GROWTH AND YIELD ATTRIBUTES OF A WHITE MAIZE GENOTYPE SAUWMOPMDT273 UNDER DIFFERENT PLANTING CONFIGURATIONS

SHAKIL AHAMED

REGISTRATION NO. : 13-05297

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

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BY

SHAKIL AHAMED

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Approved by:

(Professor Dr. Md. Jafar Ullah) **Supervisor**	**(Professor Dr. Md. Shahidul Islam)** **Co-Supervisor**

(Prof. Dr. Md. Shahidul Islam)
Chairman
Examination Committee

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

CERTIFICATE

This is to certify that the thesis entitled ***"GROWTH AND YIELD ATTRIBUTES OF A WHITE MAIZE GENOTYPE SAUWMOPMDT273 UNDER DIFFERENT PLANTING CONFIGURATIONS"*** *submitted to the Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTERS OF SCIENCE (M.S.)*** *in* ***AGRONOMY,*** *embodies the result of a piece of bonafide research work carried out by* ***Shakil Ahamed, Registration No. 13-05297*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

June, 2020

Dhaka, Bangladesh

(Professor Dr. Md. Jafar Ullah)
Department of Agronomy
SAU, Dhaka

Dedicated to

My

Beloved Parents

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The Author

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ABSTRACT

A field experiment was carried out at the Agronomy Field of Sher-e-Bangla Agricultural University, during the period from July to October, 2018 to study the growth, phenology, yield attributes and yield of a white maize genotype SAUWMOPMDT273 under different planting configurations. Fifteen planting configurations *viz*., 40 cm × 15 cm (T_1), 40 cm × 20 cm (T_2), 40 cm × 25 cm (T_3), 45 cm × 15 cm (T_4), 45 cm × 20 cm (T_5), 45 cm × 25 cm (T_6), 50 cm × 15 cm (T_7), 50 cm × 20 cm (T_8), 50 cm × 25 cm (T_9), 55 cm × 15 cm (T_{10}), 55 cm × 20 cm (T_{11}), 55 cm × 25 cm (T_{12}), 60 cm × 15 cm (T_{13}), 60 cm × 20 cm (T_{14}) and 60 cm × 25 cm (T_{15}) were considered for the present study. Data on different growth and yield attributes were recorded, processed, analyzed and found having statistically varied. Results showed that the, treatment T_{15} showed significantly the maximum plant height, tassel length and leaf area at silking, grain filling and at harvest. At silking stage, the T_{15} had the highest area of an individual leaf 477.9 cm^2, 879.3 cm^2 and 496.3 cm^2 as well as stem dry matter weight of 28.73 g, 21.35 g and 27.40 g $plant^{-1}$ below cob-node, at cob-node and above the cob-node respectively. The treatment T_{13} showed maximum biological yield (14.64 t ha^{-1}) which was identical to T_2, T_4 and T_7 in this respect. T_{14} treatment showed significantly the highest cob length (15.94 cm) and number of grains row^{-1} (20.00), but the highest number of grains cob^{-1} (231.50), 100 seed weight (29.99 g), grain weight cob^{-1} (59.81 g) were recorded from T_{12}. T_{11} had significantly the highest grain yield (4.77 t ha^{-1}) which however was not significantly higher than those of T_5, T_{13} and T_{14} (4.62-4.75 t ha^{-1}). As the treatment T_{14} had sparser configuration (60×20 cm) requiring less seed rate, this configuration may be followed.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSIR	=	Bangladesh Council of Scientific and Industrial Research
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	Millilitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celsius
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Milligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
Mg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

Chapter I

Introduction

CHAPTER I

INTRODUCTION

Maize *(Zea mays* L.) is one of the most important cereal crops of the world. In Bangladesh, the cultivation of maize has been gaining popularity in recent years because of its high productivity and diversified use (Tajul *et al.* 2013). In Bangladesh, it covers about 3.5 lac hectares of land producing 23 lac metric tons grains (Baral, 2016). Maize crop has been included as a major enterprise in the crop diversification and intensive cropping programmes (Zamir *et al.* 2011).

Preferences for endosperm color depend on the local traditions, though white is generally chosen for human food. Yellow maize is preferred for feeding animals because it contains carotenoids; for this reason, white-maize production decreased from 50% in 1920 to 1% in 1970 (Troyer, 1999). Today, white maize is preferred for human consumption because degradation of carotenoids during baking or frying causes a strong aroma and flavor. Commercial quality requirements for white maize are quite strict for purity of the white color, large uniform size of kernels, high specific density, hard endosperm, and white cob (Watson, 1988). There are few publications on white-maize breeding because it is mainly performed by private companies. The genetics of endosperm color has been summarized by Coe *et al*. (1988), who exposed the complex genetic interactions of the numerous factors involved in the determination of endosperm color and other traits, such as chlorophyll synthesis or endosperm morphology.

As food, it can be consumed directly as green cob, roasted cob or popped grain. Its grains can be used for human consumption in various ways, such as, edible oil, corn meal, fried grain and flour. Green parts of the plant and grain are used as livestock and poultry feed. Sheaths of cobs are used to make paper of improved quality cigarettes. Stover, dry leaves, coverings of cobs and shelled cobs are used as good fuel (Ahmed, 1994). Maize is a major cereal crop for both livestock feed and human nutrition, worldwide. With its high content of carbohydrates, fats, proteins, some important vitamins and minerals, maize acquired a well-deserved reputation as a "poor man's nutria-cereal" (Prasanna *et al.***,** 2001). So, maize can contribute in food and nutritional security program in Bangladesh because of its higher productivity and nutritional value.

The average yield of maize in Bangladesh is not satisfactory. It is rather very low compared to leading maize growing countries of the world. The national average yield is only 6.45 t ha^{-1}, whereas, the newly released varieties have the potential to produce more than 8 t ha^{-1} (AIS, 2015).

Plant spacing is important factor, which plays a significant role on growth, development and yield of maize. Plant population and nutrient management usually affect on crop environment, which influence crop growth and yield. Less plant population and poor nutrient management practices are the major yield reducing factors in maize (Dawadi and Sah, 2012). The majority of farmers are not aware much about information on crop management aspects, especially optimum row spacing, suitable variety and maintaining optimum plant population per hectare. Conventional broadcast method of maize cultivation has a lot of defect includes, trouble to establish a correct plant population, trigger-off inter-plant and intra-plant competition; provide uneven opportunity for all plants for nutrients, water and light. The Broadcasting method produced the most effective spatial arrangements. It generally gave lower yields than sowing in rows (Krezel and Sobkowicz, 1996).

Hence, there is a scope to improve the maize productivity via several agronomic manipulations. Spacing is usually relies on expected growth of specific crop in given agro-climatic condition and determining controlling factor in their growth, development and yield. Agronomic management, especially row spacing which significantly influence on yield, since it is ultimately correlated with plant population, root development, plant growth and fruiting (Davi *et al*., 1995).

Maize differs in its responses to plant density (Luque *et al*., 2006). Closer row spacing leading to overcrowding, enhanced inter-plant competition for incident photosynthetic photon flux density and soil rhizosphere resource, resulting reduced yield per plant because of its influence on hormonally mediated apical dominance, exaggerated barrenness, and there by finally decreases the number of ears plant^{-1} and kernels ear^{-1} (Sangoi, 2001).

Optimum plant population provides scope to the plants for efficient utilization of solar radiation and nutrients. Lower plant population under wider spacing, solar radiation can penetrate canopy more easily and can reach the soil surface, which may cause excessive evaporation of soil moisture. Closer spacing hampers intercultural operations and as such more competition arises among the plant for nutrients, air and light. As results, plant becomes taller but weaker & thinner and consequently reduces yield of maize. Adjustment of proper plant spacing in the maize field is important to ensure maximum utilization of solar energy by the crop and reduce evaporation of soil moisture (FAO, 2012).

Wider row spacing causes low density of population promotes dense vegetative growth, increased weed density due to more feeding area available and remain nutrient and moisture unutilized thereby decrease in total yield. However, under high population density, cumulative yield is higher per production area, but drops yield per plant. The appropriate row spacing outcome optimum plant population per area for optimum yield. So, optimum population should be maintained to exploit maximum natural resources, such as nutrients, sunlight, and soil moisture, to ensure satisfactory growth and yield. Narrow row spacing and higher plant density results to delay initiation of intra- specific competition (Duncan, 1975) resulting effect is vigourous early crop (Bullock *et al.* 1988).

Thus the optimum plant spacing has to be ensured with a view to maximizing yield of maize. With the above view, this experiment was designed to evaluate growth, phenology and yield attributes of maize under different planting configurations with the following objectives:

1. To examine the effects of varying planting configurations on the growth, phenology and yield of the white maize genotype SAUWMOPMDT273.

2. To find out the optimum planting configuration for achieving the highest seed yield of the white maize genotype SAUWMOPMDT273.

Chapter II
Review of literature

CHAPTER II

REVIEW OF LITERATURE

Maize (*Zea mays* L.) ranks the largest cereal crops after rice and wheat on the basis of acreage covered by it. Its grain is a rich source of many important nutrients and used for multipurpose needed. But yield of maize crop is alarmingly affected due to lack of proper cropping technique. Optimum plant population per unit area is a key to enhance and sustain crop productivity. Therefore, the available findings of the effect of planting configuration of maize as sole crop have been briefly reviewed below:

Koirala *et al*. (2020) carried out a field experiment to study the effect of different row spacings on different maize varieties at Deupur, Lamahi municipality. Four levels of spacings (boardcasting and three row spacings of 45, 60 and 75 cm) and two maize varieties (Rampur Composite and Arun-2) were evaluated using randomized complete block design with three replications. The highest grain yield was found in Rampur Composite and Arun-2 while they were planted with row spacing of 60 cm with plant to plant spacing of 25 cm. The highest grain yield, cob length, cob circumference, number of rows per cob, thousand grain weight were reported when maize was planted in the row spacing 60×25cm. Among the maize varieties, Rampur Composite produced the highest grain yield, cob length, cob circumference, number of rows per cob as compared to Arun-2. This study suggested that maize production can be maximized by cultivating maize varieties with row spacing of 60 cm with plant to plant spacing of 25 cm.

Fromme *et al*. (2019) conducted a field studies were conducted (a) to determine the effects of plant density levels on plant height, ear height, stalk diameter, lodging, corn grain yield, test weight, and photosynthetically active radiation with modern corn hybrids in central Louisiana and (b) to test the hypothesis that the response of grain yield to plant population density would depend on the reproductive plasticity (flex, semiflex, or fixed ear) of the hybrids evaluated.

Rainfall was above average while air temperatures were below average during the growing season in both years. Higher plant height was achieved with lower populations. Grain yield showed a hybrid response in one of two years (fixed ear greater than semiflex ear) while yields increased as plant populations increased. Test weights were less with the fixed ear hybrid and the effect of plant populations was inconsistent with increased populations resulting in greater test weight in one of two years. Lodging increased as plant populations increased with the fixed ear hybrid resulting in greater lodging in one of two years. /ere was a hybrid by plant population interaction for ear height and seed weight. /e effect of plant populations is an important factor for corn yield; however, yield gains associated with higher plant populations may be dependent on the genetic predisposition of corn hybrids (regardless of the reproductive plasticity) to tolerate various environmental conditions and stresses associated with higher populations.

Shrestha and Yadav (2018) conducted a study to assess the effects of nitrogen fertilizer application and plant density on phenology (days to tasseling, silking and maturity) and grain yield of maize (Variety: Rampur Composite) at Mangalpur VDC-3, Anandapur, Chitwan, Nepal during 2006-07 winter season. The five levels of nitrogen as 0, 50, 100, 150 and 200 kg N/ha and three levels of the plant population as 55555, 66666 and 83333 plants/ha were evaluated using two factorial randomized complete block design with three replications. The days of flowering (tasseling and silking) decreased with increasing nitrogen level up to 200 kg N/ha and increased with increasing level of plant population up to 83333 plants/ha). Physiological maturity and grain yield increased with increasing level of nitrogen up to 200 kg N/ha and plant population up to 83333 plants/ha. The highest grain yield (6925.79 kg/ha) was obtained with 200 kg N/ha + 66666 plants/ha. This study suggested that maize production can be maximized by cultivating maize with the use of 200 kg N/ha and maintaining the plant density of 66666 plants/ha.

Zeleke *et al*. (2018) conducted a field experiment to determine N rate and planting density on maize yield in South Achefer district during 2014 cropping season at 3 locations. Three planting densities and four N levels were tested in randomized complete block design in the factorial arrangement with three replications. There were significant differences ($P<0.05$) among panting densities. Plant height, ear height, and leaf area index were significantly increased with increasing planting density from 44444 to 88888 plants ha^{-1}. However, the cob diameters, cob length, numbers of kernels per cob were decreased with increasing plating density. The grain yield was increased by 65.16% on 88888 plants ha^{-1} with 161 kg N ha^{-1} as compared to 44444 plants ha^{-1} with 92 kg N ha^{-1} and it was the best economically (39746.9 birrrs) profitable treatment combination.

Jiang *et al*. (2013) conducted a study with summer maize (*Zea mays* L) cultivar Denghai 661 and planted in rectangular tanks (0.54 m x 0.27 m x 1.00 m) under 27 cm (normal) and 6 cm (narrow) plant spacing and treated with zero and 7.5 g nitrogen (N) per plant. Compared to normal plant spacing, narrow plant spacing generated less root biomass in the 0-20 cm zone under both N rates, slight reductions of dry root weight in the 20-40 cm and 40-70 cm zones at the mid-grain filling stage, and slight variation of dry root weights in the 70-100 cm zone during the whole growth period. Narrow plant spacing decreased root reductive activity in all root zones, especially at the grain-filling stage. Grain yield and above-ground biomass were 5.0% and 8.4% lower in the narrow plant spacing than with normal plant spacing, although narrow plant spacing significantly increased N harvest index and N use efficiency in both grain yield and biomass, and higher N translocation rates from vegetative organs. These results indicate that the reductive activity of maize roots in all soil layers and dry weights of shallow roots were significantly decreased under narrow plant spacing conditions, resulting in lower root biomass and yield reduction at maturity. Therefore, a moderately dense sowing is a basis for high yield in summer maize.

Ibeawuchi and Matthews-Njoku (2008) conducted field experiments to determine the influence of plant spacing on the yield and dry matter accumulation of local and improved maize varieties. The experiments were laid out as a split plot in a randomized complete block design (RCBD) with four replications consisting sixteen (16) treatments per replicate. The results obtained showed that maize growth and yield was significantly ($P = 0.05$) affected by the different plant spacing used. The highest dry maize grain yield was obtained in the hybrid varieties using plant spacing of 25 x 75cm while the lowest yield was obtained in the local maize type with plant spacing of 100 x 100cm. The trend observed in the other plant attributes measured such as the Mean Leaf Area (MLA)(cm^2), the plant height and the Dry Matter Accumulation (DMA) showed that the hybrid maize varieties performed significantly better than the local ones and had higher nutrient efficiency and conversion rate than the local cultivars although the yield was predicated on plant population. Based on the research findings, growing maize sole using plant spacing of 25 x 75cm remains the best recommendation for optimum maize grain yield in the field and an improvement of the local maize cultivars genetically for sustainability and food security purposes.

Enujeke (2013) carried out a study to evaluate the effects of variety and spacing on growth characters of hybrid maize. It was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicates. Three hybrid maize varieties were evaluated under three different plant spacing for such growth characters as plant height, number of leaves, leaf area and stem girth. The results obtained during the 8^{th} week after sowing indicated that hybrid variety 9022-13 which had mean plant height of 170.0cm number of leaves of 13.2, leaf area of $673.2cm^2$ and stem girth of 99.4mm was superior to other varieties investigated. With respect to spacing, plants sown on 75 cm x 15 cm had higher mean height and number of leaves of 176.7 cm and 13.8, respectively while plants sown on spacing of 75 cm x 35 cm had higher mean leaf area of 713.7 cm^2 and stem girth of 99.4mm, respectively. Results of interaction showed that variety and spacing were significantly ($P<0.05$) different in 2008 and 2009. Based on the findings of this study, it is recommended that (i) hybrid variety 9022-13 be grown in the study area of enhanced growth characters which interplay to improve grain yield of maize (ii) spacing of 75 cm x 35 cm be used to enhance increased stem girth and leaf area whose photosynthetic activities could positively influence maize yield.

Farnham (2001) conducted studies at six locations to determine: (i) if there is a different optimum plant density or (ii) if hybrids of varying relative maturity respond differently for corn grown in narrow row spacings (38 cm) compared with conventional row widths (76 cm) in maize. Averaged across years, locations, and plant densities, corn grown in 76-cm row spacings produced higher yields than that grown in 38-cm rows (10.5 vs. 10.3 Mg ha^{1}, respectively). Harvest moisture content of corn grown in 38-cm row spacings was significantly less than that of corn grown in 76-cm row spacings (160 vs. 161 g kg^{1}, respectively). Averaged across years and locations, there was no statistically significant ($P<0.05$) yield difference between the two row spacings for four of the six hybrids tested. Hybrid MAX23 yielded significantly more grain in 76cm row spacings (9.4 vs. 8.9 Mg ha^{-1}) while 'MAX454' yielded more grain in 38-cm row spacings (10.0 vs. 9.8 Mg ha^{1}). It is thus concluded that optimum plant densities for narrow-row corn production are similar to those required to produce maximum yields for conventional wide-row corn production. In addition, a strong hybrid X row spacing interaction among the six hybrids tested here suggests that certain hybrids may perform better at prescribed row spacings.

Fanadzo *et al.* (2010) conducted a study to determine the effects of inter-row spacing (45 and 90 cm) and plant population (40000 and 60000 plants ha^{-1}) on weed biomass and the yield of both green and grain materials of maize plants. The experiment was set up as 2 factorial in a randomised complete block design with three replications. Plant population had no significant effects and interaction among factors was not significant on weed biomass. Narrow rows of 45 cm reduced weed biomass by 58%. Growing maize at 40000 plants ha^{-1} resulted in similar green cob weight regardless of inter-row spacing. Cob length decreased with increase in plant population and with wider rows. Similar grain yield was obtained regardless of inter-row spacing when maize was grown at 40000 plants ha^{-1}, but at 60000 plants ha^{-1}, 45 cm rows resulted in 11% higher grain yield than 90 cm rows. Increasing plant population from 40000 to 60000 plants ha^{-1} resulted in a 30% grain yield increase. The study demonstrated that growers could obtain higher green and/or grain yield by increasing plant population from the current practice of 40000 to 60000 plants ha^{-1} and through use of narrow rows.

Stephanus *et al*. (2018) reviewed that maize (*Zea mays* L.) productivity has increased globally as a result of improved genetics and agronomic practices. Plant population and row spacing are two key agronomic factors known to have a strong influence on maize grain yield. A systematic review was conducted by Stephanus *et al*. (2018) to investigate the effects of plant population on maize grain yield, differentiating between rainfall regions, N input, and soil tillage system (conventional tillage [CT] and no-tillage [NT]). Data were extracted from 64 peer-reviewed articles reporting on rainfed field trials, representing 13 countries and 127 trial locations. In arid environments, maize grain yield was low (mean maize grain yield = 2448 kg ha^{-1}) across all plant populations with no clear response to plant population. Variation in maize grain yield was high in semiarid environments where the polynomial regression ($p < 0.001$, $n = 951$) had a maximum point at 140,000 plants ha−1, which reflected a maize grain yield of 9000 kg ha^{-1}. In subhumid environments, maize grain yield had a positive response to plant population ($p < 0.001$). Maize grain yield increased for both CT and NT systems as plant population increased. In high-N-input (r2 = 0.19, $p < 0.001$, n = 2 018) production systems, the response of plant population to applied N was weaker than in medium-N-input (r2 = 0.49, $p < 0.001$, $n = 680$) systems. There exists a need for more metadata to be analyzed to provide improved recommendations for optimizing plant populations across different climatic conditions and rainfed maize production systems. Overall, the importance of optimizing plant population to local environmental conditions and farming systems is illustrated.

Hasan *et al*. (2018) conducted an experiment to investigate the effect of variety and plant spacing on yield attributes and yield of maize. The experiment comprised of five varieties viz., Khoi bhutta, BARI hybrid maize 7, BARI hybrid maize 9, C-1921, P-3396 and five plants spacing viz., 75 cm × 20 cm, 75 cm × 25 cm, 75 cm × 30 cm, 75 cm × 35 cm and 75 cm × 40 cm. The experiment was laid out in a randomized complete block design with three replications. Results revealed that variety and plant spacing had significant effect on the studied crop characters and yield. The highest plant height, highest number of leaves plant^{-1}, longest cob, maximum diameter of cob, highest number of kernel cob^{-1}, the highest 1000-grain weight, maximum grain yield and stover yield were observed in BARI hybrid maize 7. On the other hand, the shortest plant, lowest number of cob, diameter of cob, lowest number of grains cob^{-1}, 1000-grain weight, grain yield and stover yield were observed in Khoi bhutta. The longest plant, highest cob, maximum diameter of cob, highest number of kernel cob^{-1} the highest 1000- grain weight, maximum grain yield and stover yield was observed in the spacing of 75 cm × 25 cm. In contrast, the spacing of 75 cm × 30 cm produced the lowest values of the above mentioned plant parameters and also showed the lowest grain yield. In regard to interaction effect of variety and spacing, the highest plant height (232.67 cm), maximum number of cob plant-1 (1.73), maximum diameter of cob (4.60 cm), highest number of kernel cob-1 (34), maximum stover yield (12.38 t ha-1) were observed at the spacing of 75 cm × 25 cm with BARI hybrid maize 7 and resulting in the highest grain yield (9.04 t ha^{-1}). The lowest values of the above parameters were recorded in the narrowest plant spacing of 75 cm × 35 cm with Khoi bhutta. Based on the experimental results, it may be concluded that maize (cv. BARI hybrid maize 7) can be cultivated with a spacing of 75 cm × 25 cm for appreciable grain yield.

Rahman *et al*. (2016) conducted an experiment to investigate the effect of planting spacing and nitrogen levels on yield attributes and yield of maize cv. Khaibhutta. The experiment comprised three nitrogen levels viz. 50, 100 and 150 kg N ha-1 and five plant spacings viz. 75 cm × 25 cm, 75 cm × 20 cm, 50 cm × 25 cm, 50 cm × 20 cm and 100 cm × 20 cm. The experiment was laid out in a randomized complete block design with three replications. Results revealed that nitrogen levels and plant spacing had significant effect on yield attributes and yield of Khaibhutta. The highest number of cobs plant^{-1}, grains row^{-1}, grain yield and stover yield were recorded with 150 kg N ha^{-1} followed by 100 kg N ha^{-1} and the lowest values were observed in 50 kg N ha^{-1}. The highest number of cobs plant^{-1}, grain rows cob^{-1}, grains row^{-1}, grains cob^{-1}, 1000-grain weight, grain yield and harvest index were recorded at 75 cm × 25 cm spacing. In contrast, the closest spacing of 50 cm x 20 cm produced the lowest values of grain rows cob^{-1}, grains row^{-1}, grains cob^{-1}, 1000-grain weight and grain yield. In case of interaction, the highest grain yield and harvest index were obtained at 75 cm × 25 cm spacing fertilized with 150 kg N ha^{-1}. The lowest values of the above parameters were recorded in the closest spacing 50 cm × 20 cm with 50 kg N ha^{-1}. From this study it may be concluded that maize (cv. Khaibhutta) can be cultivated at the spacing of 75 cm × 25 cm with 150 kg N ha^{-1} for appreciable grain yield.

Muranyi (2015) investigated the development of yield amounts of eight different genotypes in a small-plot field experiment with four replications on a calcareous chernozem soil type at the Látókép Research Site of the University of Debrecen in the crop years 2013 and 2014. Row distances of 45 and 76 cm, just as plant densities of 50 000, 70 000 and 90 000 plants per ha were set. Significant differences were found between the yield amounts of the studied hybrids in both studied crop years, while the effect of plant density on yield amount showed different results. In the crop year of 2013 the hybrids resulted high yields in the treatment with a row distance of 45 cm and plant density of 90 000 plants per ha, however, in 2014 significant yield decrease was found in comparison with the previous year, that can be attributed to the weather conditions in the months April-May and June. Optimal plant densities of hybrids, just as the corresponding expectable yield amounts were determined with quadratic equations. Optimal plant densities of the hybrids were different in the two studied crop years: in 2013, regarding the treatments set with the row distance of 45 cm, increasing plant densities resulted in higher yields, while in 2014, the yield showed decreasing tendency parallel to the increasing plant densities, that is confirmed by the fact that plant densities of 50 000 and 65 000 plants ha-1 proved to be more favourable. Regarding the treatments with a row distance of 76 cm, hybrids obtained their yield maximums by 80 327 plants ha^{-1} in 2013, while in the vegetation of 2014, by higher plant density (85 845 plants ha^{-1}).

Golla and Chalchisa (2019) conducted a field experiment to determine the response of maize phenology and grain yield for various nitrogen fertilizer rates and plan spacing. The experiment was arranged in a Randomized Complete Block Design in factorial combination with three replications. Three plant spacing i.e. 20cm, 30cm and 40cm, with one row spacing of 75cm and six nitrogen rates i.e. 0kg ha^{-1}, 23kg ha^{-1}, 46kg ha^{-1}, 69kg ha^{-1}, 92kg ha^{-1} and 115kg ha^{-1} were assigned to the experimental plot by factorial combinations. The results showed that reduction in plant spacing and nitrogen starvation resulted delaying to attain 50% tasseling and silking while it speeding up maturity period. Maximum grain yield (10,207.8 kilo gram per hectare) obtained under the narrowest plant spacing (20 centimeters) with application of the highest rate of nitrogen (115 kilo gram nitrogen per hectare). This yield result surpassed by 8.9% compared to the standard check. The experiment indicated an increasing trend of grain yield with increasing N rate and decreasing plant spacing, so further increasing of N rates and reducing plant spacing might further increased the grain yield.

Carlos (1990) reported that ‘super sweet’ corn can be grown for young cobs at a population density of 60, 000 plants ha^{-1}, the population, however, can be increased up to 1, 80, 000 plants ha^{-1}.

Thakur *et al.* (1995) evaluated the performance of maize cultivar early composite for baby corn production under different spacing regimes ***viz.,*** 40 cm and 60 cm of inter-row spacing and 10 cm and 20 cm of intra-row spacing. They found 40 cm × 20 cm and 40 cm × 10 cm spacings as optimum for baby corn and baby corn + green fodder productions, respectively. Significantly higher yield of baby corn (1737 kg ha^{-1}) was recorded by planting the crop at 40 × 20 cm spacings than the other spacing of 60 ×10 cm (1561 kg ha^{-1}), 40 ×10 cm (1588 kg ha^{-1}) and 60 × 20 cm (1555 kg ha^{-1}).

Experiments on three plant populations, at densities of 1, 06, 666, 1, 60, 000 and 2, 13,333 plants ha^{-1} resulting from the row spacing of 75 cm and 25 cm between hills with 2, 3 and 4 plants $hill^{-1}$, respectively showed that there was significant difference in husked and unhusked young cob weights and husk weights at different densities (Soonsuwon *et al*., 1996).

Thakur *et al.* (1997) conducted a field experiment on corn and indicated that the wider spacings of 60 cm × 20 cm increased significantly all the yield attributing character *viz*. cob per plant, cob number per unit area, cob weight with and without husk of corn as compared to other spacing of 40 cm × 20 cm, 60 cm × 10 cm and 40 cm × 10 cm. But the spacings of 40 × 20 cm recorded significantly more corn yield of 17.37 q ha^{-1} as compared to 40 × 10 cm (15.88 q ha^{-1}) and 60 × 20 cm (13.55 q ha^{-1}) spacing.

Thakur *et al.* (1998) reported that cob yield with husk and maize yield was significantly higher under plant spacing of 40 cm × 20 cm compared to 60 cm × 20 cm and 60 cm × 10 cm, whereas green fodder yield was significantly higher under spacing 40 cm × 10 cm compared to other plant spacings.

Sahoo and Panda (1999) reported that plant spacing of 40 cm × 20 cm, being at par with 40 cm × 15 cm recorded significantly higher maize yield in wet season compared to 40 cm × 25 cm spacing, whereas green fodder yield during winter season was significantly higher under 40 cm × 15 cm spacing compared to other spacings.

Sukanya *et al.* (1999) found that the green fodder yield of maize increased significantly with reduction in plant spacing compared to other spacings.

Thakur and Sharma (2000) conducted a field experiment on maize and showed significantly higher length of cob with husk and cobs per plant under wider spacings of 60 cm × 30 cm and 40 cm × 40 cm as compared to other closer spacing.

Raja (2001) conducted a field experiment and reported that green ear weigh t ha^{-1} and green kernel weigh t ha^{-1} of super sweet corn was significantly higher at the population density of 88,888 pants/ha (108.05 q ha^{-1} and 83.15 q ha^{-1}) than the other plant population to s ***viz.*** 66,666 and 53,333 plants/ha.

Pandey *et al.* (2002) conducted a field experiment and reported that the lower plant density (1,11,000 plants ha^{-1}) of maize recorded significantly higher weight of green cob and maize/plant than 1,33,000 and 1660 plants per ha. It was also reported that the maize yield and fodder yield obtained respectively at plant density of 1660 plants ha^{-1}. (1,148 kg ha^{-1} and 24.5 t ha^{-1}) and 1,33,000 plants ha^{-1} (1,0536 kg ha^{-1} and 23.4 t ha^{-1}) were on par and significantly superior to that of 1,11,000 plants ha^{-1} (900 kg ha^{-1} and 20.3 t ha^{-1}).

Ramchandrappa *et al.* (2004) carried a field study and observed that the length and girth of corn was adversely affected with the increase in plant densities and the differences were not significant. The wider spacings of 45 × 30 cm recorded higher number of baby ears per plant, husked corn length, girth and weight. Wider spacings of 45 cm × 30 cm also recorded significantly higher corn yield than other spacings (45 cm × 20 cm and 30 cm × 30 cm).

Sahoo and Mahapatra (2004) conducted a field trial on sweet corn and reported that higher plant population (83,333 plants per ha) with spacings of 60 cm × 20 cm produced maximum number of ears. But green cob weight and length of dehusked cob were maximum under lower plant population (55,555 plants per ha) which was at par with 66,666 plant population per ha. It was also reported, significantly higher green cob yield and fresh grain yield when sweet corn was sown with a spacings of 60 cm × 25 cm than that of 60 cm × 20 cm and 60 cm × 30 cm spacings.

Ochapong (2005) reported no significant difference in maize yield among plant densities. The results suggested that planting of 2 plants hill^{-1} at the recommended plant density especially when field practices and cost of seed were also taken into consideration and application of nitrogen 40 kg ra^{-1} yielded highest maize production.

Kar *et al.* (2006) conducted a field experiment and reported that the spacings of 60 x 20 cm significantly increased the number of prime cobs, green cob yield, highest net return and benefit : cost ratio over the 45 × 30, 45 × 20 and 60 × 30 cm spacing.

Zarapkar (2006) observed from a field study that the yield attributing characters of cob such as length of cob, number of cobs per plant, cob weight with husk and cob weight without husk were significantly higher under wider spacings of 60 cm × 20 cm as compared to closer spacings of 30 cm × 20 cm. It was also found that baby corn yield was significantly higher under the closer spacings of 45 cm×× 20 cm than remaining spacing viz. 30 cm × 20 cm and 60 cm × 20 cm. However, green fodder yield and total biomass yield per hectare were significantly higher under spacings of 30 cm × 20 cm than other spacing.

Prodhan *et al.* (2007) reported that the plant density of 1, 33,000 plants ha^{-1}

gave significantly higher husked, dehusked yield and standard yield of baby corn compared to plant densities of 66, 000 and 2,08,000 plant ha^{-1} whereas barrenness per cent was significantly higher in plant density of 66,000 plants ha^{-1} and fodder yield was significantly higher under density 1, 33, 000 compared to 2, 08, 000 plants ha^{-1}.

Kunjir (2007) conducted a field experiment on sweet corn and observed that length of cob, rows per cob, girth of cob, weight of cob, weight of grains per cob, number of grain rows per cob, weight of grains per cob and 1000 grains weight increased significantly with wider spacing (75 cm x 20 cm) as compared to narrower spacing (45 cm × 20 cm and 60 cm × 20 cm). The experiment also showed that the close spacings of 45 cm × 20 cm reported significantly higher cob yield (114.99 q per ha), stover yield (73.79 q ha^{-1}) and total biomass yield (188.78 q ha^{-1}) than the remaining broader spacing (60 x 20 cm and 75 x 20 cm).

The results of a study on light interception and productivity of baby corn as influenced by crop geometry, intercropping and integrated nutrient management practices revealed that barring at 25 DAS, plant spacing of 60 x 19 cm registered higher green cob yield and baby corn equivalent yield compared to 45 × 25 cm spacing (Thavaprakaash and Velayudham, 2008).

Long *et al*. (2009) carried out the study on effects of plant density on hybrid maize production. Four plant densities (two plants/hill): D_1 (114,000 plants/ha), D_2 (133,000 plantsha^{-1}), D_3 (143,000 plantsha^{-1}) and D_4 (167,000 plantsha^{-1}) and 3 maize varieties: RL1, RL4 and LVN23 (check) were assigned. At plant density D_4 (167000 plantsha^{-1}), total yield, green fodder yield and marketable yield of three hybrids were higher than other densities at significant level of P>95% while remaining at short growth duration and ensured to obtain exportation standard size. RL1 had highest yield (2.37) in plant density D_4, higher than LVN23 (1.98) respectively at P>95%.

Shafi *et al*. (2012) conducted this present study to investigate the effect of planting density on plant growth and yield of maize varieties. The experiment consist of four maize varieties *viz*., Azam, Pahari, Jalal-2003 and Sarhad white with three plant densities of 45000, 55000 and 65000 plants ha^{-1}. Data indicated that planting density had a significant ($p<0.05$) effect on ear length, number of grains ear^{-1}, grain weight ear^{-1}, 1000 grain weight, biological yield, stover yield, grain yield and harvest index. Maximum biological yield, stover yield, grain yield and harvest index was recorded from planting density of 65000 plants ha^{-1}. The combined effect of Sarhad white with planting density of 65000 plants ha^{-1} produced highest grain weight cob^{-1}, biological yield, stover yield, grain yield and harvest index.

Kheibari *et al*. (2012) conducted an experiment to investigate the "effects of variety and plant density on yield and yield component of corn varieties. Three plant densities (75,000 115,000 and 155,000 $plantsha^{-1}$) and 3 corn varieties (KSC403su, KSC600 and KSC704) were evaluated. The data on yield parameters influenced significantly by plant density. Plant density of 155,000 $plantsha^{-1}$ with variety KSC403su showed highest yield ha^{-1}.

Golada *et al*. (2013) conducted a field experiment to study the effect of crop spacing (45 × 20, 60 × 15 and 90 × 10 cm) on yield attributes, yield and economics of baby corn. The crop spacing 60 × 15 cm significantly influenced yield attributes. Maximum green cob yield, baby corn yield and green fodder yield was recorded at 60 × 15 cm spacing which was higher (14.0, 24.3 and 8.8%, respectively) over 90 × 10 cm.

Sarjamei *et al*. (2014) conducted an experiment to investigate the effect of planting method and plant density, on morpho-phenological traits of maize (*Zea mays* L.) variety KSC 704. Three levels of plant density (D_1: 90,000; D_2: 120,000 and D_3: 150,000 $plantha^{-1}$) were initiated. The highest and lowest ear yield belonged to D_2 and D_1 plant density by 9987 and 8780 $kgha^{-1}$ ear production respectively. D_3 produced the highest de husked ear yield by mean of 1969 kg ha^{-1}.

Bairagi *et al*. (2015) conducted this experiment to study the effect of crop geometry impacts on growth and yield of maize (Var. G-5414). Three levels of plant population *viz*. 45 × 30 cm (S_1), 45 × 20 cm (S_2) and 45 × 10 cm (S_3) were assigned. Corn yield and fodder yield were higher when maize planted in wider spacing of 45 × 30 cm. whereas, closer spacing of 45 × 10 cm resulted in reduction of both corn and fodder yield per plant. The yield parameters of maize were clearly indicative that they were thermo- sensitive and maize cobs and fodder yield are higher at closer spacing.

Singh *et al*. (2015) conducted a field experiment to study the effect of two varieties (VL Baby Corn-1 and HM 4), two spacings (45×25 cm and 60×25 cm) and three sowing dates (1^{st} October, 30^{th} October and 29^{th} November) on performance of baby corn (*Zea mays* L.). The results indicated that the maximum corn yield (32.55%) and fodder yield (26.21%) was found to be higher from 45×25 cm spacing over 60×25 cm spacing.

Chamroy *et al*. (2017) carried out an experiment entitled "Growth and yield response of maize (*Zea mays* L.) to geometry". Four levels of sowing periods (i.e. Last week of Aug., Sept., Oct. and Nov.) and five different crop geometry (30cm × 30cm, 45cm × 15cm, 45cm × 30cm, 60cm × 15cm and 60cm × 30cm) were used. It was observed that the yield attributing characters such as, number of cobs $plant^{-1}$(3.43), cob weight (9.87 g) and cob yield $plant^{-1}$ without husk (31.64 g) were found highest in S_5 (60 × 30 cm). However, S_2 (45 × 15 cm) exhibited highest yield $hectare^{-1}$ (81.10 q).

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Kharif-II season from July to October, 2018 to study the growth, phenology and yield attributes of a white maize genotype SAUWMOPMDT273 under different planting configurations. The materials used and methodology followed in the investigation have been presented details in this chapter.

3.1 Description of the experimental site

3.1.1 Geographical location

The experimental area was situated at $23^0$77' N latitude and $90^0$33' E longitude at an altitude of 9 meter above the sea level.

3.1.2 Agro-ecological region

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

3.1.3 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 ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level. The physico-chemical properties of soil is presented in Appendix II.

3.1.4 Climate

The area has subtropical climate, 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 Rabi season (October-March). Climatic condition of the experimental site is presented in Appendix III.

3.2 Experimental details

3.2.1 Treatments

The single factor experiment considered as different planting configuration was used as follows:

1. T_1 = 40 cm × 15 cm
2. T_2 = 40 cm × 20 cm
3. T_3 = 40 cm × 25 cm
4. T_4 = 45 cm × 15 cm
5. T_5 = 45 cm × 20 cm
6. T_6 = 45 cm × 25 cm
7. T_7 = 50 cm × 15 cm
8. T_8 = 50 cm × 20 cm
9. T_9 = 50 cm × 25 cm
10. T_{10} = 55 cm × 15 cm
11. T_{11} = 55 cm × 20 cm
12. T_{12} = 55 cm × 25 cm
13. T_{13} = 60 cm × 15 cm
14. T_{14} = 60 cm × 20 cm
15. T_{15} = 60 cm × 25 cm

3.2.2 Layout of the experiment

The experiment was laid out into Randomized Complete Block Design (RCBD) with three replications. There were 15 planting configuration, in total 45 plots for 3 replications. Each block consisted of 15 unit plots. The size of each unit plot was 3.5 m × 1.8 m. The distance maintained between two replications and two plots were 0.5 m and 0.5 m, respectively. The layout of the experiment is shown in Appendix IV.

3.2.3 Planting materials

In this research work, White maize genotype - SAUWMOPMDT273 was used as plant materials and the seeds were collected from SAU, Dhaka.

3.3 Preparation of the experimental field

The land was opened with the help of a tractor drawn disc harrow on July 4, 2018, and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on July 6, 2018 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.4 Fertilizer application

During final land preparation, the land was fertilized as per treatment. 4 levels of fertilizer treatments were used under the present study based on recommended doses of fertilizers. The recommended doses of fertilizers were as below:

Name of fertilizer	**Rate ha^{-1}**
Urea	300 kg
TSP	150 kg
MoP	100kg
Gypsum	150 kg
$ZnSO_4$	10 kg

Source: BARI (2014)

The total amount of nitrogen in the form of urea was divided into three equal portions; one third was applied during final land preparation. The rest two portions were applied as split doses at 25 DAS and 45 DAS, respectively. Whole amount of TSP, MoP, Gypsum and $ZnSO_4$ were applied at the time of final land preparation.

3.5 Seed sowing

The seeds were sown in lines maintaining plant to plant and row to row distance as per treatments having 2 seeds $hole^{-1}$ under direct sowing in the well prepared plot on July 7, 2018.

3.6 Intercultural operations

3.6.1 Thinning and gap filling

The plots were thinned out and gap filled on 15 days after sowing having single plant $hill^{-1}$ to maintain a uniform plant stand.

3.6.2 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. Two hand weedings were done; first weeding was done at 25 days after sowing followed by second weeding at 45 days after sowing.

3.6.3 Earthen up

Earthen up is a major intercultural operation for better establishment and anchorage of crown root of baby corn. It was done two times, 1^{st} one at 25 days after sowing, 2^{nd} one at 45 days after sowing.

3.6.4 Irrigation and drainage

Irrigation water was added to each plot, first irrigation was done as pre-sowing and other four were given at 20, 40 and 60 days after sowing. Drainage channels were properly prepared to easy and quick drained out of excess water.

3.6.5 Plant protection measures

The crops were infested by insects. Ripcord 10 EC @500 ml in 20 L water was sprayed at 46 days after sowing.

3.7 Harvesting and post-harvest operations

At 21 October, 2018, the cobs of five randomly selected plants of each plot were separately harvested for recording data on yield attributes and other parameters. The five cobs were harvested for recording cob yield and other data.

3.8 Recording of data

Experimental data were collected at the time of harvest. Five plants were randomly selected and fixed in each plot from the inner row of the plot for recording data. Dry weight of plants were collected by harvesting five plants at different specific dates from the inner rows leaving border plants and harvest area for cob of baby corn.

The following data were recorded:

3.8.1 Growth parameters

1. Plant height (cm)
2. Tassel length plant^{-1} (cm)
3. Leaf area plant^{-1} (cm^2)
4. Dry weight plant^{-1} (g)

3.8.2 Yield contributing parameters

1. Cob length (cm)
2. Cob breadth (cm)
3. Number of rows cob^{-1}
4. Number of grains row^{-1}
5. Number of grains cob^{-1}
6. Weight of 100 seeds (g)

3.8.3 Yield parameters

1. Grain weight cob^{-1} (g)
2. Shell weight cob^{-1} (g)
3. Chaff weight cob^{-1} (g)
4. Grain yield (t ha^{-1})
5. Stover yield (t ha^{-1})
6. Biological yield (t ha^{-1})
7. Harvest Index (%)

3.9 Procedures of recording data

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

3.9.1 Growth characters

Plant height (cm)

The height of plant was recorded in centimeter (cm) at harvest. Data were recorded as the average of 5 plants selected from the inner rows of each plot. The height was measured from the ground level to the tip of the plant.

Tassel length $plant^{-1}$ (cm)

Tassel length was measured from base to top of tassel from five selected plants of each plot and the average data were recorded. Tassel length was taken at three times of crop duration *viz*., at silking, 15 days after silking and at harvest.

Leaf area (cm^2 $leaf^{-1}$)

Leaf area was measured at three stages *viz*., at silking, 15 days after silking and at harvest and these data were taken from three parts of the plant (lower leaves, cob leaf and upper leaves) separately. It was measured with the help of a meter scale by taking leaf length and breadth in cm.

Dry matter content plant^{-1} (g)

Dry matter content plant^{-1} was measured at three stages *viz.*, at silking, 15 days after silking and at harvest and this data was taken from three part of the plant (lower leaves, cob leaves and upper leaves) separately. Sample plants from each plot were collected. The plant parts were packed in paper packets then kept in the oven at 80°C for 72 hrs to reach a constant weight. Then the dry weights were taken with an electric balance. The mean values were determined.

3.9.2 Yield contributing parameters

Cob length (cm)

Cob length was measured in centimeter from the base to the tip of the ear of 5 corn from the five selected plants in each plot with the help of a meter scale then average data were recorded.

Cob diameter (cm)

The diameter of cob was measured from five randomly selected cobs from the five selected plants in each plot in centimeter and averaged.

Number of rows cob^{-1}

Row number of five randomly selected cobs from the five selected plants plot^{-1} were counted and finally averaged.

Number of grains row^{-1}

Grains number of five randomly selected cobs from the five selected plants plot^{-1} were counted and total number of grains was divided by total number of rows for counting number of grains row^{-1}.

Number of grains cob^{-1}

Total number of grains from five randomly selected cobs from the five selected plants plot^{-1} were counted and finally averaged.

Weight of 100 seeds (g)

One hundred cleaned dried grains were counted randomly from each plot and weighed by using a digital electric and the mean weight was expressed in gram.

3.9.3 Yield parameters

Grain yield ha^{-1} (t)

Weight of grains collected from each plot was taken after final completion of cob harvest and converted into hectare and were expressed in t ha^{-1}.

Stover yield ha^{-1} (t)

Weight of cleaned and well dried stover were collected from each plot were taken and converted into hectare and were expressed in t ha^{-1}.

Biological yield ha^{-1} (t)

Cob (dehusked) yield and stover yield were all together regarded as biological yield. Biological yield was calculated with the following formula:

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

Harvest Index (%)

It denotes the ratio of economic yield to biological yield and was calculated with following formula (Donald, 1963; Gardner *et al.***,** 1985).

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

3.10 Statistical analysis

The data obtained for different characters were statistically analyzed using MSTAT-C software. The mean values of all the characters were evaluated and analysis of variance was performing by the ‘F’ test. The significance of the difference among the treatments means was estimated by the Least Significant Difference Test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

An experiment was conducted at the Agronomy research field of Sher-e-Bangla Agricultural University farm to observe the growth, phenology and yield attributes of a white maize genotype SAUWMOPMDT273 under different planting configurations. Data on different growth and yield parameters of maize were recorded. The analysis of variance on different growth and yield contributing characters as well as yield of maize was influenced by different planting configurations presented in Appendix. The results have been presented and discussed with the help of tables or graphs and possible interpretations have been given under the following headings.

4.1 Growth parameters

4.1.1 Plant height (cm)

Significant influence was recorded on plant height of maize at different growth stages as affected by different planting configurations (Table 1 and Appendix V). Plant height was recorded at silking time, 15 days of silking time and at harvest (Table 1).

At silking time, the highest plant height (217.00 cm) was recorded from the treatment T_{15} which was significantly different from other treatments whereas the lowest plant height (190.30 cm) was found from the treatment T_1.

Similarly, at 15 days of silking time, the highest plant height (220.30 cm) was recorded from the treatment T_{15} which was statistically identical with T_{15} whereas the lowest plant height (184.30 cm) was found from the treatment T_1.

At harvest, the highest plant height (220.70 cm) was recorded from the treatment T_{15} followed by T_{10}, T_{12} and T_{13} whereas the lowest plant height (175.50 cm) was found from the treatment T_1 which was statistically similar with T_4 and T_9.

Table 1. Plant height of maize as influenced by different planting configurations

Treatments	Plant height (cm)		
	At silking	At 15 days of silking	At harvest
T_1	190.3 h	184.3 g	175.5 h
T_2	197.7 g	200.7 c	190.6 e
T_3	200.3 f	206.7 b	184.1 f
T_4	209.7 c	209.3 b	176.5 gh
T_5	197.0 g	200.3 c	179.3 g
T_6	210.3 c	194.3 ef	179.3 g
T_7	211.3 c	196.3 e	194.2 d
T_8	204.7 de	197.0 de	201.2 c
T_9	206.7 d	201.3 c	177.0 gh
T_{10}	201.7 f	195.0 ef	206.5 b
T_{11}	214.3 b	208.7 b	186.3 f
T_{12}	205.0 de	217.7 a	204.2 bc
T_{13}	196.0 g	192.7 f	204.0 bc
T_{14}	202.7 ef	199.7 cd	194.0 d
T_{15}	217.0 a	220.3 a	220.7 a
$LSD_{0.05}$	2.464	3.092	3.128
CV(%)	8.59	6.97	9.12

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

From the result, it was observed that the treatment T_{15} showed highest plant height at all three stages (217.00, 220.30 and 220.70 cm at silking time, 15 days after silking time and at harvest, respectively) whereas the shortest plant was observed from T_1 (190.30, 184.30 and 175.50 cm at silking time, 15 days after silking time and at harvest, respectively). Similar result was found with the findings of Fromme *et al*. (2019) who found higher plant height was achieved with lower populations. But Zeleke *et al*. (2018) found that plant height, significantly increased with increasing planting density from 44444 to 88888 plants ha^{-1}.

4.1.2 Tassel length (cm)

Significant influence was recorded on tassel length of maize at different growth stages as affected by different planting configurations (Table 2 and Appendix VI). Tassel length was recorded at silking, 15 days of silking and at harvest (Table 2).

At silking, the highest tassel length (48.00 cm) was recorded from the treatment T_{15} followed by T_6, T_7, T_{11} and T_{12} whereas the lowest tassel length (33.00 cm) was found from the treatment T_1, which was statistically identical with T_3.

At 15 days after silking time, the highest tassel length (52.80 cm) was recorded from the treatment T_{15} which was significantly different from other treatments whereas the lowest tassel length (26.67 cm) was found from the treatment T_1.

At harvest, the highest tassel length (39.77 cm) was recorded from the treatment T_{15} which was significantly different from other treatments followed by T_{14} whereas the lowest tassel length (27.98 cm) was found from the treatment T_1 which was statistically identical with T_2.

From the result, it was observed that the treatment T_{15} showed maximum tassel length of maize at all three stages (48.00, 52.80 and 39.77 cm at silking time, 15 days after silking time and at harvest, respectively) whereas the minimum tassel length was observed from T_1 (33.00, 26.67 and 27.98 cm at silking time, 15 days after silking time and at harvest, respectively). It was observed from the above result that the highest tassel length from T_{15} which might be due to cause of higher nutrients light and air availability during the cropping period.

Table 2. Tassel length of maize as influenced by different planting configurations

Treatments	Tassel length (cm)		
	At silking	At 15 days of silking	At harvest
T_1	33.00 f	26.67 f	27.98 j
T_2	37.67 e	32.10 e	28.93 j
T_3	34.33 f	37.70 d	31.30 hi
T_4	44.00 c	39.17 cd	30.50 i
T_5	41.33 d	37.77 d	34.38 de
T_6	46.00 b	37.17 d	31.02 hi
T_7	44.00 bc	37.30 d	33.37 ef
T_8	43.33 cd	37.13 d	32.60 fg
T_9	38.00 e	40.13 c	36.33 c
T_{10}	37.00 e	38.20 cd	31.67 gh
T_{11}	44.00 bc	38.17 cd	35.23 d
T_{12}	44.00 bc	37.97 cd	37.28 c
T_{13}	39.00 e	44.33 b	36.52 c
T_{14}	43.33 cd	44.63 b	38.72 b
T_{15}	48.00 a	52.80 a	39.77 a
$LSD_{0.05}$	1.948	2.06	1.048
CV(%)	9.66	7.55	6.53

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

4.1.3 Leaf area (cm^2 $leaf^{-1}$)

4.1.3.1 Leaf area at silking time

Significant influence was recorded on leaf area of maize at silking time as affected by different planting configurations (Table 3 and Appendix VII). Leaf area at silking time was recorded at three different parts of the plant *viz*. at leaves below cob- node, leaf at cob-node and leaves above cob-node (Table 3).

Leaves below cob- node, the highest leaf area at silking time (302.50 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} which was significantly different from other treatments followed byT_{14} whereas the lowest leaf area at silking time (477.90 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was statistically identical withT_6.

Leaf at cob-node, the highest leaf area at silking time (879.30 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} which was significantly different from other treatments whereas the lowest leaf area at silking time (595.50 cm^2 $leaf^{-1}$) was found from the treatment T_1.

Leaves above cob-node, the highest leaf area at silking time (496.30 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} followed by T_{14} whereas the lowest leaf area at silking time (262.90 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was significantly different from other treatments.

From the result, it was observed that at all three portion of maize plant, the maximum leaf area at silking time (477.90, 879.30 and 496.30 cm^2 $leaf^{-1}$ at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_{15} followed by T_{14} whereas the minimum leaf area at silking time (302.50, 595.50 and 262.90 cm^2 $leaf^{-1}$ at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_1.

Table 3. Leaf area of maize at silking as influenced by different planting configurations

Treatments	Leaf area at silking (cm^2 leaf^{-1})		
	Leaves below cob- node	Leaf at cob-node	Leaves above cob-node
T_1	302.5 k	595.5 k	262.9 l
T_2	350.0 j	621.4 i	316.4 ij
T_3	356.3 i	662.9 g	293.3 k
T_4	364.9 h	681.1 e	409.3 ef
T_5	373.4 g	659.0 g	353.8 g
T_6	306.5 k	676.5 ef	428.3 d
T_7	406.2 e	614.6 j	311.0 ij
T_8	370.0 gh	627.5 i	309.9 j
T_9	346.6 j	613.2 j	331.3 h
T_{10}	389.5 f	646.8 h	318.8 i
T_{11}	375.7 g	671.5 f	404.0 f
T_{12}	442.4 d	734.0 d	414.0 e
T_{13}	452.1 c	747.0 c	444.6 c
T_{14}	470.3 b	771.3 b	464.6 b
T_{15}	477.9 a	879.3 a	496.3 a
$LSD_{0.05}$	5.824	6.404	7.529
CV(%)	10.17	12.24	9.00

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

4.1.3.2 Leaf area (cm^2 leaf^{-1}) at 15 days of silking time

Significant influence was recorded on leaf area of maize at 15 days after silking time as affected by different planting configurations (Table 4 and Appendix VIII). Leaf area at 15 days after silking time was recorded at three different parts of the plant *viz*. at leaves below cob- node, leaf at cob-node and leaves above cob-node (Table 4).

Leaves below cob- node, the highest leaf area at 15 days after silking time (511.60 cm^2 leaf^{-1}) was recorded from the treatment T_{15} followed by T_{14} whereas the lowest leaf area at 15 days after silking time (247.70 cm^2 leaf^{-1}) was found from the treatment T_1.

Leaf at cob-node, the highest leaf area at 15 days after silking time (756.40 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} which was statistically similar withT_{12} whereas the lowest leaf area at 15 days after silking time (562.80 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was statistically identical withT_5.

Table 4. Leaf area of maize at 15 days after silking time as influenced by different planting configurations

Treatment	Leaf area 15 days after silking (cm^2)		
	Leaves below cob- node	Leaf at cob-node	Leaves above cob-node
T_1	247.7 l	562.8 k	256.6 j
T_2	281.1 k	591.6 i	274.5 i
T_3	297.8 j	633.5 f	291.8 h
T_4	313.9 i	617.6 g	273.3 i
T_5	326.0 h	562.6 k	289.4 h
T_6	369.8 g	579.5 j	299.1 g
T_7	380.9 f	674.2 e	291.0 h
T_8	367.3 g	715.2 d	311.2 f
T_9	298.4 j	720.3 cd	368.8 bc
T_{10}	283.2 k	668.6 e	350.5 d
T_{11}	393.1 e	605.3 h	321.4 e
T_{12}	414.1 d	749.8 ab	362.3 c
T_{13}	441.6 c	726.5 c	372.9 b
T_{14}	467.6 b	745.1 b	355.1 d
T_{15}	511.6 a	756.4 a	381.0 a
$LSD_{0.05}$	7.161	6.926	6.754
CV(%)	8.79	10.17	13.20

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

Leaves above cob-node, the highest leaf area at 15 days after silking time (381.00 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} followed by T_{14} whereas the lowest leaf area at 15 days after silking time (256.60 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was significantly different from other treatments.

From the result, it was observed that at all three portion of maize plant, the maximum leaf area at 15 days after silking time (511.60, 756.40 and 381.00 cm^2 $leaf^{-1}$ at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_{15} followed by T_{14} whereas the minimum leaf area at 15 days after silking time (247.70, 562.80 and 256.60 cm^2 $leaf^{-1}$ at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_1.

4.1.3.3 Leaf area at harvest

Significant influence was recorded on leaf area of maize at harvest as affected by different planting configurations (Table 5 and Appendix IX). Leaf area at harvest was recorded at three different parts of the plant *viz*. at lower leaves, cob leaves and upper leaves (Table 5).

Leaves below cob- node, the highest leaf area at harvest (302.10 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} followed by T_{14} whereas the lowest leaf area at harvest (145.70 cm^2 $leaf^{-1}$) was found from the treatment T_1.

Leaf at cob-node, the highest leaf area at harvest (615.60 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} which was significantly different from other treatments followed by T_{14} whereas the lowest leaf area at harvest (365.40 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was significantly different from other treatments.

Leaves above cob-node, the highest leaf area at harvest (389.00 cm^2 $leaf^{-1}$) was recorded from the treatment T_{15} followed by T_{14} whereas the lowest leaf area at harvest (211.10 cm^2 $leaf^{-1}$) was found from the treatment T_1 which was significantly different from other treatments.

Table 5. Leaf area of maize at harvest as influenced by different planting configurations

Treatment	Leaf area at harvest (cm^2 leaf^{-1})		
	Leaves below cob- node	**Leaf at cob-node**	**Leaves above cob-node**
T_1	145.7 k	365.4 j	211.1 k
T_2	183.9 h	438.6 i	262.7 ef
T_3	170.8 j	446.1 h	246.3 h
T_4	181.8 hi	446.9 h	253.8 g
T_5	175.2 ij	445.5 h	259.6 fg
T_6	233.9 d	513.0 d	267.7 e
T_7	201.6 g	432.7 i	236.7 i
T_8	172.7 j	445.9 h	224.0 j
T_9	200.6 g	494.8 ef	290.1 d
T_{10}	230.1 de	474.5 g	294.6 d
T_{11}	226.4 e	490.4 f	288.7 d
T_{12}	209.1 f	497.5 e	315.3 c
T_{13}	256.3 c	523.2 c	318.5 c
T_{14}	284.1 b	549.1 b	344.3 b
T_{15}	302.1 a	615.6 a	389.0 a
$LSD_{0.05}$	6.964	6.688	6.838
CV(%)	7.14	11.86	12.57

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

From the result, it was observed that at all three portion of maize plant, the maximum leaf area at harvest (302.10, 615.60 and 389.00 cm^2 leaf^{-1} at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_{15} followed by T_{14} whereas the minimum leaf area at harvest (147.70, 365.40 and 211.10 cm^2 leaf^{-1} at leaves below cob- node, leaf at cob-node and leaves above cob-node, respectively) was found from the treatment T_1. Similar result was also observed by Enujeke (2013) who found higher leaf area per plant with 75 cm × 35 cm compared to 75 cm × 15 cm plant spacing.

4.1.4 Dry matter content (g)

4.1.4.1 Dry matter content at silking time

Significant influence was recorded on dry matter content of maize at silking time at different portion of plant as affected by different planting configurations (Table 6 and Appendix X). Dry matter content at silking time was recorded at three different parts of the maize plant *viz*. at below cobs-node, at cob-node and above cob-node (Table 6).

Below cobs-node, the highest dry matter content at silking time (31.32 g plant^{-1}) was recorded from the treatment T_{12} which was statistically similar with T_{15} followed by T_{14} whereas the lowest dry matter content at silking time (16.85 g plant^{-1}) was found from the treatment T_1 which was significantly different from other treatments.

At cob-node, the highest dry matter content at silking time (29.17 g plant^{-1}) was recorded from the treatment T_{12} which was significantly different from other treatments followed by T_{15} whereas the lowest dry matter content at silking time (15.46 g plant^{-1}) was found from the treatment T_1 which was statistically identical withT_3 and T_{11}.

Above cob-node, the highest dry matter content at silking time (27.25 g plant^{-1}) was recorded from the treatment T_{12} which was statistically identical with T_{15} whereas the lowest dry matter content at silking time (15.46 g plant^{-1}) was found from the treatment T_1 which was significantly different from other treatments.

From the result, it was observed that at all three portion of maize plant, the maximum dry matter content at silking time (31.32, 29.17 and 27.25 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_{12} whereas the minimum dry matter content at silking time (16.85, 11.95 and 15.46 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_1.

Table 6. Stem dry matter content of maize at silking time as influenced by different planting configurations

Treatment	Stem dry matter content (g $plant^{-1}$)		
	Below cob-node	**At cob-node**	**Above cob-node**
T_1	16.85 f	11.95 h	15.46 h
T_2	22.80 de	15.81 g	18.01 fg
T_3	22.12 de	12.51 h	17.38 g
T_4	21.52 e	19.88 ef	22.38 c
T_5	23.28 de	24.39 bc	18.36 fg
T_6	22.04 de	16.01 g	25.51 b
T_7	24.25 cde	23.81 c	18.12 fg
T_8	24.45 cd	19.75 f	19.44 ef
T_9	26.66 bc	22.25 d	20.66 de
T_{10}	28.29 b	21.59 d	21.93 cd
T_{11}	23.05 de	12.60 h	22.37 c
T_{12}	31.32 a	29.17 a	27.25 a
T_{13}	22.73 de	18.89 f	18.05 fg
T_{14}	27.61 b	21.35 de	19.33 ef
T_{15}	28.73 ab	25.91 b	27.40 a
$LSD_{0.05}$	0.5196	0.2915	0.2828
CV(%)	8.89	7.47	6.60

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

4.1.4.2 Dry matter content (g) at 15 days after silking

Significant influence was recorded on dry matter content of maize at15 days after silking as affected by different planting configurations (Table 7 and Appendix XI). Dry matter content at15 days after silking was recorded at three different parts of the maize plant *viz*. at below cobs-node, at cob-node and above cob-node (Table 7).

Table 7. Dry matter content of maize at 15 days after silking as influenced by different planting configurations

Treatment	Dry matter content at 15 days after silking (g plant^{-1})		
	Below cob-node	At cob-node	Above cob-node
T_1	19.45 j	28.99 k	17.06 h
T_2	20.90 ij	32.80 j	17.63 h
T_3	24.59 fg	44.09 g	15.52 i
T_4	26.91 de	33.33 ij	17.71 gh
T_5	23.32 gh	34.28 i	19.38 ef
T_6	32.73 a	37.73 h	21.65 d
T_7	30.61 b	47.50 f	25.58 b
T_8	26.13 ef	50.57 de	19.03 fg
T_9	28.41 cd	49.33 e	23.54 c
T_{10}	24.93 fg	51.23 d	18.28 fgh
T_{11}	29.67 bc	52.87 c	18.11 fgh
T_{12}	34.47 a	73.54 a	28.00 a
T_{13}	22.15 hi	49.71 e	19.35 ef
T_{14}	29.45 bc	50.33 de	20.65 de
T_{15}	34.27 a	64.46 b	27.97 a
$LSD_{0.05}$	0.3512	0.2702	0.2633
CV(%)	9.80	11.60	10.89

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

Below cobs-node, the highest dry matter content at 15 days after silking time (34.47 g plant^{-1}) was recorded from the treatment T_{12} which was significantly different from other treatments T_6 and T_{15} whereas the lowest dry matter content at 15 days after silking time (19.45 g plant^{-1}) was found from the treatment T_1 which was statistically similar with T_2.

At cob-node, the highest dry matter content at 15 days after silking time (73.54 g plant^{-1}) was recorded from the treatment T_{12} which was significantly different from other treatments followed by T_{15} whereas the lowest dry matter content at 15 days after silking time (28.99 g plant^{-1}) was found from the treatment T_1 which was significantly different from other treatments.

Above cob-node, the highest dry matter content at 15 days after silking time (28.00 g plant^{-1}) was recorded from the treatment T_{12} which was statistically identical with T_{15} whereas the lowest dry matter content at 15 days after silking time (17.06 g plant^{-1}) was found from the treatment T_1 which was statistically identical with T_2.

From the result, it was observed that at all three portion of maize plant, the maximum dry matter content at 15 days after silking time (34.47, 73.54 and 28.00 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_{12} whereas the minimum dry matter content at 15 days after silking time (19.45, 28.99 and 17.06 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_1.

4.1.4.3 Dry matter content (g) at harvest

Significant influence was recorded on dry matter content of maize at harvest as affected by different planting configurations (Table 8 and Appendix XII). Dry matter content at harvest was recorded at three different parts of the maize plant *viz*. at below cobs-node, at cob-node and above cob-node (Table 8).

Below cobs-node, the highest dry matter content at harvest (28.07 g plant^{-1}) was recorded from the treatment T_{12} which was statistically identical withT_{15} whereas the lowest dry matter content at harvest (15.76 g plant^{-1}) was found from the treatment T_1 which was statistically identical withT_4.

At cob-node, the highest dry matter content at harvest (56.21 g plant^{-1}) was recorded from the treatment T_{12} which was statistically identical withT_{14} andT_{15} whereas the lowest dry matter content at harvest (33.17 g plant^{-1}) was found from the treatment T_1 which was statistically similar withT_5 andT_7.

Above cob-node, the highest dry matter content at harvest (15.10 g plant^{-1}) was recorded from the treatment T_{12} which was statistically similar withT_{14} andT_{15}

whereas the lowest dry matter content at harvest (10.62 g plant^{-1}) was found from the treatment T_1 which was statistically similar with T_9 and T_{11}.

From the result, it was observed that at all three portion of maize plant, the maximum dry matter content at harvest (28.07, 56.21 and 15.10 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_{12} whereas the minimum dry matter content at harvest (15.76, 33.17 and 10.62 g plant^{-1} at below cobs-node, at cob-node and above cob-node, respectively) was found from the treatment T_1. Ibeawuchi and Matthews-Njoku (2008) achieved highest dry matter with the plant spacing of 25 × 75cm and found that higher nutrient efficiency showed higher dry matter accumulation in plants. Under the present study higher plant spacing T_{12} showed higher dry matter content compared to others which was supported by the finding of Ibeawuchi and Matthews-Njoku (2008).

Table 8. Total dry matter content of maize at harvest as influenced by different planting configurations

Treatment	Total dry matter content at harvest (g plant^{-1})		
	Below cob-node	**Below cob-node**	**Below cob-node**
T_1	15.76 h	33.17 g	10.62 g
T_2	22.73 de	46.73 b	12.97 cd
T_3	21.24 f	37.90 ef	12.17 def
T_4	17.11 h	37.34 f	12.78 cd
T_5	20.50 f	35.31 fg	13.56 bc
T_6	18.61 g	40.92 de	12.65 cde
T_7	20.58 f	34.73 fg	14.00 b
T_8	21.00 f	36.38 f	13.43 bc
T_9	23.77 cde	37.41 f	11.64 efg
T_{10}	22.64 e	43.38 cd	12.59 cde
T_{11}	24.03 cd	46.48 bc	11.20 fg
T_{12}	28.07 a	56.21 a	15.10 a
T_{13}	24.38 c	49.59 b	14.07 b
T_{14}	26.00 b	54.81 a	14.33 ab
T_{15}	28.30 a	54.45 a	14.24 ab
$LSD_{0.05}$	0.2614	0.6028	0.1932
CV(%)	12.05	9.20	7.51

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

4.2 Yield contributing parameters

4.2.1 Cob length (cm)

Significant influence was recorded on cob length of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results showed that the highest cob length (15.94 cm) was recorded from the treatment T_{14} which was significantly different from all other treatments followed by the treatment T_{13}. Treatment T_{12} and T_{15} also showed higher cob length compared to other treatments but significantly different from T_{14}. The lowest cob length (9.19 cm) was found from the treatment T_1 which was statistically identical with the treatment T_2 and T_3. Treatment T_4, T_5, T_6 and T_7 also showed lower result but statistically similar with each other but significantly higher from T_1. Fanadzo *et al*. (2010) found similar result with the present study and observed that higher cob length per plant was found from higher plant spacing. Ramchandrappa *et al***.** (2004), Kunjir (2007), Bairagi *et al*. (2015) and Chamroy *et al*. (2017) also found similar result with the present study.

4.2.2 Cob breadth (cm)

Significant influence was recorded on cob breadth of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results revealed that the highest cob breadth (13.06 cm) was recorded from the treatment T_{12} which was statistically similar with the treatment T_9, T_{10} and T_{13}. On the other hand, the lowest cob breadth (9.62 cm) was found from the treatment T_1 which was statistically similar with the treatment T_2 and T_3. Under the present study, the highest cob breadth (13.06 cm) from T_{12} which might be due to cause of higher nutrient uptake from lower plant population due to less competition of nutrients.

4.2.3 Number of rows cob^{-1}

Significant influence was recorded on number of rows cob^{-1} of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results showed that the highest number of rows cob^{-1} (12.33) was recorded from the treatment T_{12} which was significantly different from all other treatments followed byT_6, T_9 and T_{10}. The lowest number of rows cob^{-1} (8.22) was found from the treatment T_1 which was statistically similar with the treatment T_2 and T_3. Rahman *et al*. (2016) supported the present study who reported that number of rows cob^{-1} per plant basis was achieved with wider row spacing compared to lower plant spacing. Similar result was also observed by Kunjir (2007).

4.2.4 Number of grains row^{-1}

Significant influence was recorded on number of grains row^{-1} of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results showed that the highest number of grains row^{-1} (20.00) was recorded from the treatment T_{14} which was significantly different from all other treatments followed byT_{12} andT_{15}. The lowest number of grains row^{-1} (6.89) was found from the treatment T_1 which was significantly different from all other treatments. Treatment T_2, T_3 and T_4 also showed lower result compared to other treatments but significantly higher than T_1. Similar result was also observed by Rahman *et al*. (2016) and Kunjir (2007).

4.2.5 Number of grains cob^{-1}

Significant influence was recorded on number of grains cob^{-1} of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results showed that the highest number of grains cob^{-1} (231.50) was recorded from the treatment T_{12} which was significantly different from all other treatments followed by T_{14}. Treatment T_{13} and T_{15} also showed higher result but significantly different T_{12}. The lowest number of grains cob^{-1} (61.21) was found from the treatment T_1 which was significantly different from all other treatments. Treatment T_2 and T_3 also gave lower number of grains cob^{-1} but significantly higher than T_1. The result obtained from the present study was similar with the findings of Rahman *et al*. (2016), Kunjir (2007) and Bairagi *et al*. (2015).

Table 9. Yield contributing parameters of maize as influenced by different planting configurations

Treatment	Yield contributing parameters					
	Cob length (cm)	Cob breadth (cm)	Number of rows cob^{-1}	Number of grains row^{-1}	Number of grains cob^{-1}	100-seed weight (g)
T_1	9.187 g	9.623 f	8.223 i	6.890 j	61.21 k	23.38 e
T_2	9.577 g	10.03 ef	8.833 hi	10.56 hi	93.58 j	24.04 e
T_3	9.313 g	10.10 ef	8.667 hi	9.663 i	86.86 j	25.46 d
T_4	10.78 f	10.69 e	9.223 gh	11.33 h	107.4 i	27.77 c
T_5	11.80 ef	11.52 d	10.00 f	14.00 f	140.2 g	28.29 bc
T_6	11.05 f	12.22 c	11.67 b	14.11 ef	164.1 e	25.73 d
T_7	11.51 ef	10.68 e	10.67 de	15.55 d	165.6 e	27.38 c
T_8	13.13 cd	12.08 cd	11.11 bcd	15.33 de	170.3 e	27.55 c
T_9	13.51 bcd	12.94 ab	11.33 bc	12.67 g	140.3 g	28.43 bc
T_{10}	12.35 de	12.54 abc	9.223 gh	13.11 fg	121.6 h	29.95 a
T_{11}	13.49 bcd	12.27 bc	9.663 fg	15.56 d	154.1 f	28.08 bc
T_{12}	13.77 bc	13.06 a	12.33 a	18.67 b	231.5 a	29.99 a
T_{13}	14.39 b	12.46 abc	11.00 cd	17.34 c	189.5 c	27.96 bc
T_{14}	15.94 a	12.01 cd	10.78 cde	20.00 a	218.5 b	29.51 a
T_{15}	14.28 bc	12.13 cd	10.22 ef	17.44 bc	181.2 d	28.94 ab
$LSD_{0.05}$	0.2258	0.1317	0.1211	0.2401	1.341	0.2008
CV(%)	7.76	8.21	13.34	7.07	12.72	8.85

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

4.2.6 Weight of 100 seeds (g)

Significant influence was recorded on 100 seed weight of maize as affected by different planting configurations (Table 9 and Appendix XIII). Results showed that the highest 100 seed weight (29.99 g) was recorded from the treatment T_{12} which was statistically similar with the treatment T_{10}, T_{14} and T_{15}. Treatment T_5, T_9 and T_{13} showed comparatively higher 100 seed weight which was statistically identical with each other but significantly different from T_{12}. The lowest 100 seed weight (023.380 g) was found from the treatment T_1 which was statistically identical with the treatment T_2. Treatment T_3 and T_6 also showed lower 100 seed weight but significantly higher than T_1. Similar result was also observed by Shafi *et al*. (2012) who found higher 100 seed weight with higher plant spacing. Kunjir (2007) also found 1000 grains weight increased significantly with wider spacing (75 cm x 20 cm) as compared to narrower spacing (45 cm × 20 cm and 60 cm × 20 cm). Rahman *et al*. (2016) also found similar result with the present study.

4.3 Yield parameters

4.3.1 Grain weight cob^{-1} (g)

Significant influence was recorded on grain weight cob^{-1} of maize as affected by different planting configurations (Table 10 and Appendix XIV). Results showed that the highest grain weight cob^{-1} (59.81 g) was recorded from the treatment T_{12} which was statistically identical with the treatment T_{15}. Treatment T_{14}, T_{11} and T_{13} also showed closer result on grain weight cob^{-1} but significantly different from T_{12}. The lowest grain weight cob^{-1} (17.42 g) was found from the treatment T_1 which was significantly different from all other treatments. The treatment T_2, T_3 and T_4 also showed lower result on grain weight cob^{-1} which was closer to T_1 but significantly different from them. Similar result was also observed by Kunjir (2007) who observed weight of grains per cob, increased significantly with wider spacing (75 cm x 20 cm) as compared to narrower spacing (45 cm × 20 cm and 60 cm × 20 cm). Similar result was also observed by Rahman *et al*. (2016).

4.3.2 Shell weight cob^{-1} (g)

Significant influence was recorded on shell weight cob^{-1} of maize as affected by different planting configurations (Table 10 and Appendix XIV). Results showed that the highest shell weight cob^{-1} (15.33 g) was recorded from the treatment T_{14} which was statistically similar with the treatment T_{12} whereas the lowest shell weight cob^{-1} (7.76 g) was found from the treatment T_1 which was statistically similar with the treatment T_2, T_4 and T_7.

Table 10. Yield parameters of maize on grain weight cob^{-1}, shell weight cob^{-1} and chaff weight cob^{-1} as influenced by different planting configurations

Treatment	Yield parameters		
	Grain weight cob^{-1} (g)	**Shell weight cob^{-1} (g)**	**Chaff weight cob^{-1} (g)**
T_1	17.42 k	7.757 i	4.000 g
T_2	26.12 i	8.323 hi	5.333 f
T_3	21.09 j	8.807 h	5.130 f
T_4	25.53 i	8.533 hi	5.337 f
T_5	40.87 e	9.697 g	6.807 c
T_6	40.32 ef	9.957 g	6.113 e
T_7	35.26 h	8.513 hi	6.240 e
T_8	41.94 e	12.19 ef	6.907 c
T_9	38.81 fg	12.70 de	6.357 de
T_{10}	37.99 g	11.70 f	6.703 cd
T_{11}	55.67 b	13.20 cd	7.673 b
T_{12}	59.81 a	14.57 ab	8.240 a
T_{13}	40.42 e	12.82 de	8.047 ab
T_{14}	55.47 b	15.33 a	8.187 a
T_{15}	58.32 a	13.81 bc	8.133 a
$LSD_{0.05}$	0.317	0.1663	0.0796
CV(%)	12.83	8.39	11.03

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

4.3.3 Chaff weight cob^{-1} (g)

Significant influence was recorded on chaff weight cob^{-1} of maize as affected by different planting configurations (Table 10 and Appendix XIV). Results showed that the highest chaff weight cob^{-1} (8.24 g) was recorded from the treatment T_{12} which was statistically identical with the treatment T_{14} and T_{15} and T_{13}. Again, the lowest chaff weight cob^{-1} (4.00 g) was found from the treatment T_1 which was statistically similar with the treatment but T_2, T_3 and T_4 also showed closer result on chaff weight cob^{-1} compared to T_1.

4.3.4 Grain yield ha^{-1} (t)

Significant influence was recorded on grain yield ha^{-1} of maize as affected by different planting configurations (Table 11 and Appendix XV). Results showed that the highest grain yield (4.77 t ha^{-1}) was recorded from the treatment T_{11}

which was statistically identical with the treatment T_5, T_7, T_{13} and T_{14} followed by T_{10}. The lowest grain yield ha^{-1} (2.11 t ha^{-1}) was found from the treatment T_3 which was significantly different from all other treatments. The treatment T_1 and T_9 also showed lower result on which was closer to T_3 but significantly different from them. Similar result was also observed by Shafi *et al*. (2012), Rahman *et al*. (2016), Hasan *et al*. (2018) and Stephanus *et al*. (2018) who observed grain yield ha^{-1} significantly increased with increasing planting density to a certain level.

4.3.5 Stover yield ha^{-1} (t)

Significant influence was recorded on stover yield ha^{-1} of maize as affected by different planting configurations (Table 11 and Appendix XV). Results showed that the highest stover yield (10.60 t ha^{-1}) was recorded from the treatment T_2 which was statistically identical with the treatment T_1, T_4 and T_{13} followed by T_7 and T_{10}. The lowest stover yield ha^{-1} (5.66 t ha^{-1}) was found from the treatment T_9 which was significantly different from all other treatments. Shafi *et al*. (2012) and Rahman *et al*. (2016) also found similar result with the present study.

Table 11. Yield parameters of maize on grain yield ha^{-1}, stover yield ha^{-1}, biological yield ha^{-1} and harvest index as influenced by different planting configurations

Treatments	Yield parameters			
	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	2.99 f	10.21 a	13.19 b	22.63 k
T_2	3.36 e	10.60 a	13.96 ab	24.06 j
T_3	2.11 g	7.13 e	9.24 i	22.82 k
T_4	3.89 c	10.24 a	14.13 ab	27.52 i
T_5	4.67 a	7.93 cd	12.60 cd	37.07 b
T_6	3.58 d	6.42 fg	10.00 h	35.84 cd
T_7	4.70 a	9.24 b	13.94 ab	33.72 f
T_8	4.19 b	7.08 e	11.28 f	37.20 b
T_9	3.02 f	5.66 h	8.68 j	34.77 e
T_{10}	4.34 b	8.98 b	13.33 b	32.58 g
T_{11}	4.77 a	7.00 e	11.78 e	40.52 a
T_{12}	3.99 c	6.63 f	10.61 g	37.57 b
T_{13}	4.62 a	10.06 a	14.68 a	31.47 h
T_{14}	4.75 a	8.15 c	12.91 c	36.83 bc
T_{15}	3.89 c	6.47 fg	10.35 gh	37.55 b
$LSD_{0.05}$	0.036	0.404	0.487	1.033
CV(%)	11.92	12.32	12.24	11.14

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

4.3.6 Biological yield ha^{-1} (t)

Significant influence was recorded on biological yield ha^{-1} of maize as affected by different planting configurations (Table 11 and Appendix XV). Results showed that the highest biological yield (14.48 t ha^{-1}) was recorded from the treatment T_{13} which was statistically similar with the treatment T_2, T_4 and T_7. The lowest biological yield ha^{-1} (8.68 t ha^{-1}) was found from the treatment T_9 which was significantly different from all other treatments. The treatment T_3 and T_6 also showed lower result on biological yield ha^{-1} which was closer to T_9 but significantly different Stephanus *et al*. (2018) and Rahman *et al*. (2016) also found similar result with the present study.

4.3.7 Harvest index (%)

Significant influence was recorded on harvest index of maize as affected by different planting configurations (Table 11 and Appendix XV). Results showed that the highest harvest index (40.52%) was recorded from the treatment T_{11} which was significantly different from all other treatments followed by T_5, T_8, T_{11} and T_{15}. The lowest harvest index (22.63%) was found from the treatment T_1 which was significantly same with the treatments T_3. The treatment T_2 and T_{13} also showed lower result on harvest index which was closer to T_1 but significantly different. Similar result was also observed by Stephanus *et al*. (2018) and Hasan *et al*. (2018).

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy Field of Sher-e-Bangla Agricultural University, during the kharif- II season from July to October, 2018 with a view to find out the best planting configuration for white maize genotype 'SAUWMOPMDT273'. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Single factor experiment was carried out with 15 planting configuration .The data on different growth characters, yield contributing characters and yield parameters were recorded and also recorded data were analyzed statistically using the MSTAT-C computer package program. The mean differences among the treatments were compared by LSD at 5% level of significance. Results showed that all the studied parameters were affected significantly by different planting configuration.

Considering growth parameters, the results revealed that the maximum plant height (217.00, 220.30 and 220.70 cm) and tassel length (48.00, 52.80 and 39.77 cm) at silking time, 15 days after silking time and at harvest, respectively were found from the treatment T_{15} whereas the minimum plant height (190.30, 184.30 and 175.50 cm) and tassel length (33.00, 26.67 and 27.98 cm) at silking time, 15 days after silking time and at harvest, respectively were observed from T_1.

Similarly, the maximum leaf area at silking time (477.90, 879.30 and 496.30 cm^2 at lower leaves, cob leaves and upper leaves, respectively), leaf area at 15 days after silking time (511.60, 756.40 and 381.00 cm^2 at lower leaves, cob leaves and upper leaves, respectively) and leaf area at harvest (302.10, 615.60 and 389.00 cm^2 at lower leaves, cob leaves and upper leaves, respectively) were found from the treatment T_{15}. On the other hand, the minimum the minimum leaf area at silking time (302.50, 595.50 and 262.90 cm^2 at lower leaves, cob leaves and upper leaves, respectively), leaf area at 15 days after silking time (247.70, 562.80 and 256.60 cm^2 at lower leaves, cob leaves and upper leaves, respectively) and leaf area at harvest (147.70, 365.40 and 211.10 cm^2 at lower leaves, cob leaves and upper leaves, respectively) were found from the treatment T_1.

Again, the maximum dry matter content at silking time (31.32, 29.17 and 27.25 g at lower leaves, cob leaves and upper leaves, respectively) dry matter content at 15 days after silking time (34.47, 73.54 and 28.00 g at lower leaves, cob leaves and upper leaves, respectively) and dry matter content at harvest (28.07, 56.21 and 15.10 g at lower leaves, cob leaves and upper leaves, respectively) were found from the treatment T_{12} whereas the minimum dry matter content at silking time (16.85, 11.95 and 15.46 g at lower leaves, cob leaves and upper leaves, respectively), dry matter content at 15 days after silking time (19.45, 28.99 and 17.06 g at lower leaves, cob leaves and upper leaves, respectively) and dry matter content at harvest (15.76, 33.17 and 10.62 g at lower leaves, cob leaves and upper leaves, respectively) were found from the treatment T_1.

In terms of yield contributing parameters, the highest cob length (15.94 cm) and number of grains row^{-1} (20.00) were recorded from the treatment T_{14} but the highest cob breadth (13.06 cm), number of rows cob^{-1} (12.33), number of grains cob^{-1} (231.50) and 100 seed weight (29.99 g) were recorded from the treatment T_{12}. On the other hand, lowest cob length (9.19 cm), cob breadth (9.62 cm), number of rows cob^{-1} (8.22), number of grains row^{-1} (6.89), number of grains cob^{-1} (61.21) and 100 seed weight (023.380 g) were found from the treatment T_1.

In case of yield parameters, the highest grain weight cob^{-1} (59.81 g) and chaff weight cob^{-1} (8.24 g) were found from the treatment T_{12} but the highest shell weight cob^{-1} (15.33 g) was recorded from the treatment T_{14}. Again, highest grain yield (4.77 t ha^{-1}) and harvest index (40.52%) were recorded from the treatment T_{11} while the highest stover yield (10.60 t ha^{-1}) was recorded from the treatment T_2 and highest biological yield (14.48 t ha^{-1}) was recorded from the treatment T_{13}. Likewise the lowest grain weight cob^{-1} (17.42 g), shell weight cob^{-1} (7.76 g) and chaff weight cob^{-1} (4.00 g) was found from the treatment T_1 whereas the lowest grain yield ha^{-1} (2.11 t ha^{-1}) was found from the treatment T_3 but the lowest stover yield ha^{-1} (5.66 t ha^{-1}) and biological yield ha^{-1} (8.68 t ha^{-1}) was found from the treatment T_9 and the lowest harvest index (22.63%) was found from the treatment T_1.

From the above result it can be stated that higher planting density (lower number of plant population per unit area) showed better performance in terms of per plant basis compared to lower plant density (higher number of plant population per unit area) but in case of yield per hactare, lower planting density showed better result compared to higher planting density. With this respect, results showed that the highest grain weight cob^{-1} (59.81 g) was found from the treatment T_{12} whereas the highest grain yield (4.77 t ha^{-1}) was recorded from the treatment T_{11}. Likewise, the lowest grain weight cob^{-1} (17.42 g) was found from the treatment T_1 whereas the lowest grain yield ha^{-1} (2.11 t ha^{-1}) was found from the treatment T_3. From the above findings, it can be concluded that the treatment T_{11} showed highest grain yield (4.77 t ha^{-1}) and harvest index (40.52%). So T_{11} had significantly the highest grain yield (4.77 t ha^{-1}) which however was not significantly higher than those of T_5, T_{13} and T_{14} (4.62-4.75 t ha^{-1}). As the treatment T_{14} had sparser configuration (60×20 cm) requiring less seed rate, this configuration may be followed.

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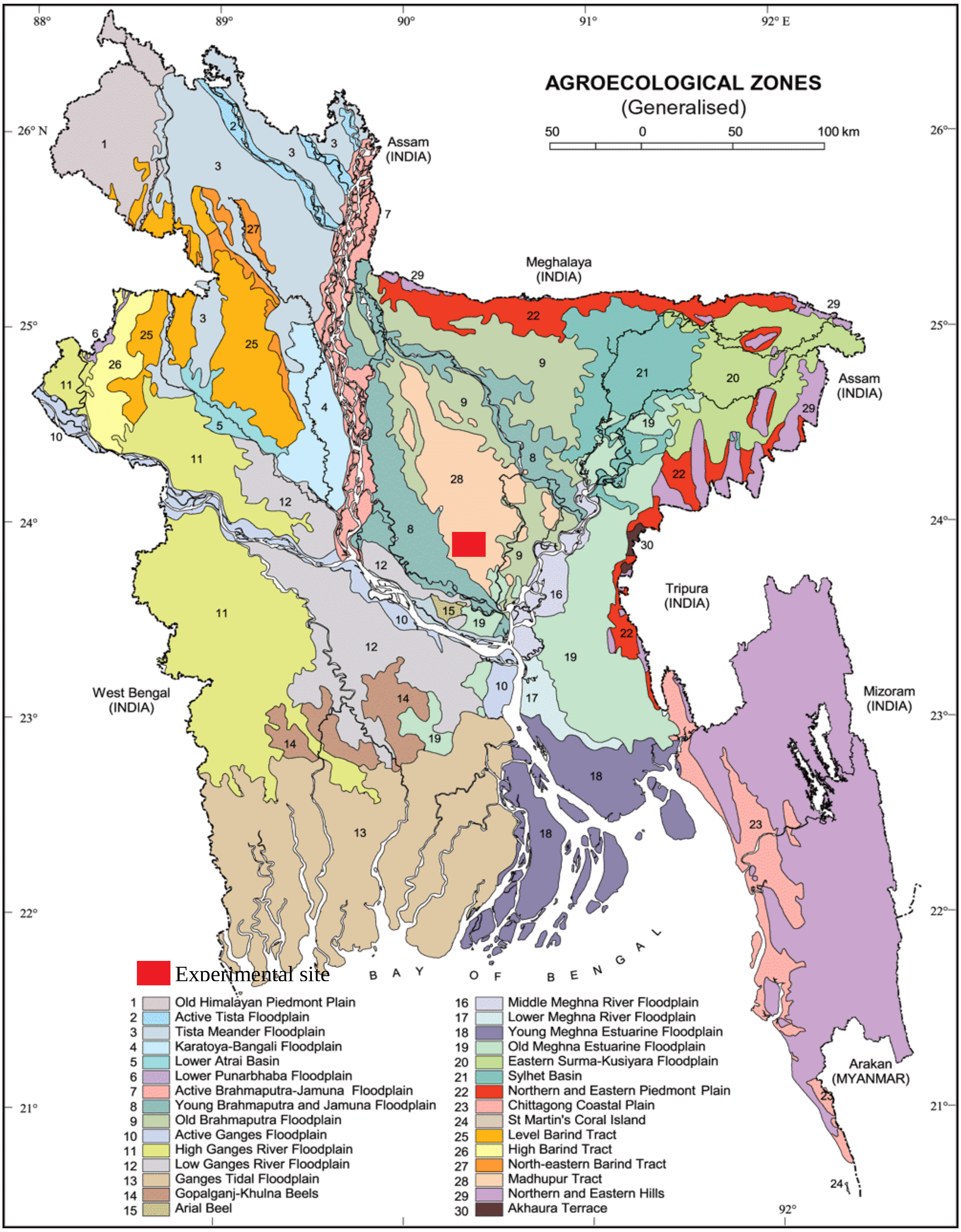
Appendices

APPENDICES

Appendix I. Agro-Ecological Zones of Bangladesh showing the experimental location



Appendix II. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur 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
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI, 2017)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

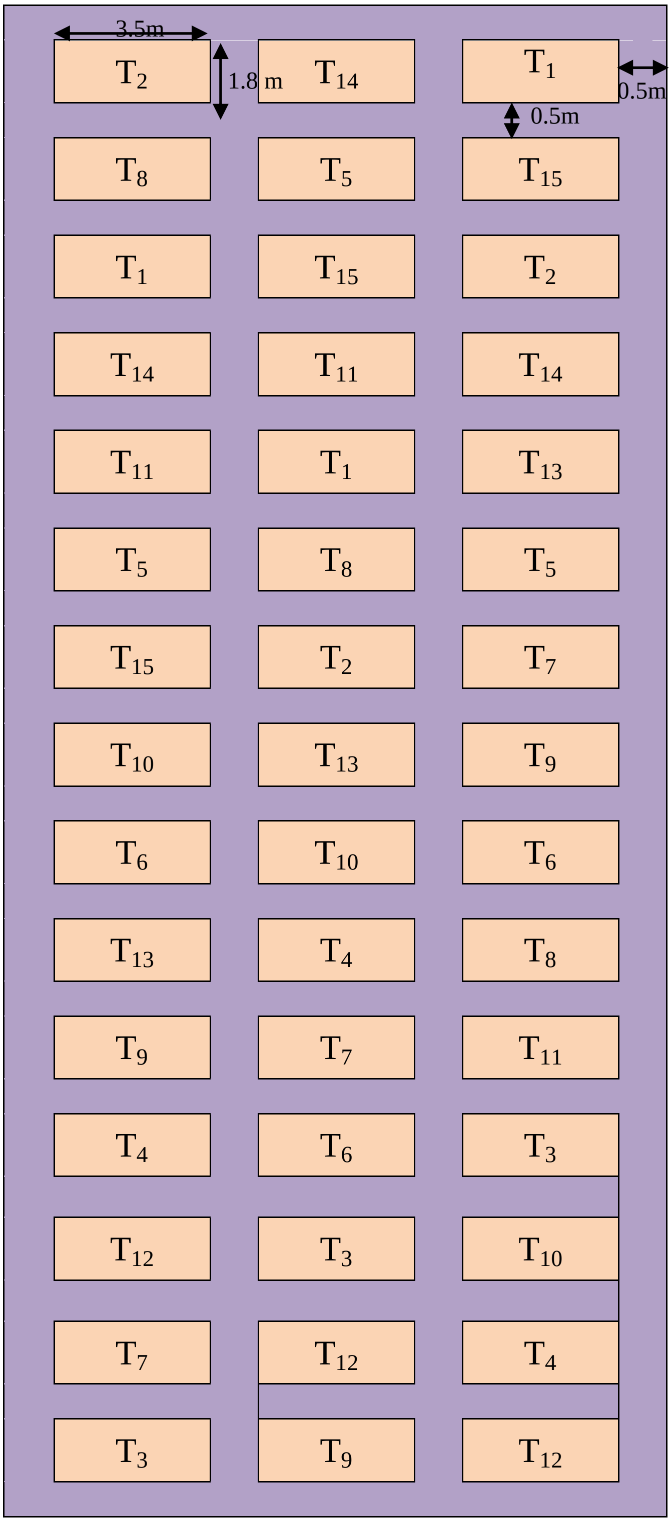
Source: Soil Resource Development Institute (SRDI, 2017)

Appendix III. Monthly records of air temperature, relative humidity and rainfall during the period from June to September 2018

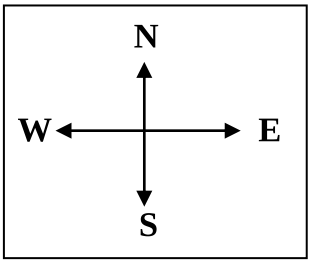
Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2018	June	27.40	23.44	25.42	71.28	190
2018	July	30.52	24.80	27.66	78.00	536
2018	August	31.00	25.60	28.30	80.00	348
2018	September	30.8	21.80	26.30	71.50	78.52

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix IV. Layout of the experiment field



Legend



Treatments

1. T_1 = 40 cm × 15 cm
2. T_2 = 40 cm × 20 cm
3. T_3 = 40 cm × 25 cm
4. T_4 = 45 cm × 15 cm
5. T_5 = 45 cm × 20 cm
6. T_6 = 45 cm × 25 cm
7. T_7 = 50 cm × 15 cm
8. T_8 = 50 cm × 20 cm
9. T_9 = 50 cm × 25 cm
10. T_{10} = 55 cm × 15 cm
11. T_{11} = 55 cm × 20 cm
12. T_{12} = 55 cm × 25 cm
13. T_{13} = 60 cm × 15 cm
14. T_{14} = 60 cm × 20 cm
15. T_{15} = 60 cm × 25 cm

Appendix V. Mean square values of plant height of maize as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At silking	At 15 days of silking	At harvest
Replication	2	3.889	4.489	7.685
Factor A	14	164.87**	272.99*	471.77*
Error	28	8.270	7.417	8.497

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Mean square values of tassel length of maize as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At silking	At 15 days of silking	At harvest
Replication	2	3.667	6.732	3.281
Factor A	14	57.705*	99.869*	37.833**
Error	28	6.357	9.517	7.393

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Mean square values of leaf area of maize at silking as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower leaf	At cob leaf	At upper leaf
Replication	2	14.215	17.951	19.108
Factor A	14	8897.781*	7024.113 *	5048.131 *
Error	28	30.127	40.660	47.265

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Mean square values of leaf area of maize at 15 days after silking as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower leaf	At cob leaf	At upper leaf
Replication	2	9.116	11.764	17.211
Factor A	14	468.452*	5333.237*	5183.702*
Error	28	12.330	17.150	22.309

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix IX. Mean square values of leaf area of maize at harvest as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower leaf	At cob leaf	At upper leaf
Replication	2	15.976	26.044	29.134
Factor A	14	5836.191*	1375.024**	6767.865*
Error	28	19.338	42.988	52.716

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix X. Mean square values of dry matter content of maize at silking as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower unit	At cob unit	At upper unit
Replication	2	6.620	1.118	5.062
Factor A	14	38.923**	79.615*	39.94**
Error	28	3.810	7.655	7.840

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XI. Mean square values of dry matter content of maize at 15 days after silking as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower unit	At cob unit	At upper unit
Replication	2	5.215	4.088	4.402
Factor A	14	66.69**	442.797*	46.372**
Error	28	7.170	13.819	5.819

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XII. Mean square values of dry matter content of maize at harvest as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		At lower unit	At cob unit	At upper unit
Replication	2	8.959	9.349	0.298
Factor A	14	39.667*	187.840*	4.745**
Error	28	4.205	8.090	3.094

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XIII. Mean square values of cob length, cob breadth, number of rows cob^{-1}, number of grains row^{-1}, number of grfains cob^{-1} 100- seed weight of maize as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value					
		Cob length	Cob breadth	Number of rows cob^{-1}	Number of grains row^{-1}	Number of grains cob^{-1}	100-seed weight
Replication	2	1.713	0.556	2.837	7.280	5.795	1.821
Factor A	14	12.43*	3.720**	4.365**	38.13*	976.0*	12.1*
Error	28	2.853	0.911	1.850	14.673	7.394	5.921

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XIV. Mean square values of grain weight cob^{-1}, shell weight cob^{-1} and chaff weight cob^{-1} of maize as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value		
		Grain weight cob^{-1}	Shell weight cob^{-1}	Chaff weight cob^{-1}
Replication	2	4.947	2.307	1.208
Factor A	14	515.76*	19.134**	5.035**
Error	28	4.703	6.283	2.319

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XV. Mean square values of yields and harvest index of maize as influenced by different planting configurations

Sources of variation	Degrees of freedom	Mean square value			
		Grain yield	Stover yield	Biological yield	Harvest index
Replicatio n	2	2.145	3.244	4.289	3.542
Factor A	14	78.533**	157.29*	299.36*	187.42**
Error	28	3.254	5.277	7.24	4.28

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level