRONOMY****, embodies the result of a piece of authentic research work carried out by* ***JEBONNESSA DHALIA,*** *Registration No.* ***17-08252*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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Author

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ABSTRACT

A field experiment was accomplished in the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2017 to April, 2018 to study the effect of alternate furrow irrigation on maize varieties. Maize varieties viz. V_1 (PSC - 121), V_2 (Yungnuo-3000), V_3 (BHM-12), V_4 (BHM-13) and Irrigation application: I (conventional irrigation), IA (Alternate furrow irrigation) were used in this experiment arranged in Randomized Complete Blocked Design (RCBD) with three replications. Data on different growth and yield attributes were taken in which all the treatment showed significant variations. Among variety, tallest plant height (234.7 cm), cob breadth (15.9 cm), grain yield/ cob (106.8 g), grain yield/ hectare (8.9 t), chaff weight/cob (11.6 g), shell weight/cob (25.3 g) were found from V_1 (PSC - 121) whereas minimum in variety V_3 (BHM-12) and for irrigation application, maximum cob bearing node (9.07), cob grain number (359.5), cob length (15.5 cm), grain yield/hectare (8.1 t) found in conventional irrigation application. Maximum yield per hectare (10.05 t) were found in V_1I and minimum (4.85 t) in V_3IA. In view of overall performances, variety V_1 with conventional irrigation application has potentiality for maize production.

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ABBREVIATIONS AND ACCORONYMS

AEZ	=	Agro-ecological Zone
Agril.	=	Agricultural
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
Biol.	=	Biology
CV	=	Coefficient of variance
DAS	=	Days after sowing
et al.	=	And others
Ex.	=	Experiment
FAO	=	Food and Agriculture Organization
g	=	Gram
Agro.	=	Agronomy
i.e.	=	That is
J.	=	Journal
Kg	=	Kilogram
LSD	=	Least Significance Difference
mm	=	Millimeter
RCBD	=	Randomized Complete Blocked Design
Res.	=	Research
SAU	=	Sher-e-Bangla Agricultural University
Sci.	=	Science
spp.	=	Species
Technol.	=	Technology
UNDP	=	United Nations Development Programme
Viz.	=	Namely

CHAPTER I
INTRODUCTION

Among the food grains, maize (*Zea Mays* L.) is the oldest one and the only cultivated species in its genus. It is a member of the Poaceae family formerly known as Gramineae and a C_4 plant. Maize is known by various common names but the most popular name is maize or corn (Paliwal, 2000). Maize is a fully domesticated plant, which has lived with man and evolved since ancient times. It is completely dependent on human care, does not grow in the wild and cannot survive in nature.

Maize is the top most important cereal crop in terms of yield productivity among all other cereals of the world (Ullah *et al.*, 2016; Ullah *et al.*, 2018; Statista, 2017). Globally, 765 million metric tons of maize was harvested in 2010 from just less than 153 million hectares. About 73 per cent of this area was located in the developing world. Maize is currently produced on nearly 100 million hectares in 125 developing countries and is among the three most widely grown crops in 75 of those countries (CGIAR, 2016). It occupies less land area than either wheat or rice but has a greater average yield per unit area of about 5.5 tons per hectare. According to Paliwal (2000) the grain of maize is the most important component for which maize is cultivated, though every part, leaves, stalk, tassel, husk and cob is employed for different purposes.

Maize has attracted the attention in the world due to its importance being used as fodder and human food (Guruprasad *et al.*, 2016; Ullah *et al.*, 2018). The grain is very nourishing; with about 70-72% assimilate carbohydrates, 4-4.5% fats and oils and 9.5-11% proteins (Larger & Hill, 1991). Another report shows that maize is a significant source of proteins (10.4%), fat (4.5%), starch (71.8%), fiber (3%), vitamins and minerals like Ca, P, S and also containing a small amount of Na. Flour obtained from maize is treated as a good diet for the patients with heart diseases due to its low gluten (protein) content (Hamayun, 2003).

Maize cultivation is gaining popularity in Bangladesh and production is increasing day by day (Ullah *et al.*, 2018). Maize currently grown in Bangladesh is of yellow type and is used in the feed industry. White maize covers only 12% of the total acreage of the world which is mostly used as human food (FAO-CIMMYT, 1997). During 1970s the productivity of grown white maize was lower compared to those of yellow ones. With the advanced breeding approaches worldwide, recent reports demonstrate that the yield productivity of white maize is almost at par with those of the yellow ones (Akbar *et al.*, 2016). Evaluation of maize varieties especially white maize is needed for suitable variety for continuous production. So, there is a need to evaluate variety for higher yield and to identify the suitable group for desirable purposes like human consumption.

In Bangladesh rice is the main staple crop while wheat is also used as the second staple. Due to the climate change the wheat production is decreasing day by day which has also been existed in Bangladesh. The productivity of wheat has decreased due to the occurrence of high temperature at the grain filling condition. Wheat and rice area $C_{3,}$ crop which has lower productivity as compared to the C4 maize (Ullah *et al.*, 2018). Due to the deficit of wheat production, Bangladesh has to import two fold amount of wheat compared to its home production. Besides this the food production scenarios of Bangladesh is still not sustainable and for this reason Bangladesh had to keep prepared one other alternative food crop which can be used as another staple after rice and wheat. It is the white maize. which has been being consumed popularly by humans worldwide owing to its better taste and diversity of food production compared to the yellow one.

Water plays an important role in the agriculture sector as it is essential for cell turgidity and absorption of various nutrients along with water absorption by roots. It is also involved in the metabolic activities of the plants. Water is also used in other sectors for economic development in the larger quantities. So, judicious use of water in the agriculture is very important.

However, for forage crops irrigation is an increasingly important practice for sustainable agriculture. Traditional irrigation methods in this region have experienced significant improvements with introduction of new technologies over the years. Increasing crop productivity, enhancement of irrigated area, protection of soil from water logging and other ill effects are challenges for today's agriculture which may be addressed to the larger extent by use of modern methods of irrigation. The age old conventional border method of irrigation has very low water-use-efficiency. By using these methods we are not only wasting the precious ground water but also deteriorating our soils. A new method of irrigation proposed by Kang *et al.* (1998) is the alternate irrigation system, by which, water is supplied to alternate sides of the plants root system. Besides, by adopting the water technologies farmers can save money by reducing the production cost through reducing the amount of irrigation water. In the alternate irrigation, only the alternate furrows are irrigated which ultimate through sea page causes the soil of the adjacent furrow to soak it. This ultimate saves half of the total irrigation water leading to a remarkable reduction of the irrigation cost.

Further all the varieties are not equally drought tolerant. Growing a drought tolerant variety incurs low production cost. So, it is also needed to screen out the drought tolerant variety among the available ones.

Keeping the above points in view the present study entitled, "Effect of alternate furrow irrigation on white maize varieties with the following objectives:

i. To select a suitable white maize variety for Bangladesh
ii. To compare the performance of alternate furrow irrigation with the conventional irrigation in respect of growth and yield of white maize varieties.
iii. To study the interactive effects of white maize varieties with alternate furrow and conventional irrigation on growth and yield of white maize.

CHAPTER II

REVIEW OF LITERATURE

In industrialized countries maize is largely used as livestock feed and as a raw material for industrial products, while in many developing countries, it is mainly used for human consumption. Maize is consumed mainly as second cycle produce in the form of meat, eggs and dairy products. The crop has immense potentiality for supporting food stuff of the huge population of Bangladesh in the near future when other crop's contribution will fall due to climate change. However, a huge number of research reports so far published on this crop have been reviewed and some of the reviews related to our topic have been embellished below:

Abdullah *et al*. (2001) studied the effects of mulch and the several irrigation water amounts on soil evaporation and on lettuce`s transpiration, evapotranspiration and yield were studied in a glasshouse pot experiment as Completely Randomized Experimental Design with three replications. Irrigation water was applied twice a week. The water quantities were regulated by weight. Increasing the amount of irrigation water applied significantly increased crop evapotranspiration (mean 45%) in the Open Soil Surface (OSS) treatments and transpiration (mean 26%) in the Covered Soil Surface (CSS) treatments. In CSS treatments, evapotranspiration was significantly reduced, while transpiration was significantly increased compared with OSS treatments. Covering the soil surface reduced the amount of irrigation water required by the lettuce crop by about 60% for all irrigation treatments compared with the amount of irrigation water added in the OSS treatments. Lettuce yield was significantly higher in CSS treatments than in OSS treatments. Especially at low water levels, lettuce yield was higher in CSS than in OSS treatment. Water use efficiency in CSS and OSS treatments was maximum for the highest water level and irrigation water use efficiency was maximum for the lower water level in CSS treatments and for the intermediate water level in OSS treatments.

The experiment was conducted to determine the evaluation of four varieties of maize for optimum growth and yield under field condition. The experiment was laid down in a Randomized Completely Block Design (RCBD) with three (3) replicates. Each block consisted of four (4) treatments. The treatments include: TZEE-Y POP STRC$_4$, EV99QPM, 2000SynEE-W QPM C$_0$ and 99TZEE-Y STR. The growth parameters evaluated include Leaf length, leaf width, plant height, number of nodes, Distance between nodes, Stem girth, Length of inflorescent, number of cob and Period it takes to tassel (days). Also the yield parameters were: Weight of cob, Weight of 100 Grains, and Number of grains per cob. The TZEE-Y POP STRC$_4$ has the best potential for increased grain yield due to the fact that it has wide genetic base which enables it to perform well irrespective of soil and environmental difference. The said treatment is also resistant to a wide range of biotic and a biotic stress which makes it a variety of first choice to farmers especially in this period of climate change. Therefore, TZEE-Y POP STRC$_4$ could be confirmed as a high yielding variety with stable vigour (Abdulraheem *et al.*, 2018).

Ahmed *et al.* (2010) Results revealed that late maturing maize hybrid Pioneer-30Y87 exhibited not only maximum leaf area index, but exceeded in crop growth rate and plant height. During both the years of experimentation, early maturing hybrid DK-919 produced higher grain yield than mid and late maturity maize hybrids. Early (DK-919) and late (Pioneer-30Y87) maize hybrids performed best at 45 cm row spacing, while mid-season hybrid (DK- 5219) did best at 60 cm row spacing. Yield components such as cob length, number of grains per ear and 1000 grain weight significantly varied among maize hybrids and with varying row spacing. Study concluded that both early and late maize hybrids as DK-919 and Pioneer-30Y87can tolerate narrow row spacing but wider spacing is required for DK-5219-type hybrids.

Akbar *et al.* (2016) explored that the plant height ranged between 243 and 279 cm across treatments with an average of 263 cm. Generally plant height increased with increasing rate of fertilizer application and plants of hybrid

PSC121 were taller than KS 510. Grain yield was found between 7.103 t/ha and 10.126 t/ha per ha across hybrids and planting scheme. 19% more yield was obtained from PSC-121 than KS 510. In general, increasing planting density resulted in increased grain yield. Planting in twin-rows resulting in 80,000 plants per hectare produced 17.7% higher yield than planting in single rows having 66,667 plants per ha with 60 cm spacing. Identical result was found by the application of fertilizers at 100% and 50% of recommended rate but gave significantly higher grain yield compared to 25% of recommended doses.

Asif *et al*. (2009) studied the effects of different levels of nitrogen on growth and yield of wheat crop.. The wheat variety, Sehar-2006 was tested at four different nitrogen rates i.e. 0, 80, 130 and 180 kg ha^{-1}. Date of sowing was during the last week with seed rate of 100 kg ha^{-1}.The results showed that number of tillers per $unit^{-1}$, plant height, spike's length, number of grain spike- ^{1}, 1000-grain weight and grain yield were significantly increased by increasing the nitrogen levels over control. Among nitrogen levels, highest grain yield (3.848 tons ha-1) was obtained by an application of 180kg N ha^{-1}).

Bandyopadhyay *et al.* (2010) conducted experiment on wheat using sprinkler irrigation. The treatments comprised of irrigation methods viz. I_1 (20 cm) 4 cm pre-sowing (sprinkler) 5 cm (sprinkler) 5 cm (sprinkler) 6 cm (sprinkler), I_2 (20 cm) 8 cm pre sowing (sprinkler) 6 cm (sprinkler) - 6 cm (sprinkler), I_3 (20 cm) 8 cm pre-sowing (sprinkler) 6 cm (flooding) - 6 cm (flooding), I_4 (20 cm) 8 cm post sowing (sprinkler) 6 cm (flooding) - 6 cm (flooding), I_5 8 cm pre-sowing (flooding) 6 cm (flooding) - 6 cm (flooding) and it was reported that in the year 2003-04 and 2004-05, 20-cm irrigation up to the flowering stage or 14-cm irrigation up to the tillering stage through sprinkler in 4 and 3 installments, respectively and I_1 gave the highest grain yield, which was significantly higher than I_2 and flooding I_5. This finding confirmed the superiority of light and frequent irrigation over heavy and infrequent irrigation. There was no significant difference in the grain yield between sprinkler irrigation alone (I_2)

and sprinkler at pre-sowing followed by flood irrigation (I3), when the same amount of water was applied at the same growth stages.

Guruprasad *et al*. (2016) performed an experiment using nine different treatments considering four groups of herbicides with control plots of hand weeding and noted that all the herbicide treated plots increased will mortality, leaf area duration (LAD), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) along with grain yield per hectare most especially in case of pre emergence herbicides.

Water deficit reduces leaf area, leaf photosynthetic rate (during the stress period, although leaves may recover completely), delays silking and reduces grain yield components, particularly grain number (Hall *et al.*, 1980).

An experiment was conducted to study the effects of competition on growth behavior of maize. Plant height, grains per cob and 1000 grain weight were maximum at 1.5 feet spacing followed by 1.0 and 0.5 feet spaced treatments. No significant changes were observed for percentage fertility. Days to 50% tasseling and silking prolonged with increasing plant density. The weeding 34 days after sowing had non-significant impact on different plant parameters (Hamayun, 2003).

An improvement in water use efficiency can be achieved through more precise irrigation methods combined with appropriate irrigation scheduling, the latter based not only on crop water requirements but designed and managed to ensure optimal use of allocated water (Huang *et al.*, 2006).

The comparative yield performance of different Maize hybrids under local conditions was investigated. Plant population, plant height number of cobs/plant, number of grain rows per cob, number of grains per cob, 1000-grain weight and grain yield were significantly affected. Maximum number of grains per cob, maximum 1000-grain weight and ultimately maximum grain yield was obtained in maize hybrid HG-3740 (Jing *et al.*, 2003).

AFI system leads to continuous stomatal inhibition and reduced leaf transpiration. In AFI drying lead to an even distribution of the root system in the soil, while drying of the fixed root zone resulted in more roots in the wet and less in the dried zone (Kang *et al.*, 1998).

Many ways of conserving agricultural water have been investigated. Researchers fixed some furrows for irrigation, while adjacent furrows were not irrigated for the whole season. Water was saved mainly by reduced evaporation from the soil surface, as in the case of drip-irrigation and also used wide spaced furrow irrigation or skipped crop rows as a means to improve WUE (Khan *et al*., 2000).

Deficit irrigation is a water management strategy in which crops are exposed to certain levels of water stress during either a particular growth period or throughout the whole growth season, without significant reduction in yields. The feasibility of deficit irrigation and whether significant savings in irrigation water are possible without significant yield penalties have been researched worldwide, although not in Ethiopia.

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from December 2017 to April 2018 to study the yield performance of some maize varieties as influenced by irrigation management at different growth stages. The experiment was laid out in a Randomized complete block design with three replications where factor (A) irrigation stages were allocated in main plots and factor (B) varieties were distributed in sub plots. In factor A five irrigation management viz. I0 = (No irrigation), I1= (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage), I2= (Four leaf stage+ eight leaf stage + tasselling stage), I3= (Eight leaf stage + tasselling stage +grain filling stage), I4=(Four leaf stage + tasselling stage+ grain filling stage), I5=(Four leaf stage+ eight leaf stage+

grain filling stage) and in factor B three varieties viz. V1= (BARI hybrid vutta-9), V2= (BARI hybrid vutta-13), V3= (pacific-559) were included as treatments in the experiment. Data were collected on yield and yield contributing characters. The highest grain yield (5.88 t/ha) was obtained with the water management treatment (Kobir *et al*., 2019).

Larger and Hill (1991) reported that the highest water-use-efficiency (2.46 and 3.41 kg m^{-3} ha-1) was obtained with the irrigation of 2380 m3 ha-1 (I1) in the 2009-10 and 2010-11 seasons, respectively. The medium irrigation treatment (I2) had medium water-use-efficiency (1.893 and 2.62 kg m-3 ha-1) in the first and second seasons, respectively.

Mansouri *et al*. (2010) studied to evaluate the effects of water stress imposed at low-sensitive growth stages (vegetative, reproductive, and both vegetative and reproductive) and level of nitrogen (N) supply (100 and 200kgha−1) on the physiological and agronomic characteristics of two hybrids of maize (Zea mays L.). A two-site field experiment was carried out using a randomized complete block design with three replications and a split-factorial arrangement. A water deficit (WD) was induced by withholding irrigation at different stages of crop development. The results showed that proline content increased and the relative water content, leaf greenness, 100-kernel weight and grain yield decreased under conditions of WD. The limited irrigation imposed on maize during reproductive stage resulted in more yield reduction than that during vegetative stage, compared with fully irrigated treatment. The 100-kernel weight was the most sensitive yield component to determine the yield variation in maize plant when the WD treatments were imposed in low-sensitive growth stages.

In a field experiment on irrigated maize plants for two consecutive years to determine soil water distribution, uniformity and water-use efficiency under alternate furrow irrigation in arid areas, water advance time did not differ between AFI, FFI and CFI at all distances monitored. Water did not advance more slowly in AFI than in FFI and CFI under a covering of plastic film over the soil surface (MCcutchen *et al*., 2001).

Irrigation efficiencies can vary from extremely low values to values approaching 100%. However, in normal irrigation practice, surface irrigation efficiencies of application are in the range of 60%. Sprinkler irrigation had the highest application efficiency of 70% while basin irrigation of rice had the lowest of 30%. Wild flooding had low which is 45% (Moutonnet *et al*., 2002).

This study was conducted by Oluwarasti *et al.* (2008) to evaluate the yield performance of different maturity groups of maize varieties at different planting dates under the marginal rainfall conditions of the rainforest ecology of Nigeria and identify the high yielding ones. The maize varieties were evaluated on five and three different planting dates in 2001 and 2005 late cropping seasons respectively. Seven planting dates were used in 2002 and 2006 early cropping seasons. All plantings were done at a weekly interval. Data were obtained on grain yield and yield components. Grain yield and yield components decreased as planting was delayed in the late seasons while in the early seasons they showed contrasting trend. ACR 90 POOL16-DT with grain yield of 3.8 tons ha^{-1} and 6.4 tons ha^{-1} were the highest yielding varieties in 2001 and 2002 respectively. In 2005 late cropping season, TZECOMP3DT (1.7 tons/ha) was the highest yielding while in 2006 early cropping seasons, ACR 95 TZECOMP4C3 (4.37 tons/ha) was the highest yielding variety.

A number of factors are involved in reducing maize growth and yield by making a competition with the crop for nutrients, water, sunlight and space and weed is the most critical one. The Photosynthetic efficiency, dry matter production and distribution to economical parts of maize plant are hindered due to the presence of weed. Because the presence of weed reduces sink capacity of crop resulting in poor grain yield. The yield loss may reach up to 30% in maize due to weed infestation (Pandey *et al*., 2000).

This study examines the interaction effects of six moisture regimes and three nitrogen rates on dry matter production and nitrogen uptake by maize grown in a Vertisol from the Accra Plains of Ghana. A local maize variety (Obaatanpa) was grown in pots measuring 18 cm x 15 cm (inner diameter x high) and containing 3.6 kg of air dry soil. The pots were arranged in a randomized complete block design with four replications. The Nitrogen rates were 0 kg N ha 31, 40 kg N ha 31 and 80 kg N ha 31. The moisture regimes were 30, 40, 50, 60, 80 and 100% of the field capacity (FC) of the soil. The interaction of 80 kg N ha 31 with 60%, 80% and 100% FC significantly increased ($p < 0.01$) biomass yield and nitrogen uptake. At moisture regimes 80% and 100% FC, evapotranspiration from plants in the 80 kg N ha 31 was significantly greater ($p < 0.01$) than those in the 0 kg N ha 31 or 40 kg N ha 31. Maize response to the applied nitrogen was influenced by availability of water in the soil. It is important therefore that fertilizer application to maize on Vertisols be done when soil water content is close to field capacity (Quaye *et al*., 2009).

Sabir *et al*. (2000) studied that root development was significantly enhanced by AFI treatment. Primary root numbers, total root dry weight, and root density were all higher in AFI than in FFI and CFI treatments. Less irrigation significantly reduced the total root dry weight and plant height in both FFI and CFI treatments but not as substantially with AFI treatments. The most surprising result was that AFI maintained high grain yield with up to 50% reduction in irrigation amount, while FFI and CFI all showed a substantial decrease in yield with reduced irrigation. As a result, WUE for irrigated water was substantially increased. We conclude that AFI is a way to save water in arid areas where maize production relies heavily on repeated irrigation.

Plant height and stem diameter are essential traits in maize breeding. A study was carried out to estimate the extent of genetic variability in genotypes of Maize (*Zea mays* L.). Fifteen genotypes of maize were evaluated on season (2003/2004) across the two environments in Sudan, to obtain information on morphological and genetic diversity in plant height and stem diameter traits were estimated in a split-plot layout within randomized complete block design with three replications. Significant differences among genotypes were found in all traits, except stem diameter (45 days). High genotypic coefficient of variation, genetic advance and heritability were exhibited by plant height at 60 days and stem diameter at 60 days. Grain yield was significantly and positively associated, at the phenotypic level, with a plant height at 45 days and a stem diameter at 45 days (Salih *et al*., 2014).

The experiment was laid out in a split-plot design with irrigation in the main plots and variety in the sub-plots; there were three replications of the treatments. The size of the main plot was 7.0 m4.5 m and that of the sub-plot was 2.0 m4.5 m. Treatment I4 produced the highest (9.30 t ha^{-1}) and Io produced the lowest (7.62 t ha^{-1}) grain yield. V3 (Pacific 984) produced the highest (8.60 t ha^{-1}) and V2 (BHM-7) produced the lowest (7.31 t ha^{-1}) grain yield. The grain yield, however, did not vary significantly ($p = 0.05$) due to the effects of irrigations and varieties. The treatment combination I4V3 produced the highest (9.31 t ha^{-1}) and IoV2 produced the lowest (6.34 t ha^{-1}) grain yield (Shariotullah *et al*., 2013).

Tahir *et al.* (2008) conducted the experiment during August 2006, the comparative yield performance of different Maize hybrids under local conditions of Faisalabad was investigated. Plant population, plant height, number of cobs/plant, number of grain rows per cob, number of grains per cob, 1000-grain weight and grain yield were significantly affected. Maximum number of grains per cob, maximum 1000-grain weight and ultimately maximum grain yield was obtained in maize hybrid HG-3740.

An experiment was carried out by Ullah *et al.* (2016) for showing the effect of planting geometry on the performance of white maize varieties and where it was shown that out of four varieties Changnuo-6 and YANGNUO-7 resulted in more average number of leaves (4.00) than others (3.33-3.88). Changnuo-6 showed the highest number of grains per cob (419), while the lowest number of grains was obtained from Yangnuo-7 (276). Consequently, the lowest 100-seed weight was recorded from Yangnuo-7 (24.33 g, other varieties showed 31.83-34.67 g). The highest significant grain yield per hectare was resulted from Changnuo-6 (8.198 tons) which is preceded by Changnuo-1 (7.457 tons) and Q-Xinagnuo-1 (6.718 tons). The lowest grain yield per hectare was obtained from Yangnuo-7 (4.393 tons) than others.

Number of leaves in the modern varieties differed from 11.66 to 13.66 per plant with a mean value of 12.88 per plant. Notwithstanding, the varieties did not vary significantly in producing number of leaves though two more leaves were exhibited in Plough-202 and Suvra (over 13 leaves per plant) as compared to that (11.66) of the Plough-201. Unlike the leaf number per plant, the stem base circumference varied significantly over the modern varieties. Significantly the highest stem base circumference was observed in Suvra (10 cm) which although was identical to that (9 cm) of the Plough-202. The variety Plough- 201 had the narrowest stem showing significantly lower value (8.33 cm) than that of the Plough-202 but identical in comparison to that of the Plough-201 (Ullah *et al*., 2017).

Usoh *et al.* (2017) studied that application of drip and furrow irrigation systems for several weeks in the cultivation of sweet maize under sandy loam soil. The effects of the systems on growth characteristics and yields were evaluated. To achieve these, the experiment was laid out in a 2 x 5 factorial design in two systems and five duration of weeks after planting (WAP) in three replicates. Amounts of irrigation water were calculated and pre-irrigation was done one week prior to planting. Subsequent irrigation was applied at two days interval on drip and three days interval on furrow. The growth characteristics (plant height, number of leaves, stem girth and leaf surface area) were measured at 2 WAP, 4 WAP, 6 WAP, 8 WAP and 10 WAP. The weeks after planting had significant effect on all the growth characteristics. Drip system gave 5941.2 kg/ha of maize while 3782 kg/ha for furrow. Therefore, drip irrigation system is recommended as more effective irrigation system.

Wang *et al*., (2012) studied that significant irrigation effect was observed on grain yield, kernel numbers and straw yield. The highest levels were achieved with a high irrigation supply, although WUE generally decreased linearly with increasing seasonal irrigation rates in 2 years. The low irrigation treatment (0.6 ET) produced significantly lower grain yield (20.7 %), kernels number (9.3 %) and straw yield (12.2 %) than high irrigation treatment (1.0 ET). The low irrigation treatment had a higher WUE (4.25 kg ha-1 mm-1) than that of 3.25 kg ha-1 mm-1 with high irrigation over the 2 years. On contrary to the irrigation, the N application rate of 221 kg ha-1 had the highest values of grain yield, kernel numbers, straw yield and WUE under the 3 irrigation regimes. The average grain yield of 221 kg N ha-1 were found to be 99.1, 45.1, 20.0 and 7.4 % higher than those of 0, 79, 140 and 300 kg N ha-1, respectively over the 2 years.

CHAPTER III
MATERIALS AND METHODS

A field experiment was accomplished at the Agronomy Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207,Bangladesh during the period from November, 2017 to April, 2018 to observe the effect of alternate furrow irrigation on white maize varieties. This chapter contains a brief description of location of the experimental site, climatic condition and soil, materials used for the experiment, treatment and design of the experiment, production methodology, intercultural operations, data collection procedure and statistical analysis etc., which are presented as following headings:

3.1 Experimental sites

The experiment was conducted at the Agronomy Farm, Sher-e-Bangla Agricultural University Field, Dhaka, during the period from November, 2017 to April, 2018 to study the alternate furrow irrigation effect on white maize varieties. The location of the site is $23^{0}74'$ N latitude and $90^{0}35'$ E longitudes with an elevation of 8.2 meter from sea level in Agro-Ecological Zone of Madhupur Tract (AEZ No. 28).

3.2 Climatic conditions

The experiment site was located in the sub-tropical monsoon climatic zone, characterized by heavy rainfall during the months from April to September (Kharif season) and scanty of rainfall during the rest of the year (Rabi season). In addition, under the sub-tropical climatic, which is individualized by high temperature, high humidity and heavy precipitation with seasonal unexpected winds and relatively long in Kharif season (April- September) and sufficient sunlight with moderately low temperature, intensity of humidity and short-day period of during Rabi season (October-March). The information of weather regarding the atmospheric temperature, relative humidity, rainfall, sunshine hours and soil temperature persuaded at the experimental site during the whole period of observation (Appendix I).

3.3 Characteristics of soil

The experimental soil belongs to the Modhupur Tract under AEZ No. 28 (UNDP-FAO, 1988). The land which selected was medium and the soil series was Tejgaon. The soil characteristics of experimental plot were analyzed in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and the experiment field primarily had a P^H of 6.5.

3.4 Experimental materials

3.4.1 Planting materials

Four varieties of white maize *viz*. PSC - 121, Yungnuo -3000, BHM-12 and BHM-13 were used in this experiment. The genetically pure and virus free seeds were collected from KGF (Krishi Gobeshona Foundation).

3.4.2 Irrigation application

Irrigation was provided in two different systems. In the conventional irrigation system, all the furrows were irrigated. While in the alternate furrow irrigation, only the alternate furrows were irrigated keeping one furrow unirrigated between two furrows. Irrigation was made using hose pipe in the individual plot.

3.5 Treatments of the experiment

The experiment was conducted to study the effect of alternate furrow irrigation on growth and yield attributes of different maize varieties. There were two factors in this experiment. They were as follows:

Factor A: Irrigation application

There were two irrigation treatments as follows;

I – Conventional irrigation irrigating in all the furrows

IA – Alternate furrow irrigation

Factor B: Maize varieties

In the experiment, four different varieties were used. These were;

V_1: PSC – 121 (Proline Seed Co. of India)

V_2: Yungnuo-3000

V_3: BHM-12

V_4: BHM-13

(BHM=Bangladesh hybrid maize released by Bangladesh Agricultural Research Institute). As such there were eight treatment combinations as follows: V_1I, V_1IA, V_2I, V_2IA, V_3I, V_3IA, V_4I, V_4IA

3.6 Design and layout of the experiment

The trial was carried out in Randomized Complete Blacked Design (RCBD) placing irrigation in the main plot while the varieties in the sub plot. Each treatment was replicated three times and as such 24 plots comprised the experiment (Fig. 1).

3.6.1 Spacing and plot size

The size of each plot was 1.8 m × 1.0 m. The distance between blocks and plots were 0.5 m and 1 m respectively. Row to row distance was maintained 75 cm and plant to plant distance was 25 cm.

3.7 Production methodology

3.7.1 Land preparation

The experiment field was first disc-ploughed and harrowed. Final land preparation was made by a tiller followed by leveling with scrapper. Clods were broken and weeds were removed from the field to obtain desirable tilth. The basal doses of manures and fertilizers were added and mixed into the soil during final land preparation. Then the experimental area was layout as per design. Irrigation channels were made around each plot.

3.7.2 Application of manures and fertilizers

Fertilizers were applied following the recommendation of BARI (2011), which has been presented in the following Table. All the fertilizers and one third of urea were applied at the final land preparation. The rest of Urea was applied as top dressing in two equal installments at 15 and 30 days after sowing.

Table 1. Manures and fertilizer with BARI recommended dose along with plot wise application dose

SL No.	Manures/ fertilizers	Recommended dose/ha.	Recommended dose/research area
1	Cow dung	10 t	43.2 kg
2	Urea	200 kg	864 g
3	TSP	150 kg	648 g
4	MoP	100 kg	432 g
5	Gypsum	100kg	432 g
6	Boron	10kg	43.2 g
7	Zinc	15kg	64.8 g

3.7.3 Seed sowing

Seeds were air-dried before sowing since water soaked to facilitate germination. Subsequently, the collected variety seeds for the experiment were sown on the field. Seeds were sown in well-prepared plot at maintaining row to row distance of 60 cm and plant to plant distance within the rows 25 cm.

3.8 Intercultural operations

While experimenting, following intercultural operations were done:

3.8.1 Weeding

Weeding was necessary to keep the plant free from weeds. The newly emerged weeds were uprooted carefully from the field after complete emergence of sprouts and afterwards when necessary.

3.8.2 Top dressing

Top dressing of the urea was done on both sides of plant rows and mixed with the soil by spade.

3.8.3 Pest control

In general, the crop was not badly affected by insects and disease. However, in case of minor attack approved insecticides were sprayed.

3.8.4 Harvesting

The crop was harvested depending upon the maturity of each variety. Maturity was determined examining the black layer at the base of grains at the attachment point with the shell.

3.9 Data collection

Data were collected in respect of following parameters:

1. **Growth parameters**
    a) Plant height (cm)
    b) Number of leaves
    c) Base circumference (cm)
    d) Distance between base to cob position (cm)
    e) Number of cob bearing node

2. **Yield attributes**
    a) Number of grains per cob
    b) Cob length (cm)
    c) Cob breadth (cm)
    d) Grain weight per cob (g)
    e) Yield per hectare (t)
    f) Hundred seed weight (g)
    g) Dry weight of plant (g)
    h) Chaff weight per cob (g)
    i) Shell weight per cob (g)
    j) Harvest index (%)

3.10 Data collection procedure

Three plants were randomly selected from each unit of plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. However, the yield of all plants was considered per plot yield. Data have been collected on the basis of growth related parameters, yield attributes.

3.10.1 Plant height

Plant height of each sample plant was measured in centimeter from the ground level to the tip of the longest leaf and mean value was calculated and expressed in cm.

3.10.2 Number of leaves per plant

The number of leaves per plant was counted from the selected plants and their average mean was taken as the number of leaves per plant. It was recorded during different days at 40 DAS, 80 DAS and harvest time.

3.10.3 Base circumference

Base circumference of each sample plant was measured in centimeter at the base of the maize plant stem and mean value was calculated.

3.10.4 Base to cob position distance

Base to cob position was measured with meter scale from base to cob bearing node and then mean value was calculated and expressed in cm.

3.10.5 Cob bearing node number from the base

The number of cob bearing node per plant was counted from the selected plants and their average mean was taken as the number of cob bearing node per plant.

3.10.6 Number of grains per cob

Three cobs were selected from each plot and the grains were counted and averaged.

3.10.7 Cob length

The length of cob was measured with a slide calipers and their average was calculated in centimeter (cm).

3.10.8 Cob breadth

Cob breadth was measured using Digital slide calipers and mean was calculated then expressed in cm.

3.10.9 Grain weight per cob

Grain weight was measured by Electronic Precision in gram. Total grain weight of three randomly selected cobs from each plot was obtained, grains threshed and weighted in an electronic balance and averaged.

3.10.10 Yield ha^{-1}

The yield obtained from one square meter area at the center of each plot was harvested, cobs threshed, weighed and then converted into per hectare and expressed in tons (t) at 14% grain moisture.

3.10.11 One Hundred seed weight

For the 100 seed weight, 100 seeds were counted from the harvested sample which were then sundried and weighed by Electronic precision balance and the expressed in gram, g.

3.10.12 Dry weight per plant

Plants were kept for drying as a natural condition and after sun drying; Sundry weight of plants was measured from each treatment and then weighted which expressed as g.

3.10.13 Chaff weight per cob

Chaff was collected after harvesting and weighted in gram which was expressed as g.

3.10.14 Shell weight per five cobs

Shell of the cob was separated after harvesting and weighed in gram which was expressed as g.

3.10.15 Harvest index

Harvest index (HI) is the ratio of harvested grain to total shoot dry matter, and this can be used as a measure of reproductive efficiency. The harvested material for biomass yield was threshed. The grains were separated and weighed, and then converted into grain yield (kg/hm^2), was calculated according to the following formula:

Harvest index (%) = Grain yield / Biological yield × 100

3.11 Statistical Analysis

The data recorded for different parameters were statistically analyzed using MSTAT-C computer package programme to find out the significance of variation among the treatments and treatment means were compared by least significant test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

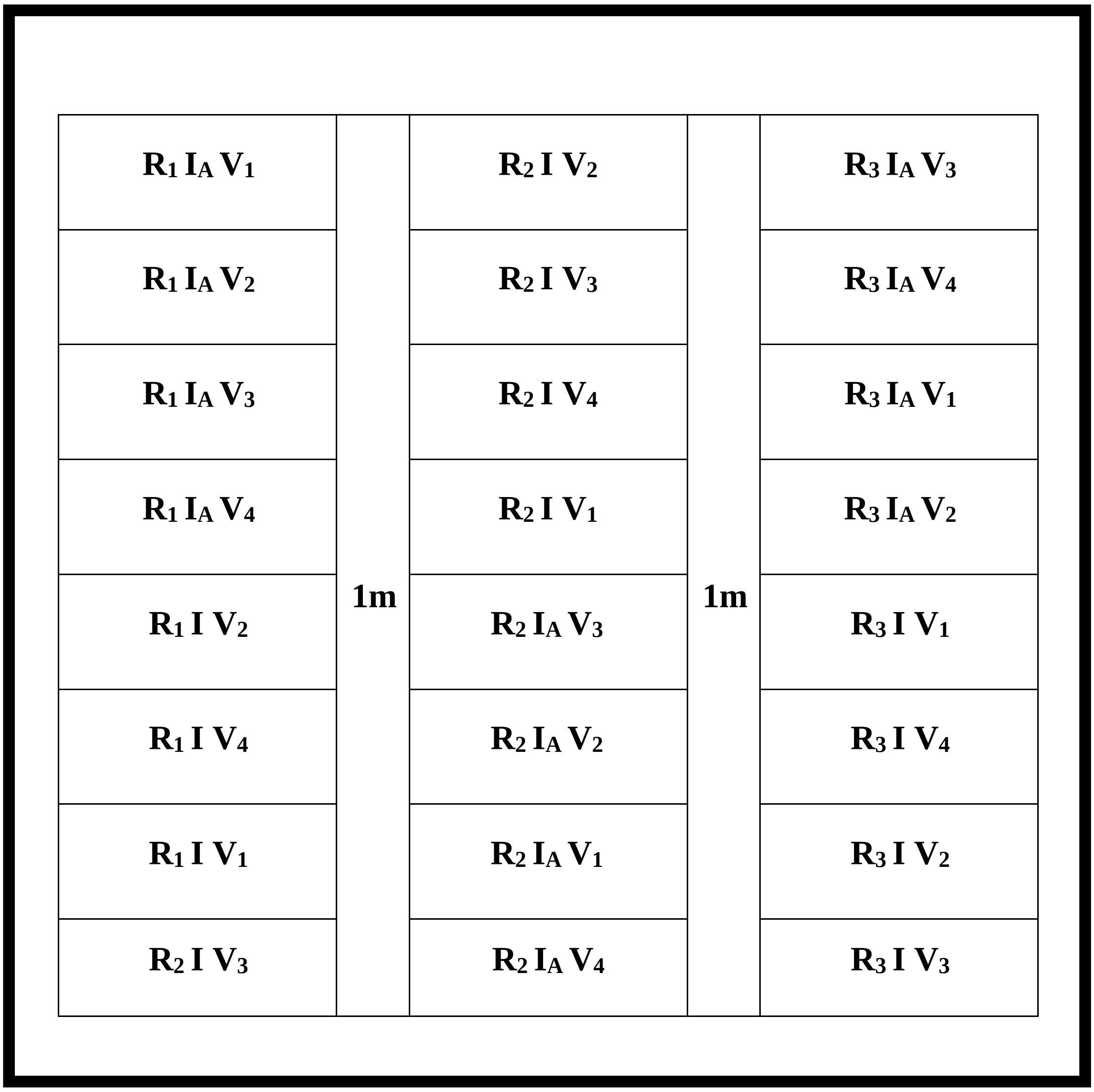
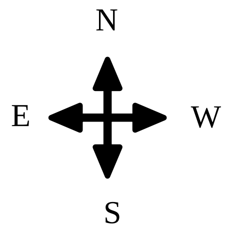


Figure 1. Layout of the experiment



Plot size – 1.8 m × 1.0 m
Plot No. – 24

Plate 1: Pictorial presentation a. Application of irrigation; b. Leaf number count; c. cob bearing node number count; d. base circumference; e. plant height measurement f. Measurement of cob breadth and length

CHAPTER IV
RESULTS AND DISCUSSION

The research work was conducted for the evaluation of the performance of white maize varieties and their performance with irrigation. The research work on "Effect of alternate furrow irrigation on white maize varieties" was undertaken in the Department of Agronomy, Sher-e-Bangla Agricultural University,Dhaka. The experimental results on growth, yield and quality parameters obtained during the entire period of study are presented as follows:

4.1. Growth related parameters

4.1.1 Plant height (cm)

Plant height (cm) is obviously important growth parameters in maize, which is growing conditions significantly influenced this trait. Significant variation was found among the performances of varieties in terms of plant height (Appendix II). Highly significant differences exist among different of varieties with regard to plant height (cm) at 40 DAS, 80 DAS and harvest time. Significant increase in plant height (cm) was observed from 40 DAS-harvest times in all the varieties. The mean plant height ranged from 201.3 cm to 247.0 cm, the maximum plant height at harvest time. The tallest plant was found from V_4 (234.7 cm) which was statistically similar with V_1 (233.2 cm) where was the shortest from V_3 (210.6cm) which was statistically similar with V_2 (214.6 cm) (Figure 2). Shariot-Ullah *et al*. (2013) found that maize plant height varied due to the varietal differences. Khan *et al*. (2000) also found the similar result in maize varieties.

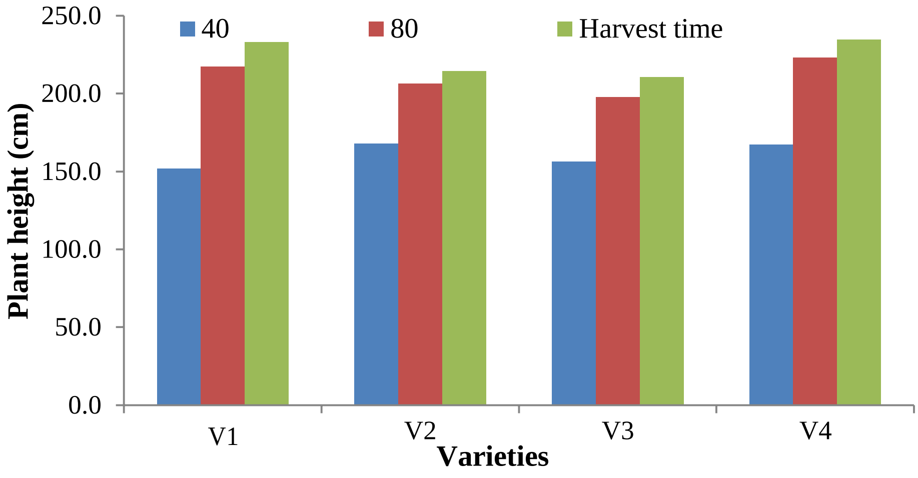


Figure 2. Effect of different white maize varieties on plant height (cm) at different days after sowing (Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13)

Plant height was significantly affected by different irrigation system (Appendix II). Plant height of white maize varieties exposed statistically significant inequality between alternate furrow and conventional irrigation applications at 40DAS, 80DAS and harvest time. The tallest plant (232.0 cm) was recorded at conventional irrigation (I) and the shortest plant (214.5 cm) was found from alternate furrow irrigation (IA) at harvest time (Figure 3). Kirda (2000) found the similar results. Quaye *et al*. (2009) also obtained increased plant height with increased application of water.

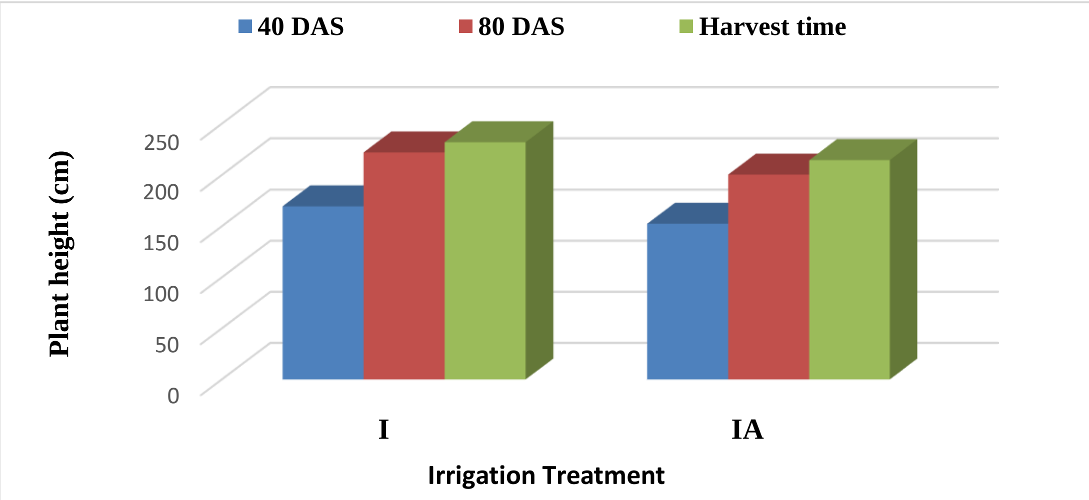


Figure 3. Effect of irrigation on plant height (cm) at different days after sowing (Here, I: Conventional irrigation; IA: Alternate furrow irrigation)

In case of interaction effect of wheat maize varieties and irrigation system to plant height also exposed significant variation (Appendix II). The tallest plant (247.0 cm) was found in Conventional irrigation and BHM-13 (V_4I) as well as the shortest plant (201.3 cm) was found in BHM-12 in alternate furrow irrigation (V_3IA) at harvest time (Table 2).

Table 2. Interaction effect of varieties and irrigation on plant height of white maize at different days **

Treatment*	40 DAS	80 DAS	Harvest time
V_1I	157.0 bc	233.2 ab	241.3 ab
V_1IA	146.9 c	201.4 c	225.0 bc
V_2I	174.5 ab	212.4 bc	219.9 cd
V_2IA	161.2 abc	200.3 c	209.3 cd
V_3I	168.6 ab	203.4 c	220.0 cd
V_3IA	144.3 c	192.3 c	201.3 d
V_4I	177.3 a	239.1 a	247.0 a
V_4IA	157.3 bc	207.3 c	222.4 bc
CV%	7.01	6.49	5.04
LSD	19.06	23.15	19.01

*Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13 and I: Conventional irrigation; IA: Alternate furrow irrigation

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

4.1.2 Number of leaves per plant

Leaves are the important organ, which helps to physiological processes, photosynthesis and transpirations. Thus it influenced the growth of a plant very much and enhances the yield of a plant. The number of leaves of white maize significantly varied among the varieties (Appendix III). Highly significant differences exist among different of varieties with regard to number of leaves at 40 DAS, 80DAS and harvest time. The maximum number of leaves per plant (18.0) was found from V_4 (BHM-13) and minimum (14.2) from V_2 (Yungnuo-3000) at harvest time and statistically similar with V_3 (BHM-12) (Figure 4). Ullah *et al*. (2017) reported the maximum number of leaf per plant from the hybrid white maize variety Suvra, more closely related to variety V1 (PSC- 121).

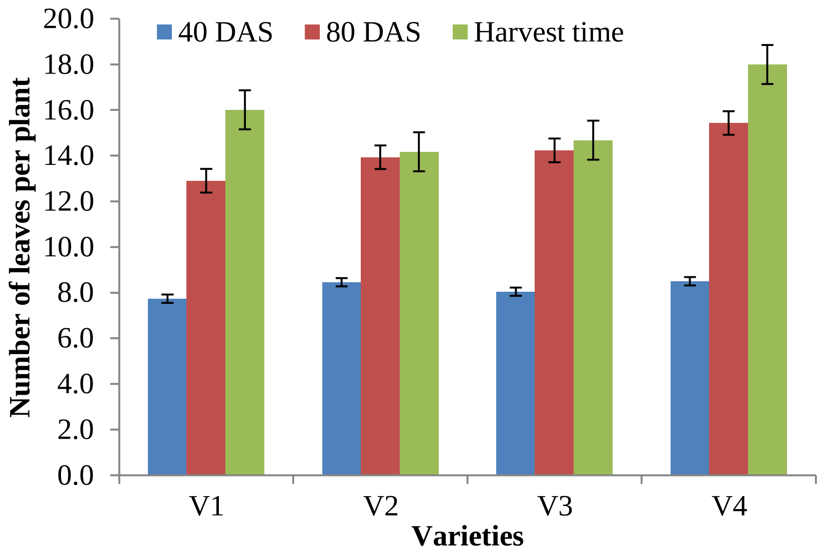


Figure 4. Performance of different white maize varieties in respect of number of leaves at different days after sowing (Here,V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4:BHM-13)

In case of irrigation treatment, variation in number of leaves per plant was observed (Appendix III). The maximum number of leaves per plant (16.0) was found from Conventional (I) and minimum (15.42) from alternate furrow irrigation (IA) with harvest time (Figure 5). Usoh *et al*. (2017) reported that sufficient supply of irrigation to the plant increase leaf number of plant for plant crop physiology. Mansouri-Far *et al*. (2010) also observed the same results in maize.

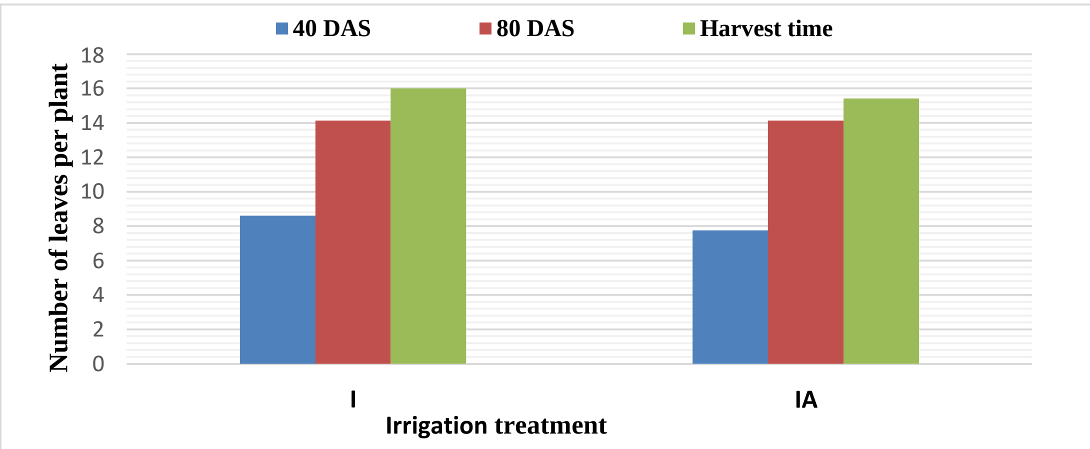


Figure 5. Effect of irrigation on number of leaves plant^{-1} at different days after sowing (Here, I: Conventional irrigation; IA: Alternate furrow irrigation)

In case of interaction effect of white maize varieties and irrigation system to number of leaves also exposed significant variation (Appendix III).)The maximum number of leaves (18.7) was found in Conventional irrigation and BHM-13 maize variety (V_4I) as well as the minimum (13.7) was found in Yungnuo-3000 in Conventional irrigation (V_2I) which was statistically similar with V_2IA and V_3IA at harvest time (Table 3).

Table 3. Interaction effect of varieties and different irrigation methods on leaf number of white maize at different days **

Treatment*	40 DAS	80 DAS	Harvest time
V_1I	8.4 ab	12.7 e	16.7 bc
V_1IA	7.0 c	13.1 de	15.3 cd
V_2I	8.6 ab	13.7 cd	13.7 d
V_2IA	8.3 ab	14.1 bc	14.7 d
V_3I	8.1 b	14.5 b	15.0 cd
V_3IA	8.0 bc	13.9 bc	14.3 d
V_4I	9.3 a	15.5 a	18.7 a
V_4IA	7.7 bc	15.3 a	17.3 ab
CV%	7.7	3.3	6.4
LSD	1.1	0.8	1.7

*Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13 and I: Conventional irrigation; IA: Alternate furrow irrigation

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

4.1.3 Base circumference (mm)

The difference in varieties for base circumference (mm) was found significant (Appendix IV). Where, maximum base circumference was recorded (15.4 cm) in V_4 (BHM-13), and the lowest circumference was 12.9 cm in V_1 (PSC-121) (Figure 6). Sabiel *et al*. (2014) who reported that plant base circumference increased due to the genetic variation of maize varieties at different growth stages.

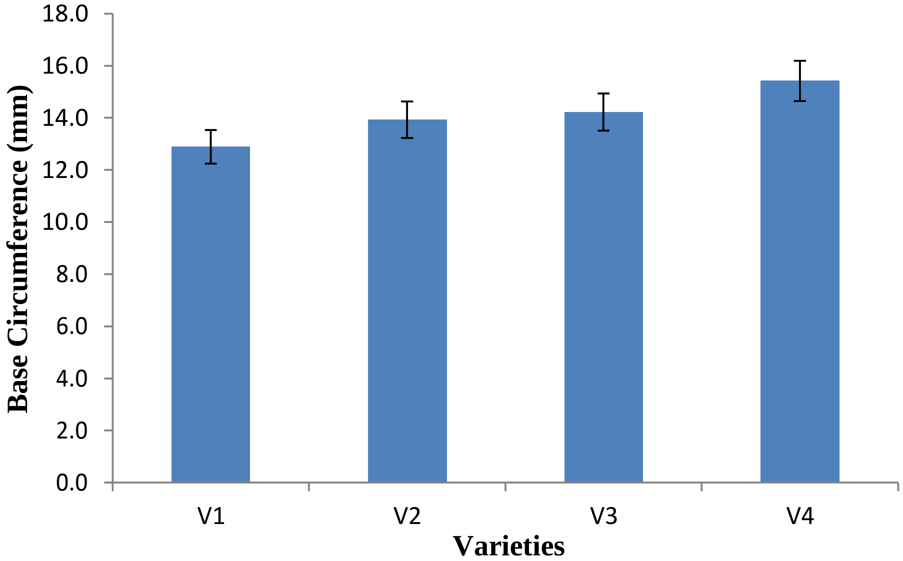


Figure 6. Performance of different white maize varieties on base circumference (Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4:BHM-13)

In case of irrigation treatment, significant variation in base circumference was observed (Appendix IV). The minimum base circumference was recorded (14.12 mm) in Conventional irrigation (I), and the maximum was (14.13 mm) in alternate furrow irrigation (IA) (Table 4). Kang *et al.* (1998) reported that stem circumference showed no significant changes in all the treatments.

Table 4. Effect of conventional and alternate furrow on base circumference, base to cob position, cob bearing node number and grain number per cob of white maize

Treatment*	Stem base circumference (mm)	Base to cob position (cm)	Cob bearing node number/plant	Grain no./cob
I	14.12 a	104.6 a	8.03 a	359.5 a
IA	14.13 a	95.23 b	7.85 b	313.8 b
CV%	3.31	12.24	7.18	9.09
LSD	0.01	6.67	0.48	25.84

*Here, I: Conventional irrigation; IA: Alternate furrow irrigation

In case of interaction effect of white maize varieties and irrigation system to base circumference of plants exposed significant variation (Appendix IV).The maximum (15.53 mm) was found in Conventional irrigation and BHM-13 maize variety (V_4I) as well as the minimum (12.67 mm) was found in PSC-121in Conventional irrigation (V_1I)(Table 5).

Table 5. Interaction effect of varieties and furrow irrigation on base circumference, base to cob position, cob bearing node number and grain number per cob of white maize**

Treatment*	Base circumference (mm)	Base to cob position (cm)	Cob bearing node number	Grain no./cob
V_1I	12.67 f	94.2 cd	7.2 cd	399.4 a
V_1IA	13.13 ef	88.1 e	6.8 d	309.3 cd
V_2I	13.73 de	103.1 b	7.4 cd	388.1 ab
V_2IA	14.13 cd	98.7 cd	7.7 b-d	361.7 ab
V_3I	14.53 bc	106.7 b	8.4 ab	309.7 cd
V_3IA	13.93 cd	93.7 d	7.9 bc	274.4 d
V_4I	15.53 a	114.2 a	9.1 a	341.0 bc
V_4IA	15.30 ab	100.4 c	9.0 a	309.7 cd
CV%	3.31	12.24	7.18	9.09
LSD	0.79	3.33	0.96	51.67

*Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13 and I: Conventional irrigation; IA: Alternate furrow irrigation

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

4.1.4 Base to cob position distance

The Position of a cob is another important parameter to predict crop yield. Significant variation was observed in white maize varieties (Appendix IV). The longest position (107.3 cm) was found in BHM-13 (V_4) while shortest position was (91.1 cm) found in PSC-121 (V_1) (Figure 7). Similar result was found by Abdulraheem *et al.* (2018), who reported that distance between base and cob position directly influenced yield which largely varied with genetic variation of different maize varieties.

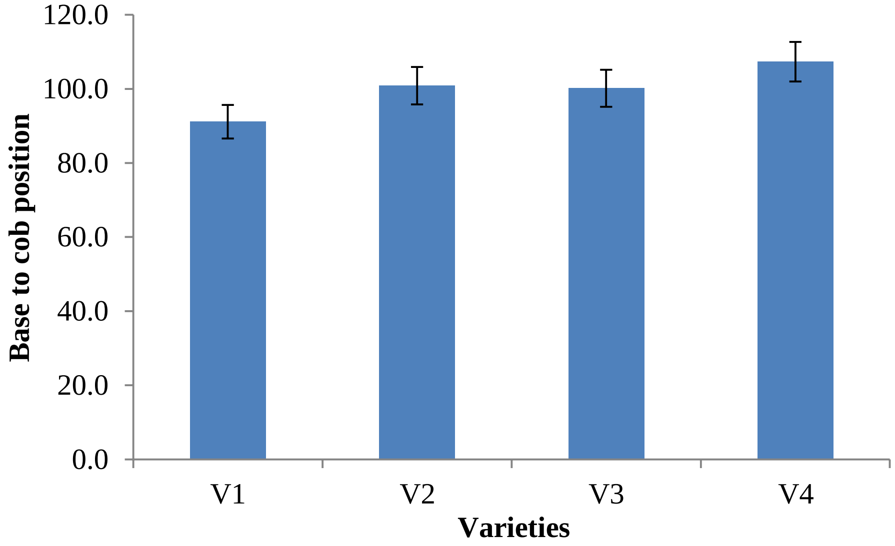


Figure 7. Effect of different white maize varieties on base to cob position distance (Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4:BHM-13)

In case of irrigation treatment, significant variation was observed in base to position of cob (Appendix IV). The maximum base position distance (104.6 cm) was recorded in Conventional irrigation (I), and the minimum was (95.23 cm) in alternate furrow irrigation (IA) (Table 4).

In case of interaction effect of white maize varieties and irrigation system to the position of from the base of plants exposed significant variation (Appendix IV).The maximum (114.2 cm) was found in Conventional irrigation and BHM-13 maize variety (V_4I) as well as the minimum (88.1 cm) was found in PSC-121 in alternate furrow irrigation (V_1IA) (Table 5).

4.1.5 Cob bearing node number from the base

Cob bearing node number is important to figure out the yield and significant variation was found among the maize varieties (Appendix V). It was revealed from the experiment that variety BHM-13 (V_4) have the supreme potentiality to produce maximum number of cob bearing node (9.1) while minimum number of cob bearing node (7.0) recorded from PSC-121 (V_1) (Figure 8). Similar result was found by Akbar *et al.* (2016).

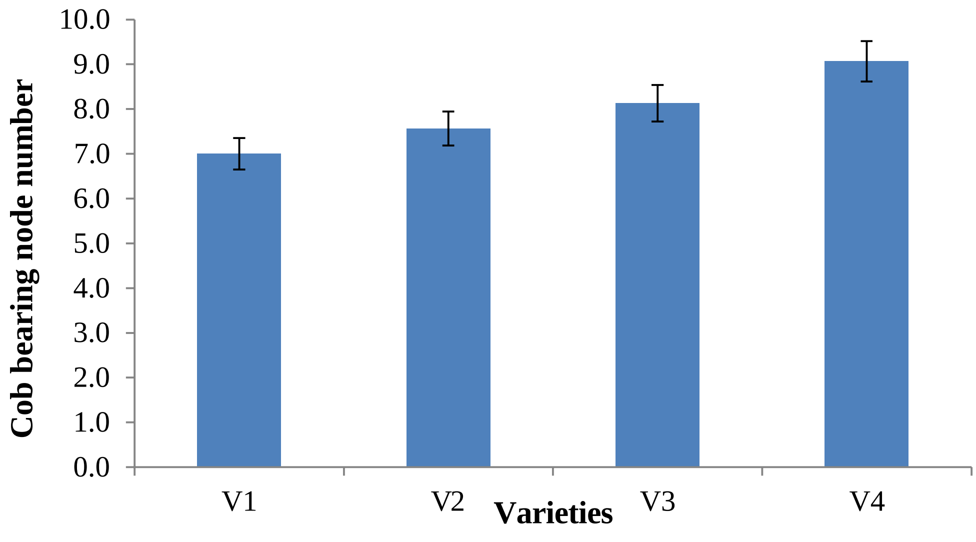


Figure 8. Performance of different white maize varieties in number of cob bearing node (Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13)

In case of different irrigation treatment significant variation was observed in the number of cob bearing node (Appendix V). The maximum cob bearing node (8.03) was recorded in Conventional irrigation (I), and the minimum was (7.85) in alternate furrow irrigation (IA) (Table 4). Asif *et al.* (2009) reported that cob bearing node number increase with the sufficient water supply.

In case of interaction effect of white maize varieties and irrigation system, significant variation exposed on the number of cob bearing node (Appendix V).The maximum (9.1) was found in Conventional irrigation and BHM-13 maize variety (V_4I) which was statistically similar with alternate furrow irrigation and BHM-13 maize variety (V_4IA) while the minimum (6.8) was found in combination of PSC-121 variety and alternate furrow irrigation (V_1IA) (Table 5).

4.2 Yield attributing parameters

4.2.1 Number of grains per cob

Number of grain per cob is the most prominent parameter for attributing yield. Significant difference was revealed on number of grain per cob with different maize varieties (Appendix V). Maximum number of grain (374.9) per cob was found in Yungnuo-3000 variety (V_2) while minimum number (292.0) recorded in BHM-12 maize variety (V_3) (Figure 9). Similar results were reported by Tahir *et al.* (2008**).**

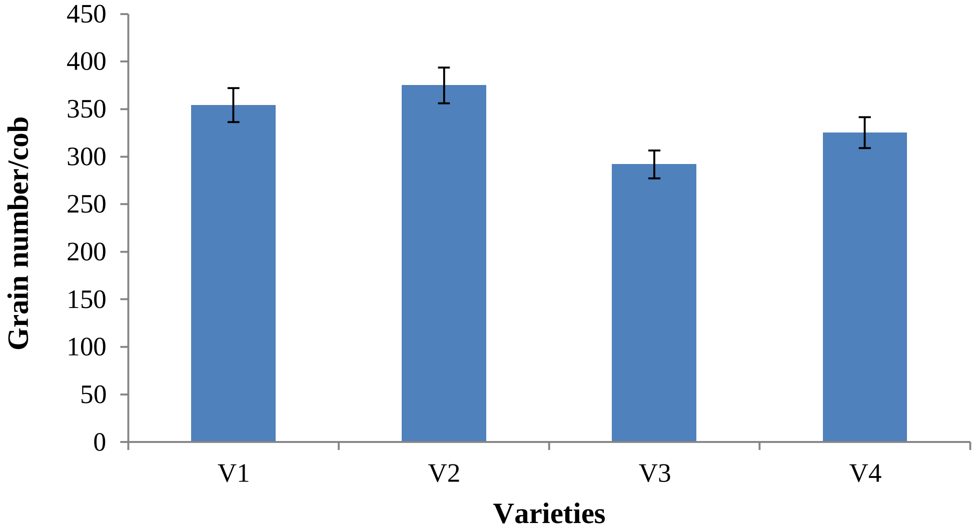


Figure 9. Performance of different white maize varieties in number of grain per cob (Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13)

Conventional irrigation and alternate furrow irrigation had significant effect on number of grains per cob (Appendix V). Maximum number of grain (359.5) per cob was found in Conventional irrigation (I), and the minimum was (313.8) in alternate furrow irrigation (IA) (Table 4). Bandyopadhyay *et al.* (2010) recorded that wheat grain number increased with increasing water use efficiency through irrigation technology.

In case of interaction effect of white maize varieties and irrigation treatment, significant variation found on the number of grain per cob (Appendix V).The maximum (399.4) was found in interaction of Conventional irrigation and PSC-121 variety (V_1I) while the minimum (274.4) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) (Table 5).

4.2.2 Cob length

A cob size is important for increasing yield of maize and also quality maize production greatly depend on cob length. Performance of different maize varieties significantly varied on cob length of maize (Appendix VI).The highest cob length (16.1 cm) was observed in Yungnuo-3000 (V_1) and the lowest cob length (13.2 cm) in BHM-12(V_3) (Table 6). Similar result was reported by Sabir *et al.* (2000).

Table 6. Performance of different white maize varieties on Cob length, cob breadth, grain wt. per cob, yield/ha and hundred seed wt. **

Treatment*	Cob length (cm)	Cob breadth (cm)	Grain wt./cob (g)	Yield/ha. (t)	100 seed wt. (g)
V_1	15.8 ab	15.9 a	106.8 a	8.9 a	31.7 b
V_2	16.1 a	14.4 ab	93.7 b	7.7 b	29.8 b
V_3	13.2 b	12.3 c	65.1 c	5.4 c	26.6 c
V_4	15.5 ab	13.9 bc	102.7 ab	8.5 ab	33.8 a
CV%	11.0	10.3	10.4	10.7	5.2
LSD	1.0	1.7	11.4	1.0	1.9

*Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13

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

In case of Conventional irrigation and alternate furrow irrigation, significant variation was observed in the length of cob (Appendix VI). The highest cob length (15.5 cm) was found in Conventional irrigation (I), and the lowest was (14.84 cm) in alternate furrow irrigation (IA) (Table 7).

Table 7. Effect of Conventional and alternate furrow on Cob length, cob breadth, grain wt. per cob, yield/ha and hundred seed wt. **

Treatment*	Cob length (cm)	Cob breadth (cm)	Grain wt./cob (g)	Yield/ha. (t)	100 seed wt. (g)
I	15.50 a	14.69 a	98.4 a	8.1 a	30.4 b
IA	14.84 b	13.52 b	85.7 b	7.1 b	30.5 a
CV%	11.04	10.30	10.4	10.7	5.2
LSD	1.32	1.23	8.1	0.7	0.07

*Here, I: Conventional irrigation; IA: Alternate furrow irrigation

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

In case of interaction effect of white maize varieties and irrigation treatment, significant variation was found on the cob length (Appendix VI). The highest cob length (17.3 cm) was found in interaction of Conventional irrigation and PSC-121 variety (V_1I) while the minimum (12.9 cm) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) (Table 8).

Table 8. Interaction effect of varieties and furrow irrigation on Cob length, cob breadth, grain wt. per cob, yield/ha and hundred seed weight **

Treatment	Cob length (cm)	Cob breadth (cm)	Grain wt./cob (g)	Yield/ha. (t)	100 seed wt. (g)
V_1I	17.3 a	16.9 a	121.2 a	10.05 a	32.7 ab
V_1IA	14.4 b-d	14.9 ab	92.3 cd	7.68 b	30.7 bc
V_2I	16.4 ab	15.0 ab	95.6 c	7.70 b	29.7 c
V_2IA	15.9 a-c	13.8 bc	91.7 cd	7.63 b	30.0 bc
V_3I	13.5 cd	12.8 bc	71.7 d	5.95 c	26.7 d
V_3IA	12.9 d	11.7 c	58.5 e	4.85 c	26.4 d
V_4I	14.8 a-d	14.1 bc	105.2 b	8.71 ab	32.7 ab
V_4IA	16.2 a-c	13.8 bc	100.3 bc	8.32 b	35.0 a
CV%	11.0	10.3	10.4	10.72	5.2
LSD	2.8	2.5	10.1	1.38	2.7

*Here, V_1: PSC-121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13 and I: Conventional irrigation; IA: Alternate furrow irrigation

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

4.2.3 Cob breadth

Significant variation was found for cob breadth (cm) in case of different irrigation treatment (Appendix VI). The maximum cob breadth (15.9 cm) was observed in Yungnuo-3000 (V_1) and the minimum cob breadth (12.3 cm) in BHM-12(V_3) (Table 6). Sabir *et al.* (2000) found the similar results between two maize varieties of cob breadth.

In case of conventional irrigation and alternate furrow irrigation, significant variation was observed in the length of cob (Appendix VI). The maximum cob breadth (14.69 cm) was found in Conventional irrigation (I), and the minimum was (13.52 cm) in alternate furrow irrigation (IA) (Table 7).

In case of interaction effect of white maize varieties and irrigation treatment, significant variation was found on the cob length (Appendix VI). The maximum cob breadth (16.9 cm) was found in interaction of conventional irrigation and PSC-121 variety (V_1I) while the minimum (11.7 cm) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) (Table 8).

4.2.4 Grain weight per cob

Grain weight per cob showed significant variation among the white maize varieties (Appendix VI). Maximum grain weight (106.8 g) was found in Yungnuo-3000 (V_1) while minimum grain weight (65.1 g) was observed in BHM-12 (V_3) (Table 6). These results are in line with those of McCutcheon *et al.* (2001), who reported significant differences among maize cultivars for grain yield.

In case of Conventional irrigation and alternate furrow irrigation, significant variation was observed in the grain weight per cob (Appendix VI). The maximum grain weight per cob (98.4 g) was found in Conventional irrigation (I), and the minimum was (85.7 g) in alternate furrow irrigation (IA) (Table 7). Wang *et al.* (2012) observed maximum grain weight in through application of irrigation.

In case of interaction effect of white maize varieties and irrigation treatment, grain weight per cob prominently influenced and varied significantly (Appendix VI). The maximum grain weight (121.2 g) was found in interaction of Conventional irrigation and PSC-121 variety (V_1I) while the minimum (58.5 g) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) (Table 8).

4.2.5 Yield per hectare

There were significant differences among the maize varieties respect to yield were highly variation (Appendix VI). The highest grain yield per hectare (8.9 t) was found from PSC-121 variety (V_1) whereas the lowest grain yield per hectare (5.4 t) was found from BHM-12 variety (V_3) (Table 6). Oluwaranti *et al.* (2008) recorded the maximum grain yield per hectare (4.6 t) among twenty maize varieties, which was dissimilar with this study.

Different irrigation application showed significant variation in respect to maize grain yield per hectare (t) (Appendix VI). Maximum grain yield per hectare (8.1 t) was obtained from Conventional irrigation (I) whereas minimum grain yield per hectare (7.1 t) was obtained in alternate furrow irrigation (IA) (Table 7). Hall *et al*. (1980) found the similar results.

In case of interaction effect of white maize varieties and irrigation treatment, grain weight per cob prominently influenced and varied significantly (Appendix VI). The maximum grain weight (121.2 g) was found in interaction of Conventional irrigation and PSC-121 variety (V_1I) while the minimum (58.5 g) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) (Table 8).

4.2.6 Hundred seed weight

There were significant variations among the maize varieties respect to hundred seed weight (Appendix VIII). Weight of hundred seed was found maximum (33.84 g) was from BHM-13 variety (V_4) whereas minimum weight (26.6 g) was found from BHM-12 variety (V3) (Table 6). The same results were also reported by Jing *et al.* (2003).

Different irrigation application showed significant variation in respect to maize hundred seed weight (g) (Appendix VIII). Maximum weight (30.5 g) was obtained from alternate furrow irrigation (IA) whereas minimum grain yield per hectare (7.1 g) was obtained in Conventional irrigation (I) (Table 7).

In case of interaction effect of white maize varieties and different furrow irrigation treatment, hundred seed weight prominently influenced and varied significantly (Appendix VIII). The maximum weight (35.0 g) was found in interaction of alternate furrow irrigation and BHM-13 variety (V_4IA) while the minimum (26.4 g) was found in interaction of BHM-12 variety and alternate furrow irrigation (V_3IA) which was statistically similar with interaction of BHM-12 variety and Conventional irrigation (V_3I) (Table 8).

4.2.7 Dry weight per plant

Effect of varieties

The varieties had significant effect on per plant dry weight (Appendix VII). V_1 had the highest dry matter (260.30 g), which was then followed by V_4. The variety V_2 had the least dry weight per plant (162.30 g) (Fig. 10).

Effect of irrigation

In case of irrigation treatment, significant variation was found in dry weight per plant (Appendix VII). The conventional irrigation had significantly higher dry weight (233.80 g), while the alternate furrow irrigation had dry matter of (192.5 g) (Fig. 10).

Interaction effect

Among the interaction treatments, significant variation was found (Appendix VII). V_1I had the highest dry weight (294.90 g) while V_2IA had the least (156.10 g). Others had intermediate dry weight per plant (Fig. 10).

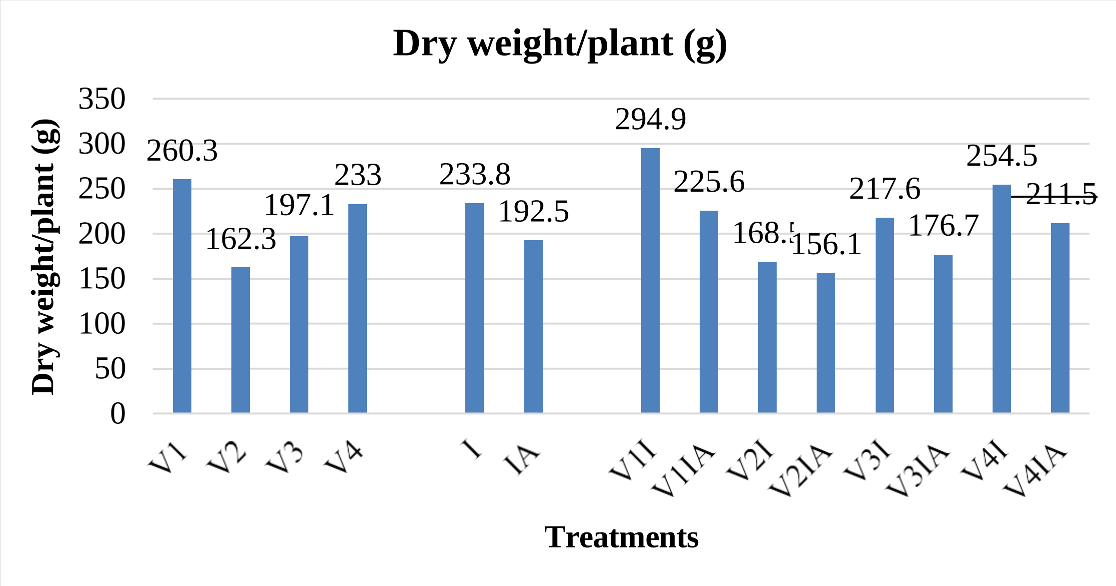


Fig. 10: Performance of variety and irrigation on the dry weight of white maize

4.2.8 Chaff weight per cobs

Chaff weight significantly varied with the performance of different maize varieties (Appendix VIII). Maximum chaff weight (11.6 g) was found from PSC-121 variety (V_1) on the other minimum chaff weight (7.3 g) observed in Yungnuo-3000 (V_2) (Fig. 11). Similar result was found in Kobir *et al.* (2019), who reported that chaff weight varies with different variety.

In case of Conventional irrigation and alternate furrow irrigation, significant variation was observed in the chaff weight per cob (Appendix VIII). Maximum weight (10.6 g) was obtained from all furrow irrigation (I) whereas the lowest chaff weight was found in (9.1 g) was obtained in alternate furrow irrigation (IA) (Fig. 11).

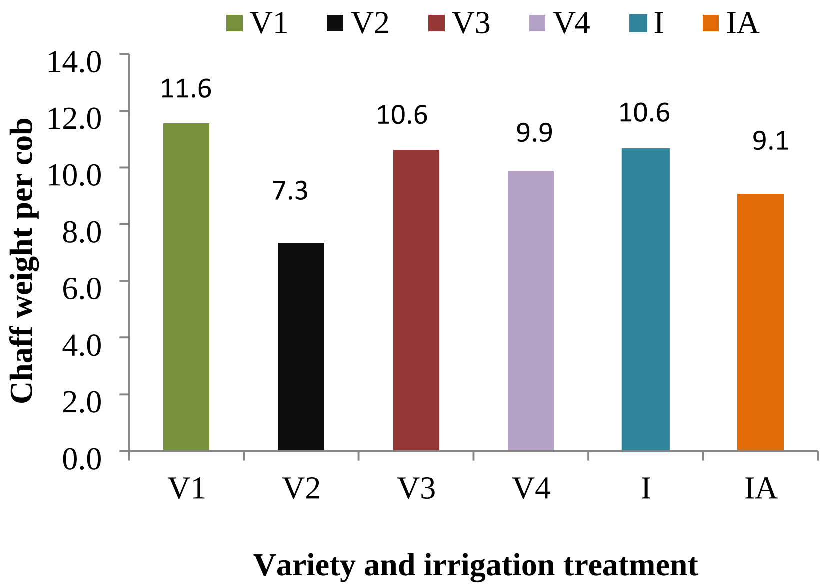


Fig. 11: Performance of variety and irrigational effect on the chaff weight per cob of white maize

In case of interaction effect of white maize varieties and different irrigation treatment showed significant variation. Chaff weight per cob of maize prominently influenced and varied significantly (Appendix VIII). The maximum weight (12.0 g) was found in interaction of all furrow irrigation and PSC-121 variety (V_1I) while the minimum (7.3 g) was found in interaction of Yungnuo-3000 variety and alternate furrow irrigation (V_2IA), which was statistically similar with in interaction of BHM-13 variety and alternate furrow irrigation (V_4IA) (Fig. 12).

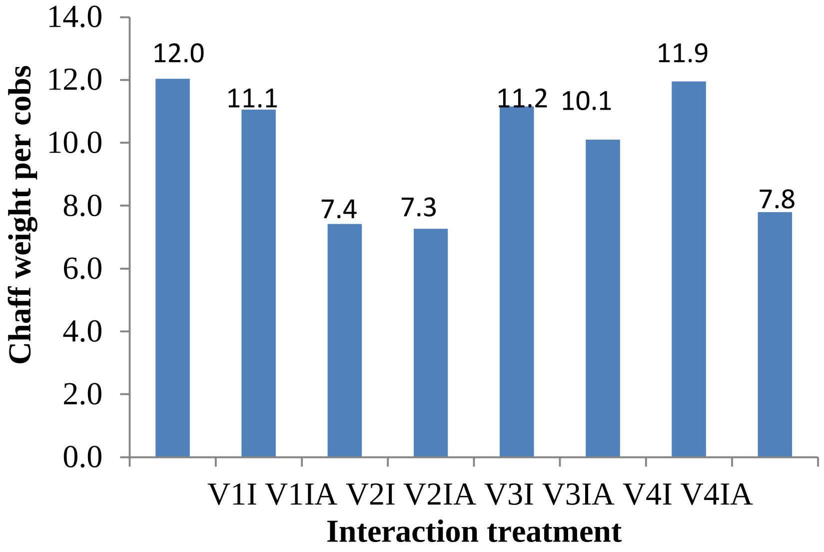


Fig. 12: Interaction of variety and irrigational effect on the chaff weight per cobs of white maize

4.2.9 Shell weight per cob

There were significant variations among the maize varieties respect to Shell weight of maize per five cobs (Appendix VIII) Shell weight was found maximum (25.3 g) was from PSC-121 variety (V_1) whereas minimum shell weight (13.9 g) was observed from Yungnuo-3000 (V_2) which was statistically similar with BHM-12 variety (V_3) (Fig. 13). Similar findings recorded by Ahmed *et al.* (2010)**.**

In case of Conventional irrigation and alternate furrow irrigation to shell weight per five cobs (Appendix VIII). Maximum weight (20.2 g) was obtained from all furrow irrigation (I) whereas the lowest shell weight was found in (17.1 g) was obtained in alternate furrow irrigation (IA) (Fig. 13). Pandey *et al.* (2000) studied the yield component with irrigation treatment.

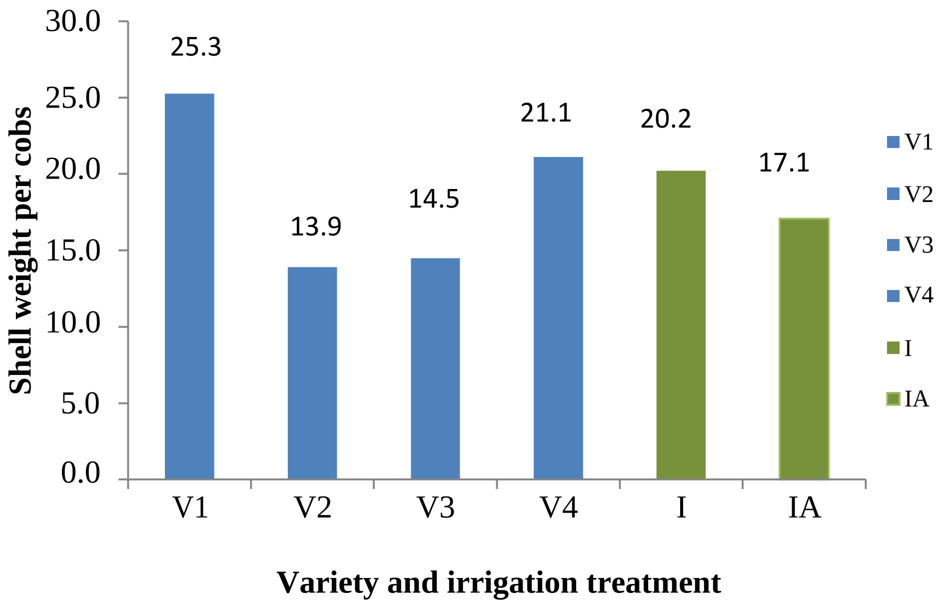


Fig. 13: Performance of variety and irrigational effect on the chaff weight per cobs of white maize

In case of interaction effect of white maize varieties and different furrow irrigation treatment showed significant variation. Shell weight of maize prominently influenced and varied significantly (Appendix VIII). The maximum weight (29.2 g) was found in interaction of all furrow irrigation and PSC-121 variety (V_1I) while the minimum (13.4 g) was found in interaction of Yungnuo-3000 variety and alternate furrow irrigation (V_2IA) (Fig. 14).

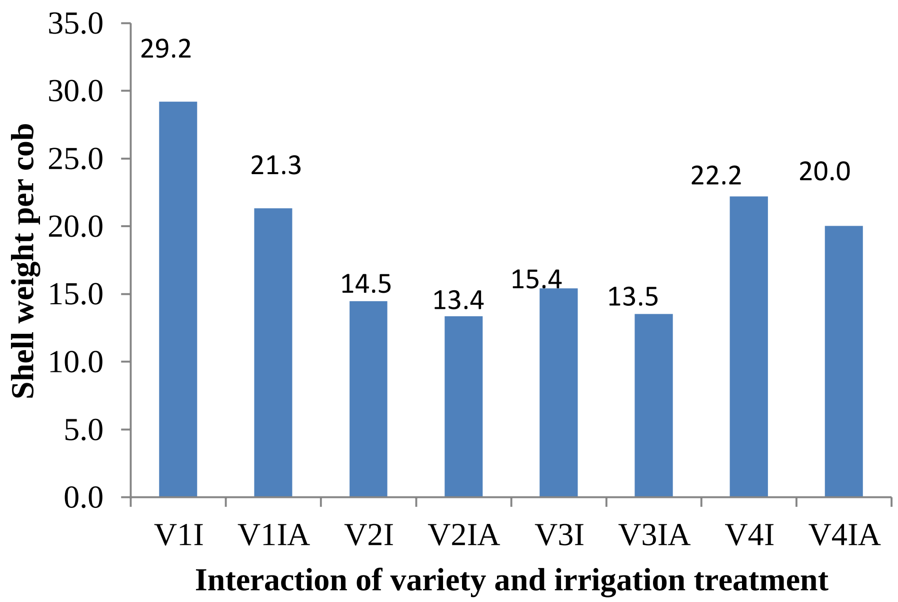


Fig. 14. Interaction of variety and irrigational effect on the chaff weight per cob of white maize

4.2.10 Harvest index

Effect of variety

Considering varieties, Significant variation was found on harvest index of maize (Appendix VII). The variety V_2 had the highest harvest index (57.75%) and the lowest was obtained with V_3 (33.02%) (Fig. 15).

Effect of irrigation

In case of irrigation, significant variation was found on harvest index of maize (Appendix VII). Conventional irrigation, IA had higher HI (45.06%) than I (43.03%) (Fig. 15).

Effect of interaction

The interaction treatment V_2IA had the highest harvest index (58.74%) which was not significantly higher than that of V_2I (56.73%), but was significantly higher than that of V_3I (32.95%) (Fig. 16).

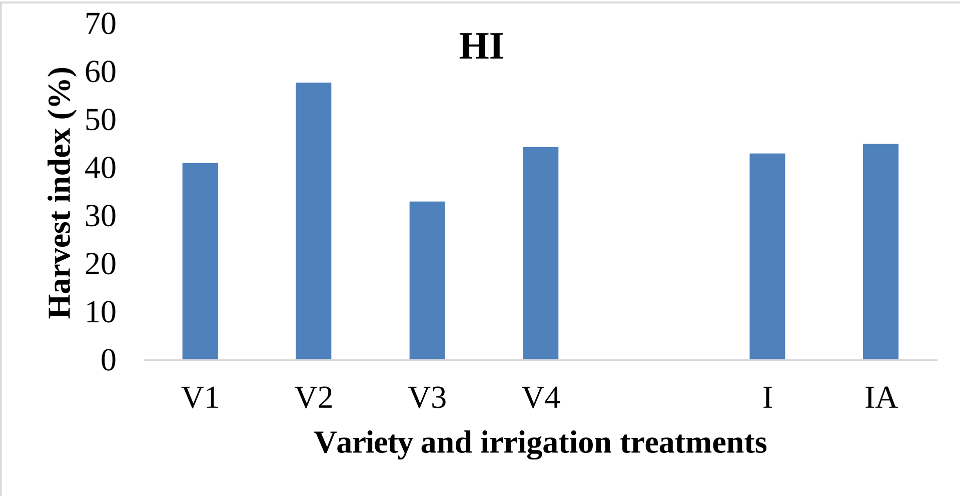


Fig. 15. Performance of variety and irrigational effect on the harvest index white maize

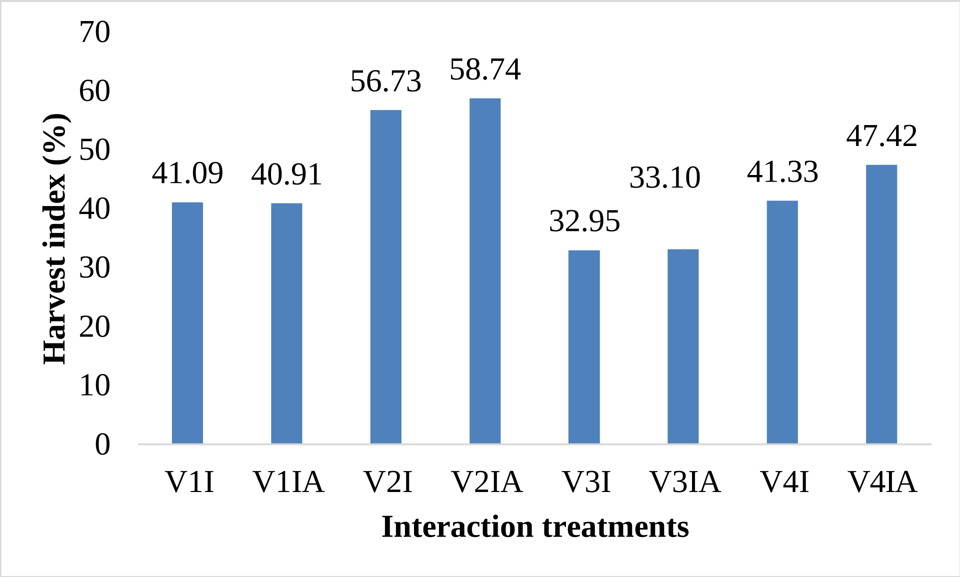


Fig. 16: Interaction effect of varieties and irrigation on the harvest index of white maize

CHAPTER V

SUMMARY AND CONCLUSION

5.1 Summary

Maize is the top most important cereal crop in terms of production of cereals of the world. It is a member of the Poaceae family formerly known as Gramineae. Maize has attracted the attention in the world due to its importance being used as fodder and human food. Maize has attracted the attention in the world due to its importance being used as fodder and human food. Maize cultivation is gaining popularity in Bangladesh and production is increasing day by day. On the other farmers deprive to get their profit because of having lack of suitable high yielding maize varieties. However, Maize plant growth and grain yield is related to irrigation system. In addition, farmers use huge amount of chemical fertilizers which leads to increase the cost as well as affect environment. Therefore, potential value of maize has to be promoted by evaluating the varieties to suitable irrigation specially furrow irrigation in our climatic condition.

In order to study the effect of alternate furrow irrigation on white maize varieties, a research was conducted to inspect the growth and yield responses of maize varieties to different furrow irrigation at the agronomy farm, Sher-e- Bangla Agricultural University, Dhaka during period from November, 2017 to April, 2018. Two factorial experiments included maize varieties viz. V_1: PSC- 121; V_2: Yungnuo-3000; V_3: BHM-12; V_4: BHM-13 and irrigation application viz. I: All furrow irrigation; IA: Alternate furrow irrigation was outlined in Randomized Complete Blocked Design (RCBD) with three replications.

Collected data were statistically analyzed for the evaluation of treatments for the detection of the best maize varieties and the best irrigation treatment. The findings and conclusion have been described in this segment.

Significant variations were observed in case of varieties as well as irrigation application of all parameters like as following –

The tallest plant was found from V_4 (234.7 cm) and from I (232.0 cm) whereas the shortest from V_3 (210.6 cm) and from IA (214.5 cm) at harvest time. In case of treatment combination, the tallest plant (247.0 cm) was found in V_4I as well as the shortest plant (201.3 cm) was found in V_4IA at harvest time.

The maximum number of leaves (18.0) was found from V_4 and minimum (14.2) from V_2 at harvest time. The maximum number of leaves (16.0) was found from I and minimum from IA (15.42) with harvesting time. In case of interaction effect, maximum number of leaves (18.7) was found from V_4I and minimum (13.7) from V_2I at harvest time.

Considering the varieties, the highest base diameter (15.42 cm) was found in V_4 and minimum (12.9) in V_1. In case of irrigation, the highest base diameter (14.13 cm) was found in IA and the lowest (14.12) in I. Combined effect of variety and irrigation treatment, the highest base diameter (15.53 cm) was found in V_4I and minimum (12.67 cm) in V_2I.

Considering the varieties, the longest position (107.3 cm) was found in (V_4) while shortest position was (91.1 cm) found in (V_1). In case of irrigation, the maximum base to cob position distance (104.6 cm) was recorded in (I), and the minimum was (95.23 cm) in IA. Combined effect of variety and irrigation treatment, the highest base to cob position distance (114.2 cm) was found in V_4I and minimum (88.1 cm) in V_1IA.

The maximum number of cob bearing node (9.07) was found from V_4 and minimum (7.0) from V_1. The maximum number cob bearing node (8.03) was found from I and minimum from IA (7.85). In case of interaction effect, maximum number cob bearing node (9.1) was found from V_4I and minimum (6.8) from V_1IA.

The maximum number of grain per cob (374.9) was found from V_2 and minimum (292.0) from V_3. The maximum number of grains per cob (359.5) was found from I and minimum from IA (313.8). In case of interaction effect, maximum number of grain per cob (399.4) was found from V_1IA and minimum (274.4) from V_3IA.

Considering the varieties, the longest cob (16.1 cm) was found in V_2 while the shortest cob (13.2 cm) in V_3. In case of irrigation application, maximum cob length (15.5 cm) was observed under I treatment and minimum (14.84 cm) in IA. In combined effect, maximum cob length (17.3 cm) was found in V_1I and minimum (12.9 cm) in V_3IA.

Considering the varieties, the highest cob breadth (15.9 cm) was found in V_1 while the shortest cob breadth (12.3 cm) in V_3. In case of irrigation application, maximum cob breadth (14.69 cm) was observed under I treatment and minimum (13.52 cm) in IA. In combined effect, maximum cob breadth (16.9 cm) was found in V_1I and minimum (11.7 cm) in V_3IA.

Maximum grain weight (106.8 g) was observed in V_1 and minimum (65.1 g) in V_3. Considering furrow irrigation application, maximum grain weight (98.4 g) was found in I and minimum (85.7 g) in I treatment. In case of combined effect, maximum grain weight (121.2 g) was found in V_1I and minimum (58.5 g) in V_3IA.

Considering the varieties, maximum yield per hectare (8.9 t) was found in V_1 while the minimum yield (5.4 t) in V_3. In case of furrow irrigation application, maximum yield (8.1 t) was observed under I and minimum (7.1 t) in IA. In combined effect, maximum yield (10.05 t) was found in V_1I and minimum (4.85 t) in V_3IA and (5.95 t) in V_3I.

The highest wt. of hundred seed (33.8 g) was found from V_4 and the lowest (26.6 g) from V_3. In case of furrow irrigation application, maximum weight (30.5 g) was obtained from IA whereas minimum (30.4 g) from I treatment. In case of combined effect, maximum weight (35.0 g) was obtained from V_4IA whereas minimum (26.4 g) from V_3IA and (26.7 g) from V_3I.

The highest dry wt. of plant (260.30 g) was found from V_1 and (85.8 g) from V_1 whereas the lowest (162.3 G) from V_2. In case of irrigation, maximum weight (233.80 g) was obtained from I whereas minimum (192.5 g) from IA treatment. In case of combined effect, maximum weight (294.90 g) was obtained from V_1I whereas minimum (156.10 g) from V_2IA.

The highest chaff wt. per cob (11.6 g) was found from V_1 whereas the minimum (7.3 g) from V_2. In case of irrigation application, maximum weight (10.6 g) was obtained from I whereas minimum (9.1 g) from IA treatment. In case of combined effect, maximum weight (12.4 g) was obtained from V_1I whereas minimum (7.3 g) from V_2IA.

Considering the varieties, the highest shell wt. of per cob (25.3 g) was found from V_1 whereas the lowest (13.9 g) from V_2 and (14.5 g) from V_3. In case of irrigation application, maximum weight (20.2 g) was obtained from I whereas minimum (17.1 g) from IA treatment. In case of combined effect, maximum weight (29.2 g) was obtained from V_1I whereas minimum (13.4 g) from V_2IA.

In case of variety, V_2 had the highest harvest index (57.75%) and the lowest was obtained with V_3 (33.02%). On the other, IA had higher HI (45.06%) than I (43.03%). Considering the interaction, V_2IA had the highest harvest index

(58.74%) which was not significantly higher than that of V_2I (56.73%), but was significantly higher than that of V_3I (32.95%).

5.2 Conclusion

An experiment was conducted at Sher-e-Bangla Agricultural University Farm during the rabi season of 2017-18 to evaluate the performance of four white maize varieties (V_1=PSC-121, V_2=Yangnuo-3000, V_3=BHM-12 and V_4=BHM=-13) under two irrigation methods (I=conventional and IA=alternate furrow irrigation). The trial was done in Randomized Complete Blocked Design (RCBD). The irrigation was placed in the main plot while the varieties were placed in the sub plots.

In respect as the above results it can be concluded that maize variety showed significant variation to furrow irrigation and alternate furrow irrigation. According to result, variety, V_1 (PSC-121) showed tallest plant height, maximum cob breadth, grain weight per cob, grain yield per hectare, sundry weight of plant, oven dry weight of plant and the highest grain weight per cob and even, showed maximum yield per hectare. On the other hand, all furrow irrigation performed as excellent between the irrigation treatments applied in terms of all yield attributes parameters. Besides the interaction, Variety, V_1 with all furrow irrigation performed as the best combination. Regarding correlation studies, it can be easily stated that cob grain number, cob length, cob breadth, grain weight per cob and ultimately grain yield per hectare was significantly positively correlated. To sum up, it can be articulated that Variety (V_1) was the most outstanding variety and (I) all furrow irrigation and combination treatment (V_1I) was the best for growth and yield attributes of maize.

5.3 Recommendation

Based on the findings of the research, following recommendations may be suggested:

The study was made at SAU farm where the environmental temperature is higher than those at the farmers' field. So, it was obvious that the conventional irrigation would be better for producing higher seed yield as the atmospheric demand for water vapour at SAU is much better as compared to that at the outskirts of farmers' field. So, for greater precision, the trial may be repeated in farmers' field at differing agro ecological conditions of Bangladesh.

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APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from November, 2017 to April, 2018				
Month	***Air temperature (ºC)**		***Relative humidity (%)**	***Rainfall (mm) (total)**
	Maximum	**Minimum**		
November,2017	29.6	19.2	53	34.4
December, 2017	26.4	14.1	50	12.8
January, 2018	25.4	12.7	46	7.7
February, 2018	28.1	15.6	37	28.9
March, 2018	32.5	20.4	38	65.8
April, 2018	35.6	24.3	48	53.4

*Monthly average,

*Source: Bangladesh Meteorological Department (Climate & weather division) Agargaon, Dhaka-1207

Appendix II. Analysis of variance on plant height at different days of maize				
Source of Variation	**Degrees of freedom**	**Mean Square for plant height (cm)**		
		40 DAS	**80 DAS**	**Harvest time**
Factor A (Maize varieties)	3	377.312*	766.299*	926.025*
Factor B (irrigation application)	1	1722.120*	2821.001*	1842.754*
Interaction (A×B)	3	61.875*	204.944*	50.872*
Error	14	127.363	187.920	126.656
***: Significant at 0.05 level of probability**				

Appendix III. Analysis of variance on the number of leaves per plant at different days of maize

Source of Variation	Degrees of freedom	Mean Square for Number of leaves		
		40 DAS	80 DAS	Harvest time
Factor A (maize varieties)	3	0.793*	6.522*	17.597*
Factor B (irrigation application)	1	4.420*	0.002*	`2.042*
Interaction (A×B)	3	0.932*	0.388*	1.819*
Error	14	0.396	0.223	1.024

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

Appendix IV. Analysis of variance on the data of Base circumference and Base to cob position distance of maize

Source of Variation	Degrees of freedom	Mean Square of	
		Base circumference	Base to cob position distance
Factor A (Maize varieties)	3	6.435*	265.544*
Factor B (Irrigation application)	1	0.001*	520.802*
Interaction (A×B)	3	0.396*	33.744*
Error	14	0.218	149.601

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

Appendix V. Analysis of variance on the data of Cob bearing node number from the base and Number of grain per cob of maize			
Source of Variation	**Degrees of freedom**	**Mean Square of**	
		Cob bearing node number from the base	**Number of grain per cob**
Factor A (maize varieties)	3	4.659*	7786.216*
Factor B (irrigation application)	1	0.202*	12567.526*
Interaction (A×B)	3	0.219*	1328.06*
Error	14	0.325	935.840
***: Significant at 0.05 level of probability**			

Appendix VI. Analysis of variance on the data of Cob length , Cob breadth, Grain wt. per cob and Yield per hectare of maize					
Source of Variation	**Degrees of freedom**	**Mean Square of**			
		Cob length (cm)	**Cob breadth (mm)**	**Grain wt. per cob (g)**	**Yield per hectare (t)**
Factor A (maize varieties)	3	10.585*	13.433*	2118.172*	14.569*
Factor B (irrigation application)	1	2.600*	8.167*	970.282*	5.782*
Interaction (A×B)	3	4.594*	0.698*	199.147*	1.550*
Error	14	2.806	2.112	90.931	0.666
***: Significant at 0.05 level of probability**					

Appendix VII. Analysis of variance on the data of Sundry weight of plant (g), Oven dry weight of plant , Harvest index of maize				
Source of Variation	**Degrees of freedom**	**Mean Square of**		
		Dry weight of plant (g)	**Oven dry weight of plant (g)**	**Harvest index (%)**
Factor A (maize varieties)	3	675.324*	599.167*	72.927*
Factor B (irrigation application)	1	1661.670*	1768.167*	300.334*
Interaction (A×B)	3	168.955*	152.056*	65.534*
Error	14	61.531	62.565	33.233
***: Significant at 0.05 level of probability**				

Appendix VIII. Analysis of variance on the data of Hundred seed weight, Chaff weight per cob and Shell weight per cob of maize				
Source of Variation	**Degrees of freedom**	**Mean Square of**		
		Hundred seed weight (g)	**Chaff weight (g)**	**Shell weight (g)**
Factor A (maize varieties)	3	57.032*	489.452*	4470.109*
Factor B (irrigation application)	1	0.070*	380.807*	1584.375*
Interaction (A×B)	3	4.782*	116.874*	364.273*
Error	14	2.495	32.450	33.639
***: Significant at 0.05 level of probability**				