INFLUENCE OF SPACING ON GROWTH AND YIELD OF HYBRID MAIZE (*Zea mays*)

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ABSTRACT

An experiment was conducted during November 2018 to March 2019 at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka to study influence of spacinng on growth and yield of hybrid maize. The experiment comprised of two factors having two varieties (V_1 = SAU Hybrid Vutta 1 and V_2 = SAU Hybrid Vutta 2) and six spacing (S_1 = 50 cm x 20 cm, S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm and S_6 =75 cm x 20 cm). The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. Results revealed that both the individual and the interaction treatments had effect on different growth, yield contributing and yield parameters of SAU Hybrid Vutta 1 and SAU Hybrid Vutta 2. The highest dry weight plant^{-1} (149.81 g) was found from the spacing S_6. In case of yield contributing parameters the highest cob length (17.17 cm), number of grain cob^{-1} (524.50), cob weight plant^{-1} (232.31 g) and total grain weight cob^{-1} (158.70 g) were found from the spacing S_6. The highest grain yield (12.39 tha^{-1}), stover yield (13.59 tha^{-1}), biological yield (25.99 tha^{-1}) were also found S_6 but highest harvest index (47.87%) was obtained from the spacing S_4. The yield contributing parameters such as the lowest cob length (15.17 cm), number of grain cob^{-1} (426.00), cob weight plant^{-1} (176.14 g), total grain weight cob^{-1} (120.15 g), grain yield (9.61 tha^{-1}), stover yield (10.51 tha^{-1}), biological yield (20.12 tha^{-1}) were found in S_1 but the lowest harvest index (46.56%) was obtained from the spacing S_2. The highest plant height (52.27 cm, 163.07 cm and 255.67 cm at 30, 60 and 90 DAS), total grain weight cob^{-1} (175.27 g), grain yield (13.50 tha^{-1}), stover yield (13.92 tha^{-1}), biological yield (27.42 tha^{-1}) and harvest index (49.29%) were obtained from the treatment combination of V_2S_6. The lowest grain yield (8.19 t ha^{-1}), stover yield (9.22 tha^{-1}), biological yield (17.41 tha^{-1}) were found from treatment combination of V_1S_1 but the lowest harvest index (46.07%) was obtained from the treatment combination of V_1S_2. So, the treatment combination of V_2 and S_6 i.e.V_2S_6 can be considered as the superior treatment combination compared to other treatment combinations under the present study.

CHAPTER I

INTRODUCTION

The word maize is used interchangeably with corn in the Western world. Although the origin of the word maize is also controversial, it is generally accepted that the word has its origin in Arawac tribes of the indigenous people of the Caribbean. On the basis of this common name, *Linnaeus* included the name as species epithet in the botanical classification maize *(Zea mays* L.). Maize is known to have been one of the first plants grown between 7000 and 10,000 years ago by farmers, with evidence of maize as food coming from some archaeological sites in Mexico where some small corn cobs were found in caves, estimated to be over 5000 years old. With respect to its evolution as a cultivated plant and as a variety of food items, the spread of maize from its center of origin in Mexico to different parts of the world has been remarkable and rapid. Maize belongs to family *poaceae*, is an important cereal crop of the world as well as of Bangladesh. Maize is the second most important cereal crop next to rice being used both food and feed crop worldwide. It shows great adaptability to a wide range of agro-climatic region and can be grown in all three seasons *viz*., Kharif-1 Kharif-2 and Rabi. Maize is multipurpose crop, provides food for human beings, feed for animals, poultry and fodder for livestock. It has high nutritional value as it contains about 72% starch, 10% proteins, 4.8% oil, 8.5% fibre, 3.0% sugar and 1.7% ash (Chaudhary, 1983). Now maize is grown throughout the world, although there are large differences in yields. The United Nations Food and Agriculture Organization (FAO) agricultural production indices include commodities that are considered edible and contain nutrients and display the relative level of the aggregate amount of agricultural production for each year compared to the 1999-2001 baseline period. It is estimated that in 2012, the total world production of maize was 875,226,630 tons, 27 with the United States, China, and Brazil harvesting 31%, 24%, and 8% of the total production of maize, respectively.

Maize is one of the most common cereal crops in many countries around the world, providing a major food source. It is a versatile crop and ranks third following wheat and rice in world production (FAO, 2002). It is grown as a fodder, feed and food crop.

It is also used as raw material for manufacturing pharmaceutical and industrial products.

The main staple crops of Bangladesh are rice and wheat from where food grains for 16 million people is supplied. However, it is postulated that rice and wheat being C_3 in genetical nature, these two crops may not be able supplying food requirements at or after fifties as the population of Bangladesh is still in increasing trend with an alarming rate. So, maize being a C_4 crop may provide necessary amount of food along with those of rice and wheat as the potentials of the C_4 crop is much higher than that of C_3. It is also forecasted that due to the continued increase in global temperature due to climate change, the yield potential of wheat will be decreasing day by day if its grain filling could not be synchronized with period of low temperature.

Introduction of maize in Bangladesh as human food can be a viable alternative for sustaining food security as the productivity of maize much higher than rice and wheat (Ray *et al*., 2013). It provides many of the B vitamins and essential minerals along with fiber, but lacks some other nutrients, such as vitamin B_{12} and vitamin C. People in many developed and developing countries produce and consume maize as staple food. Maize has been a recent introduction in Bangladesh. Rice maize cropping system has been expanded (Timsina *et al.,* 2010) rapidly in the northern districts of Bangladesh mainly in response to increasing demand for poultry feed (BBS, 2016). Maize production of Bangladesh increased from 3,000 tons in 1968 to 3.03 million tons in 2017 growing at an average annual rate of 28.35 % (FAO, 2019).

There are two kinds of maize in respect of grain color; yellow and white. Worldwide, the yellow maize is mainly used as fodder while the white ones are consumed as human food (FAO, 2002). In general the yield productivity of any crop in this country is low which is generally attributed to the poor agronomic management. Among the agronomic managements, setting optimum population density using the correct planting configuration.

Potential higher yields of modern hybrids obtainable with higher population encouraged planting maize at narrower spacing (Khan *et al*., 2005). In Bangladesh, a population density of 83,000 planted in rows at 60 cm x 20 cm configuration gave the highest grain yield. Optimum plant density, however, depends largely on genotype, season, available growth resources and agronomic management conditions significantly (Khan *et al.*, 2005).

In our country, very few research works have been conducted with the effect of spacing on hybrid maize. Appropriate plant spacing which influence yield and optimal performance of SAU hybrid vutta 1 and SAU hybrid vutta 2. Growing SAU hybrid vutta 1 and SAU hybrid vutta 2 on basis of spacing having following objectives:s

1. To evaluate the growth performance of SAU Hybrid Vutta 1 and SAU Hybrid 2 at different plant spacings.

2. To evaluate the yield performance of SAU Hybrid Vutta 1 and SAU Hybrid Vutta 2.

3. To find out the interaction effect of variety and spacing on growth and yield of maize.

CHAPTER II
REVIEW OF LITERATURE

Plant spacing is considered to be one of the most important factors in maize cultivation. A number of research works have been done in different parts of the world to study the influence of spacing on growth and yield hybrid maize. Some of the important and informative works and research findings related to the spacing of growth and yield of hybrid maize done at home and abroad have been reviewed under the following sub headings:

Planting density vary widely in different parts of the world because great abundance of maize strains and their distribution over different climatic conditions. An increase or decrease in the plant density has been found to effect the growth of the crop and a number of experiments all over the world have been carried out to determine the optimum plant density for maximum production**.**

2.1 Growth characters

On-farm experiments were observed by Akbar *et al*. (2016) in the Bandarban valley during dry season, October 2015 through March, 2016 to investigate the possibility of introducing white maize as human food evaluating seed yields under varying plant spacing. Yield response of two maize hybrids (PSC-121 and KS-510) planted in three different row arrangements was evaluated in one experiment.

Dry matter and grain yield increased with increasing sowing density and decreasing row spacing. The hybrid AG1051 recorded the highest dry matter yield and ear height regardless of row spacing and experimental year, whereas the hybrids AG9010 and DKB440 determined the highest grain yield regardless of planting density and experimental year. Alvarez (2006) conducted a field experiment in Minas Gerais, Brazil during 2001-02. The effects of row spacing (0.7 and 0.9 m) and plant density (55000 and 75000 plants ha^{-1}) on the performance of maize hybrids AG1052, AG9010 and DKB440 were determined.

Enujeke (2013) was carried out a study in Teaching and Research Farm of Delta State University, Asaba Campus from March, 2008 to June, 2010 to observed 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 8th week after sowing indicated that hybrid variety 9022-13 which had mean plant height of 170.0 cm number of leaves of 13.2, leaf area of 673.2 cm^2 and stem girth of 99.4 mm was superior to other varieties investigated. Plants sown on 75 cm x 15 cm had a higher mean height and number of leaves of 176.7 cm and 13.8 cm, respectively, with respect to spacing, while plants sown on 75 cm x 35 cm had a higher mean leaf area of 713.7 cm^2 and stem diameter of 99.4 mm, respectively. Interaction findings revealed that variety and spacing varied significantly ($P<0.05$) in 2008 and 2009. Based on the findings of this study, it is recommended that hybrid variety 9022-13 be grown in the study area of enhanced growth characters which interplay to improve grain yield of maize and 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.

Fanadzo *et al*. (2010) determined a study to 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 × 2 factorial in a RCBD 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 plants and grain yield by increasing plant population from the current practice of 40000 to 60000 plants ha^{-1} and through use of narrow rows.

Jiotode (2002) observed a field experiment with Maize cv. AMC-1 (Akola maize Composite-1) to evaluate its growth responses and water use influenced under varying irrigation levels at 40, 60 or 80 mm and irrigation as per the critical growth stages of the crop, and three row spacing of 30, 45 and 60 cm during the rabi seasons of 1996-97 in Akola, Maharashtra, India. Irrigation at 40 mm CPE recorded the highest values in terms of all the growth parameters as well as consumptive use, potential evapotranspiration, soil moisture depletion, absolute water use rate and relative water use rate. However, water use efficiency was highest in the case of irrigation as per the critical growth stages of the crop and at 60 cm row spacing. A row spacing of 60 cm recorded the highest number of leaves, leaf area, and dry matter per plant. Plant height and leaf area index were highest at the 30 cm row spacing.

Hasan *et al*. (2018) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2015 to April 2016 to determined the effect of variety and plant spacing on yield attributes and yield of maize. The experiment comprised 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 RCBD 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 circumference 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, circumference 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 circumference 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 circumference of cob (4.60 cm), highest number of kernel cob $^{-1}$ (34), maximum stover yield (12.38 t ha^{-1}) were found 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 observed 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.

Optimum intra-row spacing for maize hybrids commercially grown in Eastern Mediterranean Region during 2000 and 2001 growing seasons. Maize hybrids reacted differently to various plant density and intra-row spacing. Main plots were maize hybrids of Dracma, Pioneer 3223, Pioneer 3335, Dekalb 711 and Dekalb 626. The intra-row spacings of 10.0,12.5,15.0, 17.5 and 20.0 cm were split-plots. The effects of intra-row spacing on the grain yield and some agronomic characteristics were statistically significant. Hybrid × intra-row spacing interaction effects were significant only at ear length and grain yield. The highest grain yields were obtained from Pioneer 3223 and Dracma at 15.0 cm intra-row spacing (11718 and 11180 kg ha^{-1}, respectively). This study was conducted by Sener (2004) a two-year study at Mustafa Kemal University, Agricultural Faculty, Research Farm,Turkey.

Sahoo (1995) found no influence of different populations on days taken to harvest initiation. Whereas, plant spacing of 45 cm × 15 cm produced significantly taller baby corn plants both at grand growth stage and harvest compared to 45 × 30 and 60 × 15 cm spacing.

The effect of spacing on growth,development and yield of baby corn varieties during summer season under irrigated condition. It was conducted that the spacing of 45 cm × 15 cm found the maximum plant height of 181.8 cm, which was significantly superior to wider row spacing of 60 cm × 15 cm. Similarly, the 45 cm × 30 cm spacing produced significantly higher dry matter of 223.25 g $plant^{-1}$over other spacing. The lowest dry matter of 166.47 g $palnt^{-1}$ was recorded in 60 cm × 15 cm spacing was studied by Sukanya *et al*. (2000).

Thakur *et al*. (2000) found a field trial to study the effect of planting geometry on baby corn. They observed that maximum plant height with wider spacing (60 cm × 30 cm) than closer spacing (40 cm × 40 cm, 50 cm × 30 cm, 40 cm × 35 cm, 50 cm × 25 cm and 45 cm × 25 cm).

Pandey *et al*. (2002) observed that with increase in plant population from 111 K (lacs ha^{-1}) to 166 K plants ha^{-1} barrenness percent increased significantly; however, the plant height remained unaffected under different plant densities. They also found that with increase in plant population from 111 K (lacs ha-1) to 166 K plants ha^{-1} days to harvest initiation showed significant delay, however, there was no effect on the plant height under different plant densities. However, increase in the plant density from 111K to 166 K plants ha^{-1}, barrenness percent and harvest initiation days increased significantly, however, duration reduced by two days.

Chougule (2003) observed in a field experiment on sweet corn at Rahuri that the plant height, number of functional leaves, leaf area and total dry matter production $plant^{-1}$ were significantly higher with 60 cm × 20 cm spacing than the closer spacing *viz*. 45 cm × 15 cm, 45 cm × 20 cm and 60 cm × 15 cm.

Planting of two plants $hill^{-1}$ at a spacing 50 cm × 20 cm was found optimum for baby corn cultivation. The trend of response to thicker stand was not same in other plant characteristics *viz*. dry matter accumulation, stem diameter, leaf area, number of functional leaves and number of cobs $plants^{-1}$. This study was found by Sahu *et al*, (2005).

Zarapkar (2006) observed a field experiment to study the effect of spacings on growth and development of baby corn and revealed that plant height was significantly higher under the closer spacings of 30 cm × 20 cm than other spacing (40 cm × 20 cm and 60 cm × 20 cm). Whereas, number of functional leaves and dry matter accumulation $plant^{-1}$ was higher in case of wider spacings (60 cm × 20 cm) as compared to closer spacings.

Kunjir *et al*. (2007) observed a field trial to study the effect of spacings on the growth and development of maize (sweet corn). Results stated that the spacings of 45 cm × 20 cm produced significantly higher plant height of maize (sweet corn) than 60 cm × 20 cm and 75 cm × 20 cm spacings.

Shafi *et al*. (2012) conducted a 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}. Planting density had a significant ($p<0.05$) effect on leaf area index and plant height. Maximum leaf area index and plant height was recorded from planting density of 65000 plants ha^{-1}.

Kheibari *et al*. (2012) found 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 plants ha^{-1}) and 3 corn varieties (KSC403su, KSC600 and KSC704) were evaluated. The data on growth attributing characters like plant height, number of leaves, leaf area, leaf area index, dry matter accumulation in leaf, stem, husked baby corn and total dry matter, stem girth, average growth and crop growth rate in baby corn $plant^{-1}$ basis influenced by plant density and highest was from plant density of 75,000 plants ha^{-1}.

The effect of crop geometry impacts on growth and yield of baby corn (Var.G5414). Three levels of plant population *viz*. 45 × 30 cm (S 1), 45 × 20 cm (S 2) and 45 × 10 cm (S 3) were assigned. Plant height was higher when baby corn planted in wider spacing of 45 × 30 cm. whereas, closer spacing of 45 × 10 cm resulted in shorter plant. Days to 50% flowering did not vary among the spacing this experiment conducted by Bairagi *et al*. (2015).

Chamroy *et al.* (2017) carried out an experiment entitled growth and yield response of baby corn (*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, 60 cm × 15cm and 60 cm × 30cm) were used. Among the plant spacings, it was observed that S_3 (45 × 30 cm) exhibited highest number of leaves $plant^{-1}$ (13.63), leaf area (512.62 cm^2) and LAI (3.62). Whereas S_2 (45 × 15 cm) gives highest plant height (205.47 cm).

Ramchandrappa *et al*. (2004) determined that the length and girth of baby 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 baby corn length, girth and weight. Wider spacings of 45 cm × 30 cm also recorded significantly higher baby corn yield than other spacings (45 cm × 20 cm and 30 cm × 30 cm).

Ukonze *et al*. (2016) carried out a study and observed that how spacing influenced the performance and yield of late maize in Egwi, Etche Local Government Area (LGA) of Rivers State, Nigeria between September-December in 2013 and 2014. The study adopted experimental research design. The experiment was laid out in a (RCBD) with three replicates. One maize variety was evaluated under three spacing for performance data such as plant heights, stem girths, number of leaves, number of nodes and leaf area and for the yield, data were collected on cob length, cob weight, cob + husk weight, cob circumference and 1000 grain weight. The results obtained 56 days after planting in the two years of study showed significant differences ($p < 0.05$) in plant height, stem girth and leaf area. The 70 x 30 and 60 x 40 cm spacing gave higher values of the morphological parameters than 80 x 20 cm. With regarding yield, 80 x 20 cm gave the highest average cob weight of 0.74 kg and 1000-grain weight of 0.27tha^{-1}. Based on the findings of the study, the 80 x 20 cm spacing was recommended for local farmers in Etche for maximum yield and economic returns.

Yukui (2011) conducted an experiment with RCBD of four cropping patterns and four replicates was used. Four cropping patterns *viz*. 65 cm × 65 cm, 40 cm×90 cm, 30 cm × 100 cm and 20 cm × 110 cm respectively were studied. The results showed that all wide and narrow rows patterns and free-sow patterns have higher yield than the same spacing patterns and 30 cm × 100 cm is the optimal pattern to obtain the highest yield, followed by 20 cm × 110 cm, 40 cm × 90 cm and 65 cm × 65 cm respectively. If all farmers carried out the 30 cm × 100 cm pattern, problems on food security in China would be obviously improved.

Purseglove (1972) find out that maize is highly variable, naturally cross pollinated markedly heterogeneous, complex species in which all forms hybridize freely.

High corn yield can be obtained by planting hybrids with high yield potential early in the season,using narrow rows and high population (Larson and Hanway, 1977; Roy and Biswas, 1992).

Plant spacing is one factor that determines the efficiency of use of land, light, water and nutrients. In this way, highest total yield potential can be achieved in the smallest possible area (Oseni and Fawusi, 1986).

Lauer (1994) carried the study and observed that plants spaced equidistantly from each other compete minimally for nutrients, light and other factors. The utilization of higher plant densities within the row could be a limiting factor in wide rows, preventing the full expression of the yield potential of new cultivars.

Sangoi *et al*. (1998) carried the study and observed that the utilization of row spacing ranging from 50 cm to 75 cm may enhance maize optimum plant population especially when highly productive single-cross early hybrids are grown in soils with high fertility and under irrigation.

Reid (1959) carried the study and observed that achieved high population for forage, the seed rate should be 65 to 130kgha^{-1} in 15 – 30 cm rows.

Hozumi *et al.* (1965) carried the study and observed that plant height as a growth parameter is a resultant of stem elongation of the internodes. During the process of elongation it is influenced by the environment.

2.2 Yield attributes and yield

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

Golada *et al*. (2013) determined 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. Yield attributes were greatly affected by the crop spacing of 60 x 15 cm. 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.

Bairagi *et al*. (2015) carried the study and observed that the effect of crop geometry impacts on growth and yield of baby corn (Var. G-5414). Three levels of plant population *viz*. 45 cm × 30 cm (S_1), 45 cm × 20 cm (S_2) and 45 cm × 10 cm (S_3) were assigned. Corn yield and fodder yield were higher when baby corn planted in wider spacing of 45 cm × 30 cm. whereas, closer spacing of 45 cm × 10 cm resulted in reduction of both corn and fodder yield plant^{-1}. The yield parameters of baby corn were clearly indicative that they were thermo-sensitive and baby corn cobs and fodder yield are higher at closer spacing.

Zarapkar (2006) observed from a field study that the yield attributing characters of baby corn such as length of baby corn, number of baby corn per plant, baby corn weight with husk and baby corn weight without husk were significantly higher under wider spacing of 60 cm × 20 cm as compared to closer spacing of 30 cm × 20 cm. It was also found that baby corn yield was significantly higher under the closer spacing of 45 cm x 20 cm than remaining spacing *viz.* 30 cm × 20 cm and 60 cm × 20 cm. However, green fodder yield and total biomass yield ha^{-1} were significantly higher under spacing of 30 cm × 20 cm than other spacing.

Prodhan *et al*. (2007) carried the study and observed 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 1,33,00 compared to 2,08,000 plants ha^{-1}.

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 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. This present study conducted by Shafi *et al*. (2012).

The distribution of the dry matter during the development of the plant is a function of environment and genetic factors that influence leaf area development (Deinum and Struik, 1986). Dry matter yield of maize is positively related to plant population.

Greater dry matter yield was obtained under high population compared to low population found by Fisher and Wilson, (1975).

Brown *et al*. (1964) and Caravetta *el al.* (1990) reported that decrease within-row plant spacing and narrow row spacingare effective means of increasing dry matter production.

Esechie (1992) carried the study and observed that dry matter yield on an individual plant basis decreased with increasing plant density, since higher densities contained more plants per unit land area. Dry matter yield per unit area increased with plant density.

From the above review of literature it can be concluded that spacing had a significant effect on growth and yield of hybrid maize.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Robi season from November 2018 to March 2019 study the influence of spacing on growth and yield of hybrid maize. 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 situated at $23^0$77' N latitude and $90^0$33' E longitude at an altitude of 9 meter above the sea.

3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of “The Modhupur Tract”, AEZ-28 (Anon., 1988a). 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 (Anon., 1988b). 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).

3.2 Experimental details

3.2.1 Treatments

Factor A: Varities: Two varieties

i. V_1 = SAU Hybrid Vutta 1

ii. V_2 = SAU Hybrid Vutta 2

Factor B: Spacing – Six spacing

i. Si = 50 cm x 20 cm

ii. S_2 = 55 cm x 20 cm

iii. S_3 = 60 cm x 20 cm

iv. S_4 = 65 cm x 20 cm

v. S_5 = 70 cm x 20 cm

vi. S_6 = 75 cm x 20 cm

As such there were 12 treatment combinations or interaction treatments as follows:

V_1S_1 , V_1S_2, V_1S_3, V_1S_4 , V_1S_5, V_1S_6, V_2S_1, V_2S_2 , V_2S_3, V_2S_4, V_2S_5, V_2S_6 .

3.2.2 Layout of the experiment

The experiment was laid out into randomized complete block design (RCBD) with three replications having two varieties in the main as Factor-A and spacing in the considered as Factor-B. Each replication had 6 unit plots to which the treatment combinations were assigned randomly. The total numbers of unit plots were 36.The size of unit plot was 6.5 m^2 (3.25 m × 2 m). The distances between replication to replication and plot to plot were 1 m and plot to plot 0.50 m, respectively.

3.2.3 Planting materials

SAU Hybrid Vutta l and SAU Hybrid Vutta 2 seed

3.3 Preparation of the experimental field

The land was opened with the help of a tractor drawn disc harrow on 11 November, 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 11 November 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 requirement. Fertilizers were used under the present study based on recommended doses. The recommended doses of nutrients through fertilizers were as below:

Plant nutrients	Name of fertilizer	Fertilizer Rate (ha^{-1})
N	Urea	550 kg
P	TSP	240 kg
K	MoP	200 kg
B	Boric Acid	750 kg
Zn	$ZnSO_4$	240 kg
Cowdung		5 ton

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 P, K, S and Zn through TSP, MoP and $ZnSO_4$, respectively 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 two seeds $hole^{-1}$ under direct sowing (dibbling) in the well prepared plot on 11 November 2018.

3.6 Intercultural operations

3.6.1 Thinning and gap filling

The plots were thinned out and gap filled at 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 Earthing up

Earthing up is a major intercultural operation for better establishment and anchorage of crown root of SAU Hybrid Vutta 1 and SAU Hybrid Vutta 2. It was done at 50 days after sowing.

3.6.4 Irrigation and drainage

Irrigation water was added to each plot as and when necessary. Drainage channels were properly prepared to easy and quick drained out of excess water.

3.7 Harvesting and post-harvest operations

At 8 March 2019, the five cobs randomly selected from plants of each plot were separately harvested for recording yield attributes and other data. 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 maize corn. The following data were recorded.

3.8.1 Growth parameters

1. Plant height (cm)
2. Dry weight plant^{-1}(g)
3. Cob height from bottom (cm)

3.8.2 Yield contributing parameters

1. Cob weight plant^{-1} (g)
2. Cob length (cm)
3. Circumference of cob (cm)
4. Number of grains row^{-1}
5. Number of rows cob^{-1}
6. Number of grains cob^{-1}
7. 100 grain weight (g)
8. Rakish weight cob^{-1} (g)
9. Total grain weight cob^{-1} (g)

3.8.3 Yield parameters

1. Grain yield ha^{-1}
2. Stover yield ha^{-1}
3. Biological yield ha^{-1}
4. Harvest Index (%)

3.9 Procedures of recording data

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

3.9.1 Growth characters

Plant height (cm)

The height of plant was recorded in centimeter (cm). 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 at 30, 60 and 90 DAS after sowing.

Dry weight plant^{-1}

Dry weight plant^{-1} was collected at harvest. Five plants from each plot were collected for each recording data. The plant parts were packed in paper packets then kept in the oven at

80°C for 72 hours to reach a constant weight. Then the dry weights were taken with an electric balance. The mean values were determined.

Cob height from bottom (cm)

Cob height from bottom was recorded in centimeter (cm). 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 cob of the plant.

3.9.2 Yield contributing parameters

Cob length (cm)

Cob length was measured in centimeter. Five cobs selected in each plot with the help of a centimeter scale then average data were recorded.

Cob circumference (cm)

Cob circumference was measured in centimeter. Five cobs selected in each plot with the help of a centimeter scale then average data were recorded.

Number of rows cob^{-1}

Number of row randomly selected from the five selected cobs and were counted and finally averaged.

Number of grains row^{-1}

Number of grain row^{-1} randomly selected from the five selected cobs in each plot and the average grain number was recorded.

Number of grains cob^{-1}

Number of grain cob^{-1} randomly selected from the five selected cobs in each plot and the average grain number was recorded.

Cob weight plant^{-1} (g)

Cob weight randomly selected from the five selected cobs in each plot and the average weight was recorded in gram.

100 grain weight (g)

100 grain weight randomly selected from the five selected cobs in each plot and the average grain weight was recorded.

Rakish weight cob^{-1} (g)

Rakish weight cob^{-1} randomly selected from the five selected cobs in each plot and the average rakish weight was recorded.

Total grain weight cob^{-1} (g)

Total grain weight cob^{-1} randomly selected from the five selected cobs in each plot and the average total grain weight was recorded.

3.9.3 Yield parameters

Grain yield tha^{-1}

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

Stover yield tha^{-1}

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

Biological yield tha^{-1}

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

Biological yield (t ha^{-1}) = Cob yield (t ha^{-1}) + 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).

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

3.10 Statistical analysis

The data obtained for different characters were statistically analyzed using MSTATC software to find out yield potential of SAU Hybrid Vutta 1 and SAU Hybrid Vutta 2 as influenced by different spacing . The mean values of all the characters were evaluated and analysis of variance was performed 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

The study was conducted to determine the influence of spacing on growth and yield of SAU Hybrid Vutta 1 and SAU Hybrid Vutta 2. Data on different growth, yield contributing characters and yield were recorded to find out of the spacing for successful maize production. Results obtained from the study have been presented and discussed in this chapter.

4.1 Growth parameters

4.1.1 Plant height

Plant height showed significant variation on plant height due to the effect of two maize varieties (Figure 1). At 30 DAS the highest plant height was observed from V_2 (45.24 cm) and the lowest plant height was observed from V_1 (42.91 cm). At 60 DAS plant height was insignificant. The highest plant height was obtained from V_2 (154.29cm) and the lowest plant height was obtained from V_1 (152.19 cm). At 90 DAS plant height was insignificant where the maximum plant height was obtained from V_2 (244.36 cm) and the minimum plant height was obtained from V_1 (242.36 cm).

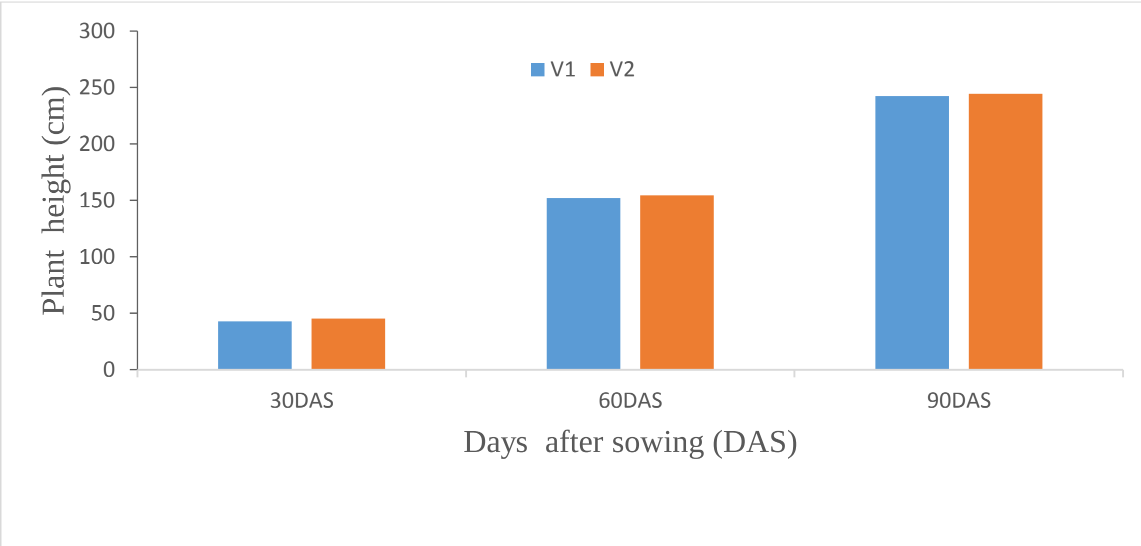

Figure. 1. Showing plant height at different growth stages due to the effects of two varieties.

($LSD_{0.05}$ = 1.5507, 2.6333 and 7.1149 at 30, 60 and 90 DAS respectively)

V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2 non significant variation was ovsered in different plant spacing at 30 DAS (Figure 2.) Results indicated the highest plant height (50.03 cm) was found from S_6 (75 cm × 20 cm). The lowest plant height (37.93 cm) was obtained from the plant spacing S_1 (50 cm × 20 cm) at 30 DAS. Plant height was significantly influenced by different plant spacing at 60 DAS. The highest plant height (161.87 cm) was found from the plant spacing S_6 (75 cm × 20 cm) and the lowest plant height (148.02 cm) was obtained from the plant spacing S_1 (50 cm × 20 cm) at 60 DAS. Plant height was significantly influenced by different plant spacing at 90 DAS. The highest plant height (254.67 cm) was found from the plant spacing S_6 (75 cm × 20 cm) and the lowest plant height (235.17 cm) was obtained from the plant spacing S_1(50 cm × 20 cm). Zarapkar (2006) found that plant height was significantly higher under the closer spacing. Similar result was also observed by Chamroy *et al.* (2017).

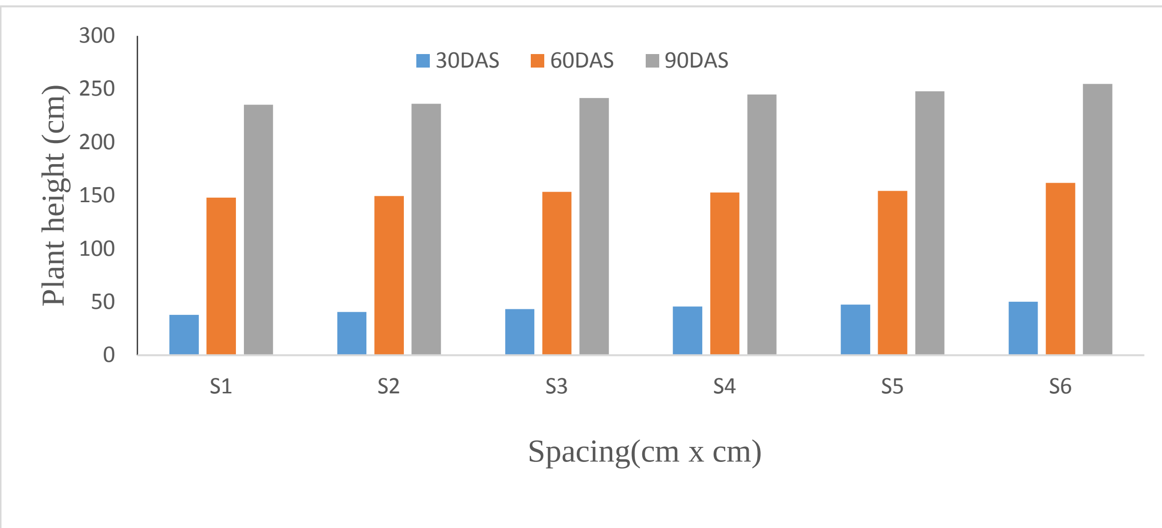

Figure. 2. Showing plant height at different growth stages due effect of different spacing. ($LSD_{0.05}$ = 2.69, 4.56 and 1232 at 30, 60 and 90 DAS respectively)

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

A significant variation was observed on plant height due to combined effect of variety and spacings (Table 1). It was observed that the highest plant height (52.27 cm) was found from the treatment combination of V_2S_6. The lowest plant height (36.33 cm) was obtained from the treatment combination of V_1S_1 at 30 DAS. At 60 DAS, the highest plant height (163.07) was found from the treatment combination of V_2S_6 and the lowest plant height (146.90 cm) was obtained from the treatment combination of V_1S_1. At 90 DAS, the highest plant height (255.67 cm) was found from the treatment combination of V_2S_6 and the lowest plant height (232.97cm) was obtained from the treatment combination of V_1S_2 which statistically similar V_1S_1.

Table 1. Interaction effect of variety and spacing on plant height (cm) of maize at different days of sowing

Treatment	30DAS	60DAS	90DAS
V_1S_1	36.33g	146.90f	235.00b
V_1S_2	39.60fg	147.33ef	232.97b
V_1S_3	43.00d-f	149.30d-f	238.33ab
V_1S_4	44.60c-e	153.47c-e	245.67ab
V_1S_5	46.13b-d	155.50b-d	248.53ab
V_1S_6	47.80bc	160.67ab	253.67a
V_2S_1	39.53fg	149.13d-f	235.33b
V_2S_2	41.27ef	151.30c-f	239.40ab
V_2S_3	43.13d-f	157.67a-c	244.87ab
V_2S_4	46.70b-d	151.73c-f	244.00ab
V_2S_5	48.53ab	152.83c-f	246.87ab
V_2S_6	52.27a	163.07a	255.67a
CV(%)	5.09	2.49	4.23
$LSD_{0.05}$	3.7985	6.4501	17.428

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

S_1 = 50 cm x 20 cm**,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

V_1 = SAU Hybrid Vutta 1 , V_2 = SAU Hybrid Vutta 2

4.1.2 Dry weight plan^{-1}

A significant variation was observed on dry weight due to the effect of two maize varieties (Figure 3). The highest dry weight plant^{-1} was observed from V_2 (152.89g) and the lowest dry weight plant^{-1} was observed from V_1 (129.45g).

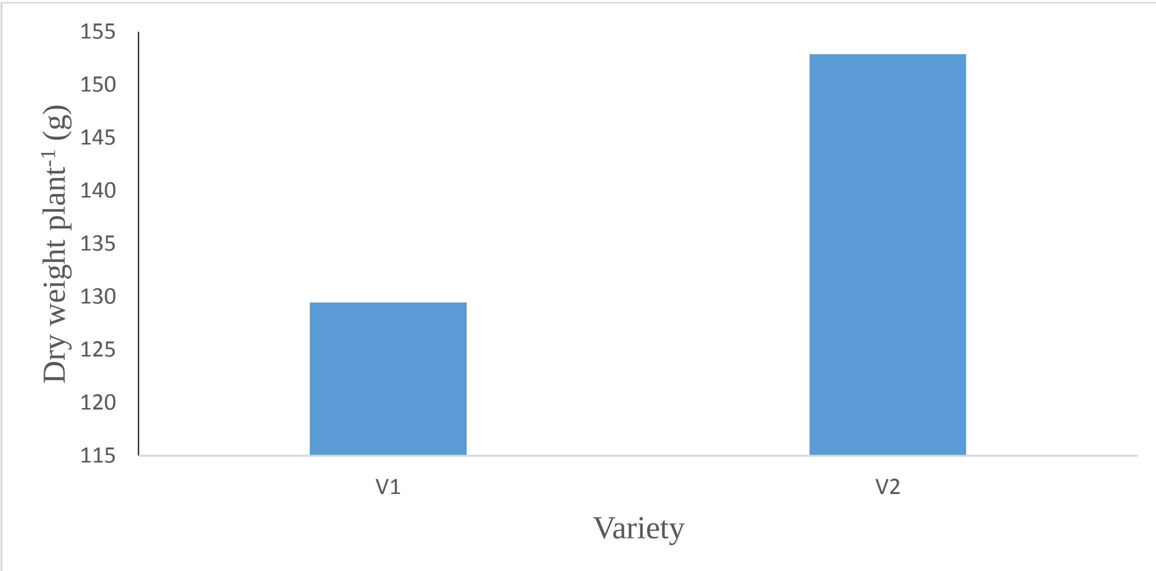

Figure. 3. Showing dry weight plant^{-1} due to the effect of two varieties ($LSD_{0.05}$ = 7.85)

V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2

A showed significant variation was observed on dry weight due to the effect of different spacings (Figure 4). The highest dry weight plant^{-1} was observed from S_6 (149.81g). The lowest dry weight plant^{-1} was observed S_1 (134.61g). Similar results was also observed by Bairagi *et a*l. (2015) and Chamroy *et al.* (2017).

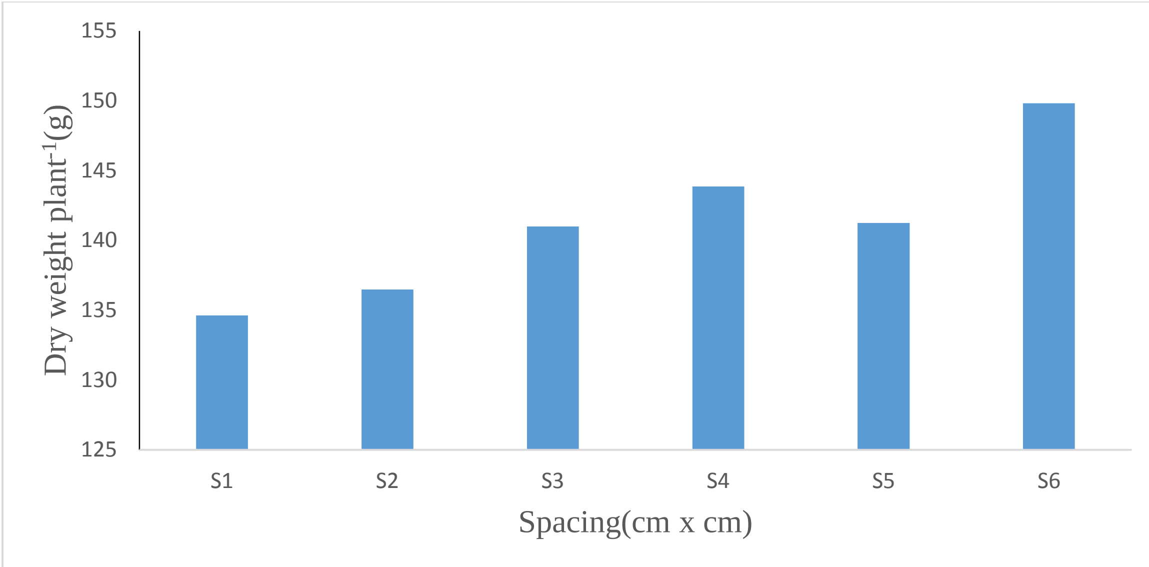

Figure. 4. Showing dry weight plant^{-1} due to the effect of different spacings (LSD$_{0.05}$ = 13.59)

S_1 = 50 cm x 20 cm , S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20, cm S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

A Showed significant variation was observed on dry weight due to combined effect of variety and spacings (Table 2). It was observed that the highest dry weight plant^{-1} from the treatment combination of V_2S_5 (154.59 g) which was statistically similar with V_2S_1, V_2S_2, V_2S_3, V_2S_4 and V_2S_6. The lowest dry weight plant^{-1} was obtained from the treatment combination of V_1S_1 (120.62 g).

4.1.3 Cob height from bottom

Cob height from bottom showed significant variation due to the effect of two maize varieties (Figure 5). The highest cob height from bottom was observed from V_1 (100.05 cm) and the lowest plant height was observed from V_2 (91.16 cm).

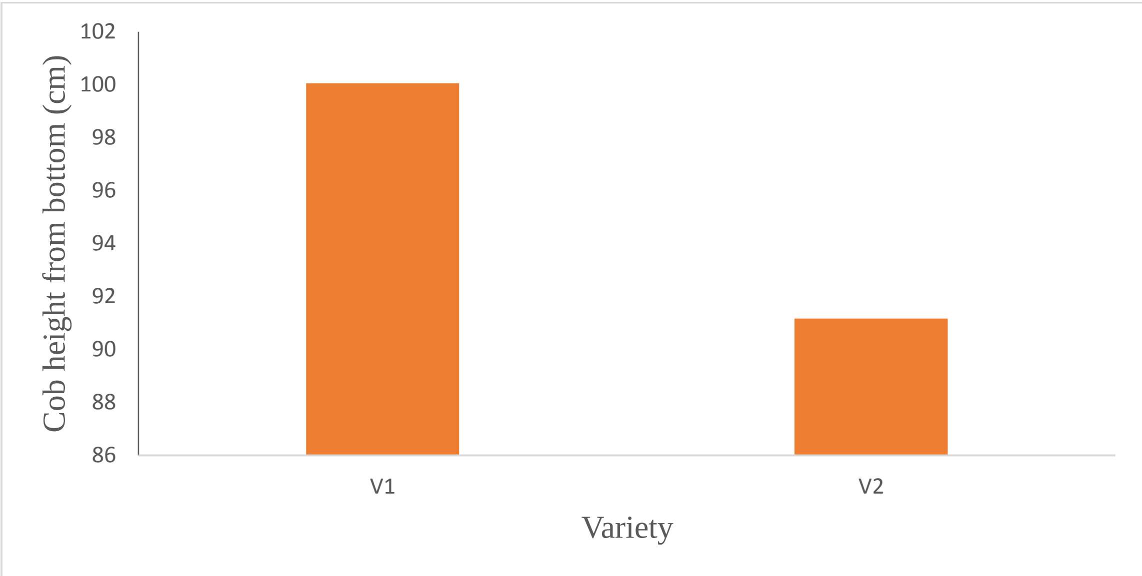

Figure. 5. Showing cob height from bottom due to the effect of two varieties ($LSD_{0.05}$ = 3.22)

V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2

Cob height from bottom showed significant variation due to the effect of different spacings (Figure 6). The highest cob height from bottom was observed from S_2 (101.12 cm) and the lowest cob height from bottom was observed from S_1 (91.00 cm).

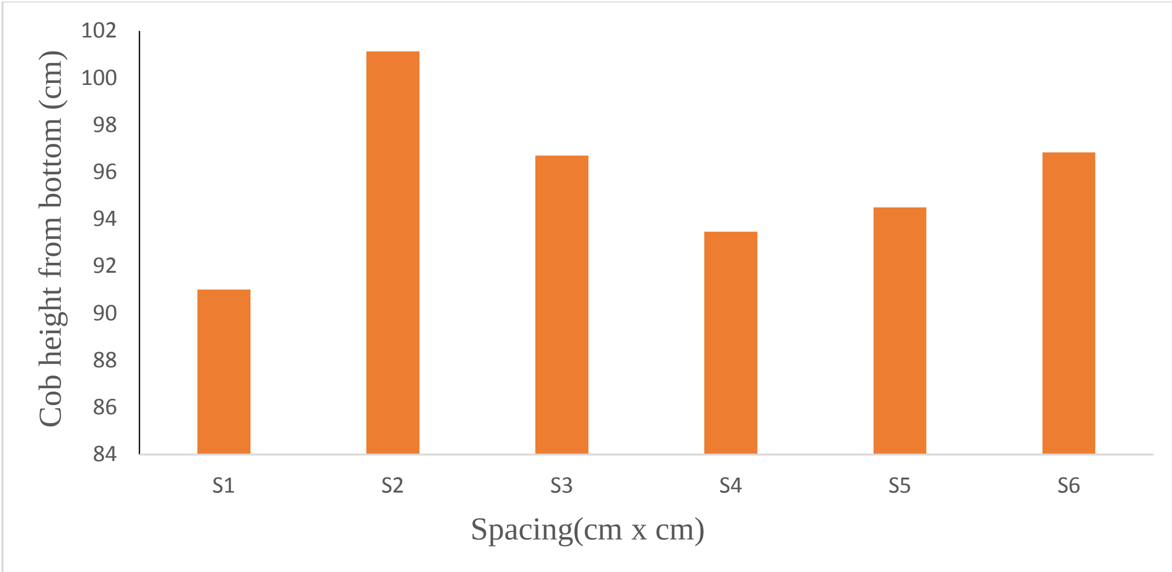

Fig. 6. Showing cob height from bottom due to the effect of different spacings ($LSD_{0.05}$ = 5.57)

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5= 70 cm x 20 cm, S_6 = 75 cm x 20 cm

A showed significant variation was observed on cob height from bottom due to combined effect of variety and spacings (Table 2). It was observed that the highest plant cob height from bottom (106.23 cm) was found from the treatment combination of V_1S_2. The lowest cob height from bottom (87.67 cm) was obtained from the treatment combination of V_2S_1.

Table 2. Interaction effect of variety and spacing on plant dry weight and cob height from bottom after sowing and harvest

Treatment	Dry weight plant^{-1} (g)	Cob height from bottom (cm)
V_1S_1	120.62 c	94.33c-e
V_1S_2	127.95bc	106.23 a
V_1S_3	135.69abc	99.27 a-c
V_1S_4	128.30bc	95.93b-c
V_1S_5	118.36c	100.87a-c
V_1S_6	145.78ab	103.67 ab
V_2S_1	148.60a	87.67 e
V_2S_2	154.55a	96.00 b-d
V_2S_3	152.03a	94.13c-e
V_2S_4	153.70a	91.00de
V_2S_5	154.59a	88.13de
V_2S_6	153.84a	90.00de
CV(%)	8.04	4.87
$LSD_{0.05}$	19.229	7.8775

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

S_1 = 50 cm x 20 cm, S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 =70 cm x 20 cm, S_6 = 75 cm x 20 cm

V_1 = SAU Hybrid Vutta 1 , V_2 = SAU Hybrid Vutta 2

4.2 Yield contributing parameters

4.2 .1 Cob length

Cob length showed significant variation due to the effect of two maize varieties (Figure 7). The highest cob length was observed from V_2 (17.22 cm) and the lowest cob length was observed from V_1 (15.72 cm).

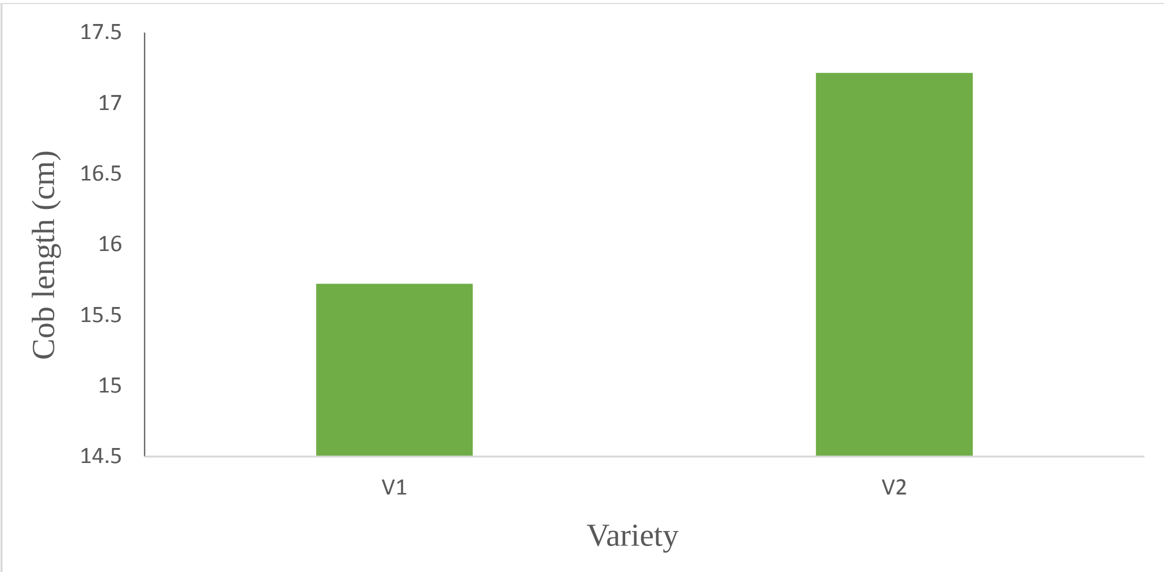

Figure. 7. Showing cob length due to the effect of two varieties ($LSD_{0.05}$ = 0.66)

V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2

Cob length showed significant variation due to the effect of different spacings (Figure 8). The highest cob length was observed from S_6 (17.17cm) which was statistically similar with S_3, S_4 and S_5 and the lowest cob length was observed from S_1 (15.17 cm). Kunjir *et al*. (2007), Bairagi *et al*. (2015) and Chamroy *et al*. (2017) found similar result which supported the present study.

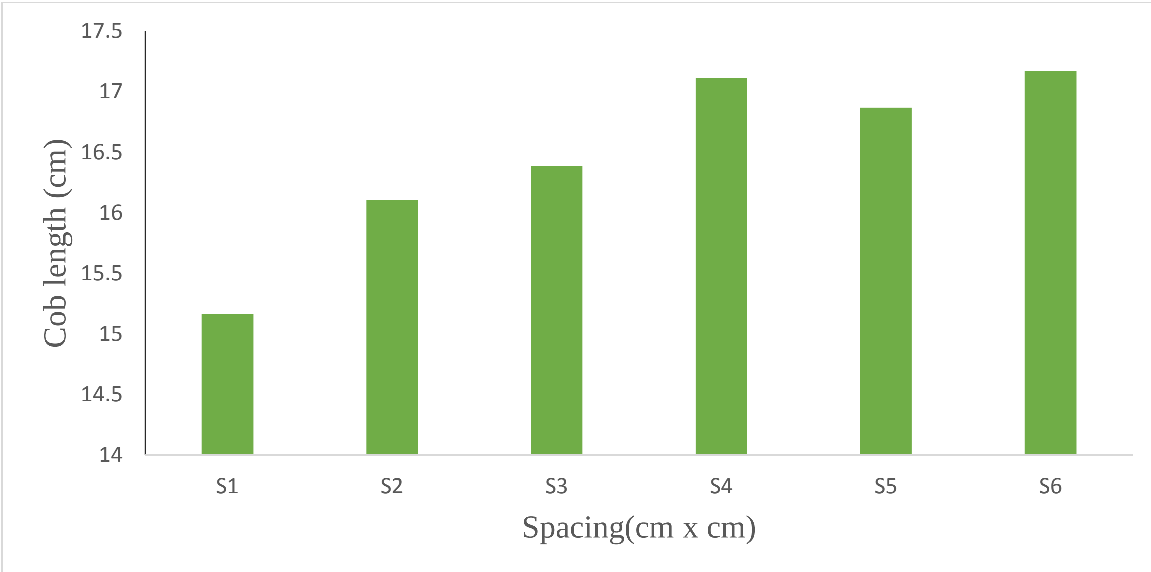

Figure. 8. Showing cob length due to the effect of different spacings ($LSD_{0.05}$ = 1.14)
S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

A significant variation was observed on cob length due to combined effect of variety and spacings (Table 3). It was observed that the highest cob length (17.77 cm) was found from the treatment combination of V_2S_3 which was statistically similar with the treatment combination of V_2S_4, V_2S_5 and V_2S_6. The lowest cob length (14.56 cm) was obtained from the treatment combination of V_1S_1.

4.2 .2 Cob circumference

Cob circumference showed significant variation due to the effect of two maize varieties (Figure 9). The highest cob circumference was observed from V_2 (13.85 cm) and the lowest cob length was observed from V_1 (12.57 cm).

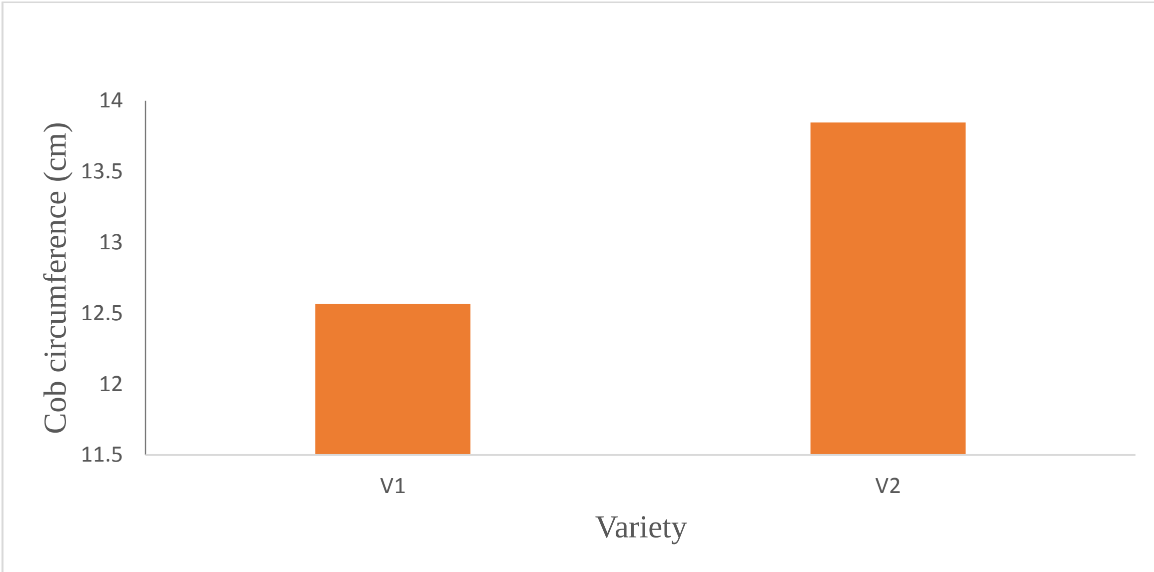

Figure. 9. Showing cob circumference due to the effect of two varieties ($LSD_{0.05}$ = 0.55)

V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2

Cob circumference showed significant variation due to the effect of different spacings (Figure 10). The highest cob circumference was observed from S_6 (14.08 cm). The lowest cob circumference (11.70 cm) was observed S_1. Ramchandrappa *et al*. (2004) and Kunjir (2007) found similar results on diameter of cob.

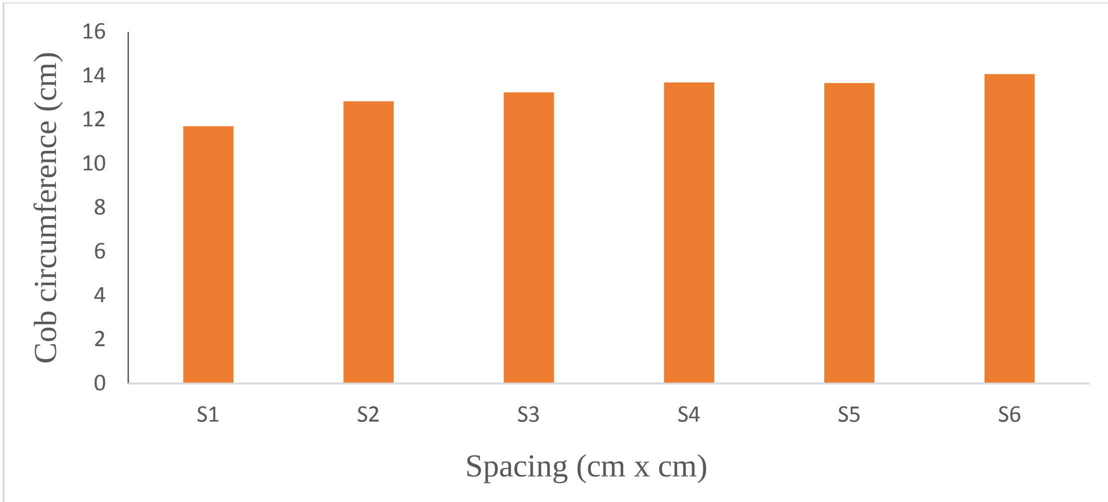

Figure. 10. Showing cob circumference due to the effect of different spacings ($LSD_{0.05}$ = 0.95)

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

A significant variation was observed on cob circumference due to combined effect of variety and spacings (Table 3). It was observed that the highest cob circumference (14.35 cm) was found from the treatment combination of V_2S_6 which was statistically similar with the treatment combination of V_1S_6, V_2S_2, V_2S_3, V_2S_4. The lowest cob circumference (10.29 cm) was obtained from the treatment combination of V_1S_1.

Table 3. Interaction effect of variety and spacing on cob length and circumference of maize

Treatment	Cob length (cm)	Cob circumference (cm)
V_1S_1	14.56d	10.29d
V_1S_2	15.19cd	11.80c
V_1S_3	16.45a-c	12.44bc
V_1S_4	15.22cd	13.50ab
V_1S_5	16.24a-c	13.56ab
V_1S_6	16.67a-c	13.81a
V_2S_1	15.77b-d	13.11a-c
V_2S_2	17.02ab	13.89a
V_2S_3	17.77a	14.06a
V_2S_4	17.55a	13.89a
V_2S_5	17.49a	13.78ab
V_2S_6	17.67a	14.35a
CV(%)	5.80	6.02
$LSD_{0.05}$	1.6171	1.3455

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

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20cm

V_1 = SAU Hybrid Vutta 1, V_2 = SAU Hybrid Vutta 2

4.2 .3 Number of row cob^{-1}

A significant variation was observed on number of row cob^{-1} due to the effect of two varieties (Table 4). The highest number of row cob^{-1} was observed from V_2 (16.22) and the lowest number of row cob^{-1} was observed from V_1 (15.33).

A significant variation was observed on number of row cob^{-1} due to the effect of different spacings (Table 4). The highest cob length was observed from S_6 (16.83). The lowest number of row cob^{-1} (14.83) was observed S_1 which was statistically similar with S_2. Kunjir *et al*. (2007) found similar result on number of rows cob^{-1}.

A significant variation was observed on number of row cob^{-1} was influenced by combined effect of variety and spacing (Table 4). It was observed that the highest number of row cob^{-1} (17.33) was found from the treatment combination of V_2S_6. The lowest number of row cob^{-1} (14.33) was obtained from the treatment combination of V_1S_1 which was statistically similar with the treatment combination of V_1S_2 .

4.2 .4 Number of grain row^{-1}

A significant variation was observed on number grain row^{-1} due to the effect of two varieties (Table 4). The highest number of grain per row was observed from V_2 (31.17) and the lowest number of grain row^{-1} was observed from V_1 (29.00).

A significant variation was observed on number grain row^{-1} due to the effect of different spacings (Table 4). The highest number of grain per row was observed from S_6 (31.17). The lowest number of grain row^{-1} (28.67) was observed S_1.

A significant variation was observed on number of grain row^{-1} due to combined effect of variety and spacing (Table 4). It was observed that the highest number of grain row^{-1} (32.00) was found from the treatment combination of V_2S_4 which was statistically similar with V_2S_5 and V_2S_6. The lowest number grain row^{-1} (27.33) was obtained from the treatment combination of V_1S_1.

4.2 .5 Number of grain cob^{-1}

A significant variation was observed on number grain cob^{-1} due to the effect of two varieties (Table 4). The highest number of grain cob^{-1} was observed from V_2 (506.17) and the lowest number of grain cob^{-1} was observed from V_1 (444.94).

A significant variation was observed on number grain cob^{-1} due to the effect of different spacings (Table 4). The highest number of grain cob^{-1} was observed from S_6 (524.50). The lowest number of grain cob^{-1} (426.00) was observed S_1. This result also collaborate the findings of Akbar *et al*, (2016) and Hasan *et al*, (2018).

A significant variation was observed on number grain cob^{-1} due to combined effect of variety and spacings (Table 4) It was observed that the highest number of grain cob^{-1} (555.00) was found from the treatment combination of V_2S_6. The lowest number grain cob^{-1} (391.00) was obtained from the treatment combination of V_1S_1.

Table 4. Effect of variety, spacing and interaction effect of variety and spacing on number of row cob^{-1}, number of grain row^{-1} and number of grain cob^{-1} of maize

Treatment	Number of row cob^{-1}	Number of grain row^{-1}	Number of grain cob^{-1}
Variety			
V_1	15.33b	29.00b	444.94b
V_2	16.22a	31.17a	506.17a
CV(%)	5.14	5.99	6.73
$LSD_{0.05}$	0.5601	1.2462	22.125
Spacing			
S_1	14.83c	28.67b	426.00d
S_2	15.00c	29.50ab	442.00cd
S_3	15.50bc	30.00ab	465.00bc
S_4	16.33ab	30.67ab	501.67ab
S_5	16.17ab	30.50ab	494.17ab
S_6	16.83a	31.17a	524.50a
CV(%)	5.14	5.99	6.73
$LSD_{0.05}$	0.9702	2.1586	38.321
Interaction (variety x spacing)			
V_1S_1	14.33d	27.33c	391.00f
V_1S_2	14.67d	28.00bc	410.33ef
V_1S_3	15.33cd	29.33a-c	449.00de
V_1S_4	15.67b-d	29.33a-c	459.67de
V_1S_5	15.67b-d	29.67a-c	465.67d
V_1S_6	16.33a-c	30.33a-c	494.00b-d
V_2S_1	15.33cd	30.00a-c	461.00de
V_2S_2	15.33cd	31.00ab	473.67cd
V_2S_3	15.67b-d	30.67ab	481.00cd
V_2S_4	17.000ab	32.00a	543.67ab
V_2S_5	16.67a-c	31.33a	522.67a-c
V_2S_6	17.33a	32.00a	555.00a
CV(%)	5.14	5.99	6.73
$LSD_{0.05}$	1.3721	3.0527	54.195

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

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20, cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm
V_1 = SAU Hybrid Vutta 1, V_2 = SAU Hybrid Vutta 2

4.2 .6 Husk Weight

A significant variation was observed on husk weight cob^{-1} due to the effect of two varieties (Table 5). The highest husk weight cob^{-1} was observed from V_2 (20.69g) and the lowest husk weight cob^{-1} was observed from V_1 (15.55g).

A significant variation was observed on husk weight cob^{-1} due to the effect of different spacings (Table 5). The highest husk weight cob^{-1} was observed from S_6(19.78g). The lowest husk weight(17.54g) cob^{-1} was observed S_1 which was statistically similar with S_2, S_3 and S_5.

A significant variation was observed on husk weight cob^{-1} due to combined effect of variety and spacings (Table 5). It was observed that the highest husk weight cob^{-1} (21.78 g) was found from the treatment combination of V_2S_5 which was statistically similar with V_2S_1,V_2S_2,V_2S_3 and V_2S_6. The lowest husk weight cob^{-1} (14.44 g) was obtained from the treatment combination of V_1S_4 which was statistically similar with V_1S_1, V_1S_2, V_1S_3 and V_1S_5.

4.2 .7 Rakish Weight

A significant variation was observed on rakish weight cob^{-1} due to the effect of two varieties (Table 5). The highest rakish weight cob^{-1} was observed from V_2 (59.13g) and the lowest rakish weight cob^{-1} was observed from V_1 (34.67g).

A significant variation was observed on rakish weight cob^{-1} due to the effect of different spacings(Table 5). The highest rakish weight cob^{-1} was observed from S_6 (53.83 g). The lowest rakish weight (38.44 g) cob^{-1} was observed S_1.

A significant variation was observed on rakish weight cob^{-1} due to combined effect of variety and spacings(Table 5). It was observed that the highest rakish weight cob^{-1} (68.11 g) was found from the treatment combination of V_2S_6 which was statistically similar with V_2S_5. The lowest rakish weight cob^{-1} (30.67 g) was obtained from the treatment combination of V_1S_1.

4.2 .8 Cob Weight

A significant variation was observed on cob weight due to the effect of two varieties (Table 5). The highest cob weight (232.26 g) $plant^{-1}$ was observed from V_2 and the lowest cob weight (173.96 g) $plant^{-1}$ was observed from V_1 .

A significant variation was observed on cob weight due to the effect of different spacings(Table 5). The highest cob weight (232.31 g) $plant^{-1}$ was found from S_6. The lowest cob weight (176.14 g) $plant^{-1}$ was found S_1.

A significant variation was observed on cob weight due to combined effect of variety and spacings (Table 5). It was observed that the highest cob weight (264.71 g) $plant^{-1}$ was found from the treatment combination of V_2S_6. The lowest cob weight (155.44) $plant^{-1}$ was obtained from the treatment combination of V_1S_1 which was statistically similar with V_1S_2.

Table 5. Effect of variety, spacing and interaction effect of variety and spacing on husk weight, rakish weight and cob weight of maize

Treatment	Husk weight (g)	Rakish weight (g)	Cob weight (g)
Variety			
V_1	15.55b	34.67b	173.96b
V_2	20.69a	59.13a	232.26a
CV(%)	13.17	9.77	8.51
$LSD_{0.05}$	1.6499	3.1666	11.943
Spacing			
S_1	17.54ab	38.44d	176.14d
S_2	18.33ab	43.95c	189.33cd
S_3	18.11ab	47.55bc	200.59bc
S_4	16.33b	45.50c	209.28bc
S_5	18.67ab	52.11ab	211.00b
S_6	19.78a	53.83a	232.31a
CV(%)	13.17	9.77	8.51
$LSD_{0.05}$	2.8577	5.4848	20.686
Interaction (variety x spacing)			
V_1S_1	14.55b	30.67e	155.44f
V_1S_2	15.22b	32.33de	157.04f
V_1S_3	15.33b	36.11de	169.18ef
V_1S_4	14.44b	32.11 de	179.94d-f
V_1S_5	15.55b	37.22de	182.22d-f
V_1S_6	18.22ab	39.55cd	199.91cd
V_2S_1	20.53a	46.22c	196.84c-e
V_2S_2	21.44a	55.56b	221.61bc
V_2S_3	20.89a	58.99b	232.01b
V_2S_4	18.22ab	58.89b	238.61ab
V_2S_5	21.78a	67.003a	239.78ab
V_2S_6	21.33a	68.11a	264.71a
CV(%)	13.17	9.77	8.51
$LSD_{0.05}$	4.0415	7.7566	29.254

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

S_1 = 50 cm x 20 cm , S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm
V_1 = SAU Hybrid Vutta 1, V_2 = SAU Hybrid Vutta 2

4.2 .9 100 grain weight

A significant variation was observed on 100 grain weight due to the effect of two varieties (Table 6). The highest 100 grain weight was observed from V_2 (30.05 g) and the lowest 100 grain weight was observed from V_1 (27.85 g).

A non significant variation was observed on 100 grain weight due to the effect of different spacings(Table 6). The highest 100 grain weight was observed from S_6 (30.22 g). The lowest 100 grain weight (28.28 g) was observed S_1. This result also relate to Akbar *et al*., (2016).

A significant variation was observed on 100 grain weight due to combined effect of variety and spacings (Table 6). It was observed that the highest 100 grain weight (31.56 g) was found from the treatment combination of V_2S_6 which was statistically similar with V_2S_3. The lowest 100 grain weight (26.22 g) was obtained from the treatment combination of V_1S_3 which was statistically similar with V_1S_2.

4.2 .10 Total grain weight cob^{-1}

A significant variation was observed on total grain weight cob^{-1} due to the effect of two varieties (Table 6). The highest total grain weight cob^{-1} was observed from V_2 (152.43 g) and the lowest total grain weight cob^{-1} was observed from V_1 (123.73 g).

A significant variation was observed on total grain weight due to the effect of different spacings (Table 6). The highest total grain weight was observed from S_6 (158.70 g). The lowest total grain weight (120.15 g) was observed S_1.

A significant variation was observed on total weight due to combined effect of variety and spacings (Table 6). It was observed that the highest total grain weight (175.27 g) was obtained from the treatment combination of V_2S_6. The lowest total grain weight (109.49 g) was obtained from the treatment combination of V_1S_2 which was statistically similar with V_1S_1.

Table 6. Effect of variety, spacing and interaction effect of variety and spacing on 100 grain weight and total grain weight cob^{-1} of maize

Treatment	**100 grain weight (g)**	**Total grain weight cob^{-1} (g)**
Variety		
V_1	27.85b	123.73b
V_2	30.05a	152.43a
CV(%)	9.26	11.48
$LSD_{0.05}$	1.8544	10.959
Spacing		
S_1	28.28a	120.15d
S_2	28.55a	127.05cd
S_3	28.83a	134.93b-d
S_4	29.44a	147.44ab
S_5	28.39a	140.22a-c
S_6	30.22a	158.70a
CV(%)	9.26	11.48
$LSD_{0.05}$	3.2119	18.982
Interaction (variety x spacing)		
V_1S_1	28.22ab	110.22e
V_1S_2	26.67b	109.49e
V_1S_3	26.22b	117.74de
V_1S_4	29.22ab	133.39c-e
V_1S_5	27.89ab	129.44c-e
V_1S_6	28.89ab	142.14b-d
V_2S_1	28.33ab	130.09c-e
V_2S_2	30.44ab	144.61bc
V_2S_3	31.44a	152.12a-c
V_2S_4	29.66ab	161.50ab
V_2S_5	28.89ab	150.99a-c
V_2S_6	31.56a	175.27a
CV(%)	9.26	11.48
$LSD_{0.05}$	4.5423	26.845

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

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm
V_1 = SAU Hybrid Vutta 1 V_2 = SAU Hybrid Vutta 2

4.3 Yield parameters

4.3 .1 Grain Yield(tha^{-1})

A significant variation was observed on grain yield due to the effect of two varieties (Table 7). The highest grain yield was observed from V_2 (12.38 tha^{-1}) and the lowest grain yield was observed from V_1 (10.32 t/h).

A significant variation was observed on grain yield due to the effect of different spacings (Table 7). The highest grain yield was observed from S_6 (12.39 tha^{-1}) which was statistically similar with S_4. The lowest grain yield (9.61 tha^{-1}) was observed S_1. The result obtained from the present study was similar with the findings of Kunjir (2007), Golada *et al.,* (2013) ,Fanadzo *et al.,* (2010) and Hasan *el al.*,(2018).

A significant variation was observed on grain yield due to combined effect of variety and spacings (Table 7). It was observed that the highest grain yield (13.50 tha^{-1}) was obtained from the treatment combination of V_2S_6 which was statistically similar with V_2S_3. The lowest grain yield (8.19 tha^{-1}) was obtained from the treatment combination of V_1S_1.

4.3 .2 Stover Yield(tha^{-1})

A significant variation on stover yield due to the effect of two varieties (Table 7). The highest stover yield was observed from V_2 (13.51 tha^{-1}) and the lowest stover yield was observed from V_1 (11.56 tha^{-1}).

A significant variation was observed on stover yield due to the effect of different spacings (Table 7). The highest stover yield was observed from S_6 (13.59 tha^{-1}). The lowest stover yield (10.51 tha^{-1}) was observed S_1. Similar findings was achieved by Kunjir (2007), Golada *et al*. (2013) , Bairagi *et al*. (2015) and Hasan *et al*. (2018).

A significant variation was observed on stover yield due to combined effect of variety and spacings (Table 7). It was observed that the highest stover yield (13.92 tha^{-1}) was obtained from the treatment combination of V_2S_6 which was statistically similar with V_2S_2, V_2S_3, V_2S_4 and V_2S_5. The lowest stover yield (9.22 tha^{-1}) was obtained from the treatment combination of V_1S_1 .

4.3 .3 Biological Yield(tha^{-1})

A significant variation was observed on biological yield due to effect of two varieties (Table 7). The highest biological yield was observed from V_2 (25.89 tha^{-1}) and the lowest biological yield was observed from V_1 (21.88 tha^{-1}).

A significant variation was observed on biological yield due to the effect of different spacings (Table 7). The highest biological yield was observed from S_6 (25.99 tha^{-1}). The lowest biological yield (20.12 tha^{-1}) was observed S_1. The result achieved from the present study was similar with the findings of Kunjir *et al.* (2007) and Zarapkar (2006).

A significant variation was observed on biological yield due to combined effect of variety and spacings (Table 7). It was observed that the highest biological yield (27.42 tha^{-1}) was obtained from the treatment combination of V_2S_6. The lowest biological yield (17.41 tha^{-1}) was obtained from the treatment combination of V_1S_1.

4.3 .4 Harvest Index(%)

A insignificant variation was observed on harvest index(%) due to the effect of two varieties (Table 7). The highest harvest index was observed from V_2 (47.82%) and the lowest harvest index was observed from V_1 (47.15%).

A significant variation was observed on harvest index due to the effect of different spacings (Table 7). The highest harvest index was observed from S_4 (47.87%). The lowest harvest index (46.56%) was observed S_2. Shafi *et al*. (2012) found similar result which supported the present study.

A significant variation was observed on harvest index due to combined effect of variety and spacings (Table 7). It was observed that the highest harvest index (49.29%) was obtained from the treatment combination of V_2S_6. The lowest harvest index (45.99%) was obtained from the treatment combination of V_1S_6 which was statistically similar with V_1S_2 .

Table 7. Effect of variety, spacing and interaction effect of variety and spacing on grain yield, stover yield, biological yield and harvest index of maize

Treatment	Grain yield (tha^{-1})	Stover yield (tha^{-1})	Biological yield (tha^{-1})	Harvest Index(%)
Variety				
V_1	10.32b	11.56b	21.88b	47.15a
V_2	12.38a	13.51a	25.89a	47.82a
CV(%)	7.76	7.21	7.14	2.30
$LSD_{0.05}$	0.6086	0.6252	1.1794	0.7537
Spacing				
S_1	9.61c	10.51c	20.12c	47.68ab
S_2	10.84b	12.40b	23.24b	46.56b
S_3	11.51ab	12.68ab	24.18ab	47.62ab
S_4	12.06a	13.11ab	25.17ab	47.87a
S_5	11.69ab	12.92ab	24.62ab	47.52ab
S_6	12.39a	13.59a	25.99a	47.64ab
CV(%)	7.76	7.21	7.14	2.30
$LSD_{0.05}$	1.0542	1.0829	2.0427	1.3055
Interaction (variety x spacing)				
V_1S_1	8.19e	9.22e	17.410e	47.08bc
V_1S_2	9.32de	10.89d	20.21de	46.07c
V_1S_3	11.31bc	12.54abc	23.84bc	47.41bc
V_1S_4	11.11bc	12.01bcd	23.12c	48.07ab
V_1S_5	10.69cd	11.44cd	22.13cd	48.27ab
V_1S_6	11.29bc	13.27ab	24.56abc	45.99c
V_2S_1	11.02bc	11.80bcd	22.82cd	48.28ab
V_2S_2	12.37ab	13.91a	26.28ab	47.05bc
V_2S_3	12.82a	13.68a	26.51ab	48.33ab
V_2S_4	12.28ab	13.83a	26.11ab	46.96bc
V_2S_5	12.32ab	13.91a	26.23ab	46.98bc
V_2S_6	13.50a	13.92a	27.42a	49.29a
CV(%)	7.76	7.21	7.14	2.30
$LSD_{0.05}$	1.4908	1.5315	2.8888	1.8462

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

S_1 = 50 cm x 20 cm **,** S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20 cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm, S_6 = 75 cm x 20 cm

V_1 = SAU Hybrid Vutta 1 , V_2 = SAU Hybrid Vutta 2

CHAPTER V

SUMMERY AND CONCLUSION

The experiment was conducted at Agronomy research farm of Sher-e-Bangla Agricultural University located in Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh**.** The experiment was executed during the period of November, 2018 to March, 2019. The objective of the experiment was to determine the influence of spacing on growth and yield of hybrid maize. The experiment was consisted of two factors: Factor A- Two varieties *viz.* V_1 = SAU Hybrid Vutta 1 and. V_2 = SAU Hybrid Vutta 2 and Factor B: Spacing – Six spacing *viz*. Si = 50 cm x 20 cm, S_2 = 55 cm x 20 cm, S_3 = 60 cm x 20cm, S_4 = 65 cm x 20 cm, S_5 = 70 cm x 20 cm and S_6 =75 cm x 20 cm. The experiment was laid out in RCBD with three replications having two varieties considered as Factor-A and spacing considered as Factor-B.

Two varieties had significant influence on different growth, yield and yield contributing parameters. Considering growth parameters, the highest plant height (45.24 cm, 154.29 cm and 244.36 cm at 30, 60 and 90 DAS) and dry weight plant^{-1} (152.89 g) were found in V_2 but cob height from bottom was found V_1 (100.05 cm). Regarding yield and yield contributing parameter the highest cob length (17.22 cm), cob circumference (13.85 cm), number of rows cob^{-1} (16.22), number of grain row^{-1}(31.17), number of grain cob^{-1} (506.17), husk weight (20.69 g), rakish weight (59.13 g), cob weight plant^{-1} (232.26 g), 100 grain weight (30.05 g), total grain weight cob^{-1} (152.43 g), grain yield (12.38 tha^{-1}), stover yield (13.51 tha^{-1}), biological yield (25.89 tha^{-1}) and harvest index (47.82%) were obtained from V_2. But lowest plant height (42.91 cm, 152.19 cm and 242.36 cm at 30, 60 and 90 DAS) and dry weight plant^{-1} (129.45 g) were found in V_1 but cob height from bottom (91.16 cm) was found V_2. Regarding yield and yield contributing, the lowest cob length (15.72 cm), cob circumference (12.57 cm), number of rows cob^{-1} (15.33), number of grain row^{-1} (29.00), number of grain cob^{-1} (444.94), husk weight (15.55 g), rakish weight (34.67 g), cob weight plant^{-1} (173.96 g), 100 grain weight (27.85 g), total grain weight (123.73 g) cob^{-1}, grain yield (10.32 tha^{-1}), stover yield (11.56 tha^{-1}), biological yield (21.88 tha^{-1}) and harvest index (47.15%) were obtained from V_1.

Different plant spacing had significant influence on different growth, yield and yield contributing parameters of SAU Hybrid Vutta 1and SAU Hybrid Vutta 2. Regarding growth parameters, the highest plant height (50.03 cm, 161.87 cm and 254.67 cm at 30 , 60 and 90 DAS), dry weight plant^{-1} (149.81 g) were found from the spacing S_6 (75 cm x 20 cm) but cob height from bottom (101.12 cm) was found from spacing S_2 (55 cm x 20 cm). In case of yield contributing parameters the highest cob length (17.17 cm), cob circumference (14.08 cm), the number of rows cob^{-1} (16.83), number of grains row^{-1} (31.17), number of grains cob^{-1} (524.50), husk weight cob^{-1} (19.78 g), rakish weight cob^{-1} (53.83 g), cob weight plan^{-1} (232.31 g), 100 grains weight cob^{-1} (30.22 g) and total grains weight cob^{-1} (158.70 g) were also found from the spacing S_6 (75 cm × 20 cm). The highest grain yield (12.39 tha^{-1}), stover yield (13.59 tha^{-1}), biological yield (25.99 tha^{-1}) were also found S_6 (75 cm x 20 cm) but height harvest index (47.87 %) were obtained from the plant spacing S_4 (65 cm x 20 cm). Conversely, the lowest plant height (37.93 cm, 148.02 cm and 235.17 cm at 30, 60 and 90 DAS), dry weight plant^{-1} (134.61 g) and cob height from bottom (91.00 cm) were found from the spacing S_1 (50 cm x 20 cm). The yield contributing parameters the lowest cob length (15.17 cm), cob circumference (11.70 cm), number of rows cob^{-1} (14.83), number of grains raw^{-1} (28.67), number of grains cob^{-1} (426.00), rakish weight cob^{-1} (38.44 g), cob weight plan^{-1} (176.14 g), 100 grains weight cob^{-1} (28.28 g) and total grains weight cob^{-1} (120.15), grain yield (9.61 tha^{-1}), stover yield (10.51 tha^{-1}), biological yield (20.12 tha^{-1}) were found S_1 (50 cm x 20 cm) but lowest husk weight cob^{-1} (16.33 g) found from S_4 (65 cm x 20 cm) and harvest index (46.56%) was obtained from the plant spacing S_2 (55 cm x 20 cm).

Combined effect of varieties and spacing showed significant influence on all the studied parameters. Regarding growth parameters, the highest plant height (52.27 cm, 163.07 cm and 255.67 cm at 30, 60 and 90 DAS) were found from the treatment combination of V_2S_6 but dry weight plant^{-1} (154.59 g) found from the treatment combination of V_2S_5 and cob height from bottom (106.23 cm) was found from the treatment combination of V_1S_2.

In case of yield contributing parameters the highest cob circumference (14.35 cm), the number of rows cob^{-1} (17.33), number of grains row^{-1} (32.00), number of grains cob^{-1} (555.00), rakish weight cob^{-1} (68.11 g), cob weight $plan^{-1}$ (264.71 g), 100 grain weight cob^{-1} (31.56 g) and total grain weight cob^{-1} (175.27 g) were found from the treatment combination of V_2S_6 but cob length (17.77 cm) was found from the treatment combination of V_2S_3 and husk weight cob^{-1} (21.78 g) found from the treatment combination of V_2S_5. The highest grain yield (13.50 tha^{-1}), stover yield (13.92 tha^{-1}), biological yield (27.42 tha^{-1}) and harvest index (49.29%) were obtained from the treatment combination of V_2S_6. Conversely, the lowest plant height 36.33 cm, 146.90cm were found from V_1S_1 at 30 , 60 DAS and 232.97 cm was found from V_1S_2 at 90 DAS, dry weight $plant^{-1}$ (120.62 g) found from V_1S_1 and cob height from bottom (87.67 cm) were found from the treatment combination of V_2S_1. The yield contributing parameters the lowest cob length(14.56 cm), cob circumference (10.29 cm), number of rows cob^{-1} (14.33), number of grains row^{-1} (27.33), number of grains cob^{-1} (391.00), rakish weight cob^{-1} (30.67g), cob weight $plan^{-1}$ (155.44 g) were found from the treatment combination of V_1S_1 but husk weight(14.44 g) was found from the treatment combination of V_1S_4, 100 grains weight cob^{-1} (26.22 g) was found from the treatment combination of V_1S_3 and total grain weight cob^{-1} (109.49 g) was found from the treatment combination of V_1S_2. The lowest grain yield (8.19 tha^{-1}), stover yield (9.22 tha^{-1}), biological yield (17.41 tha^{-1}) were found treatment combination of V_1S_1 but lowest harvest index (46.07%) was obtained from the treatment combination of V_1S_2.

Conclusion:

Based on the results of the present study, the following conclusions may be drawn-

1. V_2 (SAU Hybrid Vutta 2) showed maximum yield and yield parameters compared to V_1 (SAU Hybrid Vutta 1)

2. The plant spacing, S_6 (75 cm × 20 cm) showed best yield compared to other spacing.

3. The treatment combination of V_2 (SAU Hybrid Vutta-2) and S_6 (75 cm x 20 cm) i.e. V_2S_6 performed the best results in terms of fresh cob yield compared to other treatment combinations.

So, The treatment combination of V2 (SAU Hybrid Vutta-2) and S6 (75 cm x 20 cm) i.e. V_2S_6 can be considered as the superior treatment combination compared to other treatment combinations under the present study.

The experiment was conducted only robi season. So, considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances.
2. Some other plant spacing may be included in the further program.

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APPENDICES

Appendix I. Experimental location on the map of Agro-ecological Zones of Bangladesh

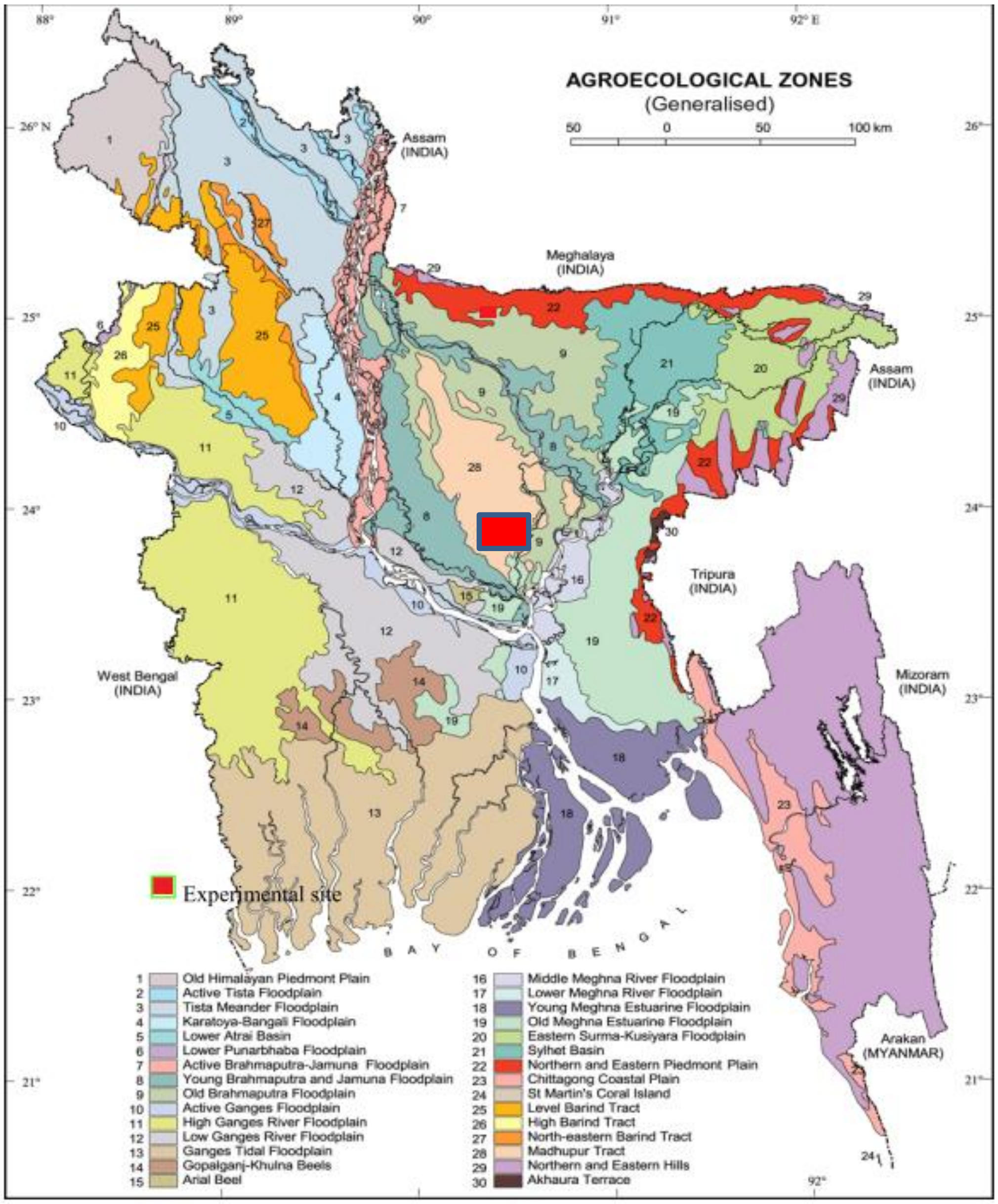

Fig. 11. Experimental site

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

A. Morphological characteristics of the experimental soil

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)

B. Physical and chemical properties of the initial soil

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

Source: Soil Resource Development Institute (SRDI)

Appendix III. Analysis of variance of the data on plant height

A. Plant height at 30 DAS

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	6.302	3.151		
variety	1	48.767	48.767	9.69	0.0051
spacing	5	603.586	120.717	23.99	0.0000
variety*spacing	5	15.968	3.194	0.63	0.6755
Error	22	110.705	5.032		
Total	35	785.328			

Grand Mean 44.075

CV 5.09

B. Plant height at 60 DAS

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	85.84	42.918		
variety	1	39.48	39.480	2.72	0.1132
spacing	5	710.54	142.107	9.79	0.0000
variety*spacing	5	120.42	24.084	1.66	0.1862
Error	22	319.22	14.510		
Total	35	1275.49			

Grand Mean 153.24

CV 2.49

C. Plant height at 90 DAS

Source	DF	SS	MS	F	P
replication	2	851.00	425.501		
variety	1	35.80	35.800	0.34	0.5669
spacing	5	1623.48	324.696	3.07	0.0301
variety*spacing	5	104.81	20.962	0.20	0.9600
Error	22	2330.46	105.930		
Total	35	4945.55			

Grand Mean 243.36

CV 4.23

Appendix IV. .Analysis of variance of the data on dry weight plant^{-1}

Source	DF	SS	MS	F	P
replication	2	374.11	187.06		
variety	1	4943.03	4943.03	38.33	0.0000
spacing	5	882.17	176.43	1.37	0.2742
variety*spacing	5	727.77	145.55	1.13	0.3745
Error	22	2836.91	128.95		
Total	35	9763.98			

Grand Mean 141.17

CV 8.04

Appendix V. Analysis of variance of the data on cob height from bottom

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	85.61	42.804		
variety	1	712.00	712.000	32.90	0.0000
spacing	5	360.51	72.103	3.33	0.0217
variety*spacing	5	111.15	22.231	1.03	0.4260
Error	22	476.13	21.642		
Total	35	1745.41			

Grand Mean 95.603

CV 4.87

Appendix VI. .Analysis of variance of the data on cob length

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	4.9002	2.4501		
variety	1	20.0853	20.0853	22.02	0.0001
spacing	5	17.4130	3.4826	3.82	0.0122
variety*spacing	5	1.8358	0.3672	0.40	0.8417
Error	22	20.0643	0.9120		
Total	35	64.2988			

Grand Mean 16.468

CV 5.80

Appendix VII. Analysis of variance of the data on cob circumference

Source	DF	SS	MS	F	P
replication	2	6.5262	3.2631		
variety	1	14.7072	14.7072	23.29	0.0001
spacing	5	21.6503	4.3301	6.86	0.0005
variety*spacing	5	8.3796	1.6759	2.65	0.0504
Error	22	13.8906	0.6314		
Total	35	65.1540			

Grand Mean 13.207

CV 6.02

Appendix VIII. Analysis of variance of the data on number of row cob^{-1}

Source	DF	SS	MS	F	P
replication	2	0.8889	0.44444		
variety	1	7.1111	7.11111	10.83	0.0033
spacing	5	18.8889	3.77778	5.75	0.0015
variety*spacing	5	0.8889	0.17778	0.27	0.9242
Error	22	14.4444	0.65657		
Total	35	42.2222			

Grand Mean 15.778

CV 5.14

Appendix IX. Analysis of variance of the data on number of grain raw^{-1}

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	27.167	13.5833		
variety	1	42.250	42.2500	13.00	0.0016
spacing	5	24.250	4.8500	1.49	0.2327
variety*spacing	5	3.583	0.7167	0.22	0.9499
Error	22	71.500	3.2500		
Total	35	168.750			

Grand Mean 30.083

CV 5.99

Appendix X. Analysis of variance of the data on number grain cob^{-1}

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	11487	5743.4		
variety	1	33733	33733.4	32.93	0.0000
spacing	5	42701	8540.2	8.34	0.0002
variety*spacing	5	2208	441.6	0.43	0.8220
Error	22	22535	1024.3		
Total	35	112665			

Grand Mean 475.56

CV 6.73

Appendix XI. Analysis of variance of the data on husk weight

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	16.103	8.052		
variety	1	238.239	238.239	41.82	0.0000
spacing	5	39.764	7.953	1.40	0.2643
variety*spacing	5	13.765	2.753	0.48	0.7849
Error	22	125.321	5.696		
Total	35	433.193			

Grand Mean 18.126

CV 13.17

Appendix XII. Analysis of variance of the data on rakish weight

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	57.57	28.79		
variety	1	5385.85	5385.85	256.67	0.0000
spacing	5	947.14	189.43	9.03	0.0001
variety*spacing	5	200.68	40.14	1.91	0.1330
Error	22	461.63	20.98		
Total	35	7052.86			

Grand Mean 46.898

CV 9.77

Appendix XIII. Analysis of variance of the data on cob weight plant^{-1}

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	1785.4	892.7		
variety	1	30593.8	30593.8	102.50	0.0000
spacing	5	11260.3	2252.1	7.55	0.0003
variety*spacing	5	582.3	116.5	0.39	0.8501
Error	22	6566.3	298.5		
Total	35	50788.1			

Grand Mean 203.11

CV 8.51

Appendix XIV. .Analysis of variance of the data on 100 grain weight

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	60.113	30.0566		
variety	1	43.648	43.6480	6.07	0.0221
spacing	5	16.819	3.3638	0.47	0.7963
variety*spacing	5	31.104	6.2207	0.86	0.5203
Error	22	158.305	7.1957		
Total	35	309.989			

Grand Mean 28.953

CV 9.26

Appendix XV. .Analysis of variance of the data on total grain weight plant^{-1}

Source	DF	SS	MS	F	P
replication	2	1709.6	854.81		
variety	1	7411.1	7411.06	29.49	0.0000
spacing	5	5822.0	1164.40	4.63	0.0049
variety*spacing	5	333.7	66.73	0.27	0.9271
Error	22	5529.4	251.33		
Total	35	20805.7			

Grand Mean 138.08

CV 11.48

Appendix XVI. Analysis of variance of the data on grain yeild

Source	DF	SS	MS	F	P
replication	2	1.9523	0.9762		
variety	1	38.3760	38.3760	49.51	0.0000
spacing	5	30.3282	6.0656	7.83	0.0002
variety*spacing	5	4.3046	0.8609	1.11	0.3833
Error	22	17.0524	0.7751		
Total	35	92.0136			

Grand Mean 11.351

CV 7.76

Appendix XVII. Analysis of variance of the data on stover yeild

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	0.9289	0.4645		
variety	1	34.2225	34.2225	41.84	0.0000
spacing	5	34.4266	6.8853	8.42	0.0001
variety*spacing	5	6.2342	1.2468	1.52	0.2230
Error	22	17.9953	0.8180		
Total	35	93.8075			

Grand Mean 12.536

CV 7.21

Appendix XVIII. Analysis of variance of the data on,biological yeild

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	5.465	2.732		
variety	1	145.078	145.078	49.85	0.0000
spacing	5	128.056	25.611	8.80	0.0001
variety*spacing	5	15.515	3.103	1.07	0.4056
Error	22	64.031	2.911		
Total	35	358.145			

Grand Mean 23.887

CV 7.14

Appendix XIX. Analysis of variance of the data on harvest index

Source	**DF**	**SS**	**MS**	**F**	**P**
replication	2	1.4754	0.73771		
variety	1	4.0162	4.01623	3.38	0.0796
spacing	5	6.5118	1.30235	1.10	0.3907
variety*spacing	5	21.5944	4.31887	3.63	0.0151
Error	22	26.1529	1.18877		
Total	35	59.7507			

Grand Mean 47.482

CV 2.30