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

S. Ahamed[1], M. J. Ullah[1], M.S. Islam[1], M.H. Mahmud[2*] and A. Hossain[3]

[1]Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[2]Project Implementation Unit-BARC, National Agricultural Technology Program-Phase-II Project, Farmgate, Dhaka, Bangladesh
[3]Sub-Station, Bangladesh Institute of Nuclear Agriculture, Sunamganj, Bangladesh
*Corresponding author, Email: h.mahmud193@gmail.com

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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 with fifteen planting configurations *viz*., T_1 (40 cm × 15 cm), T_2 (40 cm × 20 cm), T_3 (40 cm × 25 cm), T_4 (45 cm × 15 cm), T_5 (45 cm × 20 cm), T_6 (45 cm × 25 cm), T_7 (50 cm × 15 cm), T_8 (50 cm × 20 cm), T_9 (50 cm × 25 cm), T_{10} (55 cm × 15 cm), T_{11} (55 cm × 20 cm), T_{12} (55 cm × 25 cm), T_{13} (60 cm × 15 cm), T_{14} (60 cm × 20 cm), and T_{15} (60 cm × 25 cm) to study the growth, phenology, yield attributes and yield of a white maize genotype SAUWMOPMDT273. The experiment was laid out in a randomized complete block design with three replications. Regarding growth and yield parameters, the treatment 60 cm × 25 cm showed significantly the maximum plant height, tassel length and leaf area at silking, grain filling and at harvest. The highest area of an individual leaf 477.9, 879.3, and 496.3 cm^2 as well as stem dry matter weight of 28.73, 21.35, and 27.40 g $plant^{-1}$ respectively, below cob-node, at cob-node and above the cob-node during silking obtained from treatment 60 cm × 25 cm. The treatment 55 cm × 25 cm showed maximum biological yield (14.64 t ha^{-1}) and 60 cm × 20 cm 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 55 cm × 25 cm. Sparser configuration (60×20 cm) requiring less seed rate, this configuration may be followed.

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 programs (Zamir *et al.*, 2011). The average yield of maize in Bangladesh is not satisfactory. 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).

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). 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). 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.

Plant spacing is an important factor, which plays a significant role on growth, development and yield of maize. Less plant population and poor nutrient management practices are the major yield reducing factors in maize (Dawadi and Sah, 2012). The Broadcasting method produced the most effective spatial arrangements. It generally gave lower yields than sowing in rows (Krezel and Sobkowicz, 1996).

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). 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).

This experiment was designed to evaluate growth, phenology and yield attributes of the white maize genotype SAUWMOPMDT273 under different planting configurations.

Materials and Methods

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka under the Agro-ecological zone of Modhupur Tract, AEZ-28 during the Kharif-II season from July to October, 2018. The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity, and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (October-March). The experiment was laid out in a randomized complete block design with three replications. The treatments (spacing) were as follows: T_1= 40 cm × 15 cm, T_2= 40 cm × 20 cm, T_3= 40 cm × 25 cm, T_4= 45 cm × 15 cm, T_5= 45 cm × 20 cm, T_6= 45 cm × 25 cm, T_7= 50 cm × 15 cm, T_8= 50 cm × 20 cm, T_9= 50 cm × 25 cm, T_{10}= 55 cm × 15 cm, T_{11}= 55 cm × 20 cm, T_{12}= 55 cm × 25 cm, T_{13}= 60 cm × 15 cm, T_{14}= 60 cm × 20 cm, T_{15}= 60 cm × 25 cm. In this research work, White maize genotype - SAUWMOPMDT273 variety was used as plant materials and the seeds were collected from SAU, Dhaka.

The plot selected for the experiment was prepared on the first week of July 2018. Weeds and stubble were removed and finally obtained a desirable field. Fertilizers and manure were applied for the cultivation of crops as recommended by BARI, 2014. The baby corn 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 plot.

All intercultural operations like gap filling, weeding, plant protection, irrigation and drainage were taken properly. The cobs of five randomly selected plants of each plot were separately harvested for recording data on yield attributes and other parameters.The plant height, tassel length plant^{-1}, cob length and breadth as recorded in centimeters (cm) at the time of silking, 15 days of silking and at harvest. Leaf area and dry matter content plant^{-1} were 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. Number of grains row^{-1}, number of grains cob^{-1}, weight of 100 seeds (g), grain weight cob^{-1} (g), shell weight cob^{-1} (g), chaff weight cob^{-1} (g), grain yield (t ha^{-1}) and stover yield (t ha^{-1}) was counted. Cob (dehusked) and stover obtained from each unit plot were sun-dried and weighed carefully. The harvest index was calculated with the following formula:

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

The data were analyzed, and the means were separated by LSD at 5% level of significance using the statistical computer package program MSTAT-C.

Results and Discussion

Plant height

Significant influence was recorded on plant height of maize at different growth stages as affected by different planting configurations (Table 1). The treatment 60 cm × 25 cm 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 (190.30, 184.30 and 175.50 cm at silking time, 15 days after silking time and at harvest, respectively) from 40 cm × 15 cm. Similar result was found by Fromme *et al.* (2019). But Zeleke *et al.* (2018) also found that plant height, significantly increased with increasing planting density from 44,444 to 88,888 plants ha^{-1}.

Tassel length

Significant influence was recorded on tassel length of maize at different growth stages as affected by different planting configurations (Table 1). The treatment 60 cm × 25 cm 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 (33.00, 26.67 and 27.98 cm at silking time, 15 days after silking time and at harvest, respectively) from the treatment 40 cm × 15 cm. The highest tassel length from 60 cm × 25 cm which might be due to cause of higher nutrients light and air availability during the cropping period.

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

Treatments	Plant height (cm)			Tassel length (cm)		
	At silking	At 15 days of silking	At harvest	At silking	At 15 days of silking	At harvest
T_1	190.3 h	184.3 g	175.5 h	33.00 f	26.67 f	27.98 j
T_2	197.7 g	200.7 c	190.6 e	37.67 e	32.10 e	28.93 j
T_3	200.3 f	206. b	184.1 f	34.33 f	37.70 d	31.30 hi
T_4	209.7 c	209.3 b	176.5 gh	44.00 c	39.17 cd	30.50 i
T_5	197.0 g	200.3 c	179.3 g	41.33 d	37.77 d	34.38 de
T_6	210.3 c	194.3 ef	179.3 g	46.00 b	37.17 d	31.02 hi
T_7	211.3 c	196.3 e	194.2 d	44.00 bc	37.30 d	33.37 ef
T_8	204.7 de	197.0 de	201.2 c	43.33 cd	37.13 d	32.60 fg
T_9	206.7 d	201.3 c	177.0 gh	38.00 e	40.13 c	36.33 c
T_{10}	201.7 f	195.0 ef	206.5 b	37.00 e	38.20 cd	31.67 gh
T_{11}	214.3 b	208.7 b	186.3 f	44.00 bc	38.17 cd	35.23 d
T_{12}	205.0 de	217.7 a	204.2 bc	44.00 bc	37.97 cd	37.28 c
T_{13}	196.0 g	192.7 f	204.0 bc	39.00 e	44.33 b	36.52 c
T_{14}	202.7 ef	199.7 cd	194.0 d	43.33 cd	44.63 b	38.72 b
T_{15}	217.0 a	220.3 a	220.7 a	48.00 a	52.80 a	39.77 a
$LSD_{0.05}$	2.464	3.092	3.128	1.948	2.06	1.048
CV (%)	8.59	6.97	9.12	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

T_1 = 40 cm × 15 cm, T_2 = 40 cm × 20 cm, T_3 = 40 cm × 25 cm, T_4 = 45 cm × 15 cm, T_5 = 45 cm × 20 cm, T_6 = 45 cm × 25 cm, T_7 = 50 cm × 15 cm, T_8 = 50 cm × 20 cm, T_9 = 50 cm × 25 cm, T_{10} = 55 cm × 15 cm, T_{11} = 55 cm × 20 cm, T_{12} = 55 cm × 25 cm, T_{13} = 60 cm × 15 cm, T_{14} = 60 cm × 20 cm, T_{15} = 60 cm × 25 cm

Leaf area at silking time

Significant influence was recorded on leaf area of maize at silking time as affected by different planting configurations (Table 2). At all three portions 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 60 cm × 25 cm followed by 60 cm × 20 cm 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 40 cm × 15 cm.

Leaf area 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 2). 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 60 cm × 25 cm followed by treatment 60 cm × 20 cm 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 40 cm × 15 cm.

Table 2. Leaf area (cm^2 leaf^{-1}) of maize at silking, 15 days of silking time and harvest as influenced by different planting configurations

Treatments	At silking			At 15 days of silking time			At harvest		
	Leaves below cob- node	Leaf at cob-node	Leaves above cob-node	Leaves below cob-node	Leaf at cob-node	Leaves above cob-node	Leaves below cob- node	Leaf at cob-node	Leaves above cob-node
T_1	302.5 k	595.5 k	262.9 l	247.7 l	562.8 k	256.6 j	145.7 k	365.4 j	211.1 k
T_2	350.0 j	621.4 i	316.4 ij	281.1k	591.6 i	274.5 i	183.9 h	438.6 i	262.7ef
T_3	356.3 i	662.9 g	293.3 k	297.8 j	633.5 f	291.8h	170.8 j	446.1 h	246.3 h
T_4	364.9 h	681.1 e	409.3 ef	313.9 i	617.6 g	273.3 i	181.8hi	446.9 h	253.8 g
T_5	373.4 g	659.0 g	353.8 g	326.0h	562.6 k	289.4h	175.2 ij	445.5 h	259.6 fg
T_6	306.5 k	676.5ef	428.3 d	369.8g	579.5 j	299.1g	233.9 d	513.0 d	267.7 e
T_7	406.2 e	614.6 j	311.0 ij	380.9 f	674.2 e	291.0h	201.6 g	432.7 i	236.7 i
T_8	370.0 gh	627.5 i	309.9 j	367.3g	715.2 d	311.2 f	172.7 j	445.9 h	224.0 j
T_9	346.6 j	613.2 j	331.3 h	298.4 j	720.3cd	368.8c	200.6g	494.8ef	290.1 d
T_{10}	389.5 f	646.8 h	318.8 i	283.2k	668.6 e	350.5d	230.1de	474.5 g	294.6 d
T_{11}	375.7 g	671.5 f	404.0 f	393.1e	605.3 h	321.4e	226.4 e	490.4 f	288.7 d
T_{12}	442.4 d	734.0 d	414.0 e	414.1d	749.8ab	362.3c	209.1 f	497.5 e	315.3 c
T_{13}	452.1 c	747.0 c	444.6 c	441.6c	726.5 c	372.9b	256.3 c	523.2 c	318.5 c
T_{14}	470.3 b	771.3 b	464.6 b	467.6b	745.1 b	355.1d	284.1 b	549.1 b	344.3 b
T_{15}	477.9 a	879.3 a	496.3 a	511.6a	756.4 a	381.0a	302.1a	615.6 a	389.0 a
$LSD_{0.05}$	5.824	6.404	7.529	7.161	6.926	6.754	6.964	6.688	6.838
CV (%)	10.17	12.24	9.00	8.79	10.17	13.20	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

T_1 = 40 cm × 15 cm, T_2 = 40 cm × 20 cm, T_3 = 40 cm × 25 cm, T_4 = 45 cm × 15 cm, T_5 = 45 cm × 20 cm, T_6 = 45 cm × 25 cm, T_7 = 50 cm × 15 cm, T_8 = 50 cm × 20 cm, T_9 = 50 cm × 25 cm, T_{10} = 55 cm × 15 cm, T_{11} = 55 cm × 20 cm, T_{12} = 55 cm × 25 cm, T_{13} = 60 cm × 15 cm, T_{14} = 60 cm × 20 cm, T_{15} = 60 cm × 25 cm

Leaf area at harvest

Significant influence was recorded on leaf area of maize at harvest as affected by different planting configurations (Table 2). 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 60 cm × 25 cm followed by treatment 60 cm × 20 cm 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 40 cm × 15 cm. 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.

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 3). At all three portions 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 55 cm × 25 cm 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 40 cm × 15 cm.

Dry matter content at 15 days after silking

Significant influence was recorded on dry matter content of maize at 15 days after silking as affected by different planting configurations (Table 3). At all three portions 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 55 cm × 25 cm 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 40 cm × 15 cm.

Dry matter content at harvest

Significant influence was recorded on dry matter content of maize at harvest as affected by different planting configurations (Table 3).

Table 3. Stem dry matter content of maize at silking time, 15 days after silking and harvest as influenced by different planting configurations

Treatment	At silking time			At 15 days after silking			At harvest		
	Below cobs-node	At cob-node	Above cob-node	Below cobs-node	At cob-node	Above cob-node	Below cobs-node	At cob-node	Above cob-node
T_1	16.85 f	11.95 h	15.46 h	19.45 j	28.99 k	17.06h	15.76 h	33.17g	10.62g
T_2	22.80de	15.81 g	18.01fg	20.90ij	32.80 j	17.63h	22.73de	46.73b	12.97cd
T_3	22.12de	12.51 h	17.38 g	24.59fg	44.09g	15.52 i	21.24 f	37.90ef	12.17def
T_4	21.52 e	19.88ef	22.38 c	26.91de	33.33ij	17.71gh	17.11 h	37.34 f	12.78 cd
T_5	23.28de	24.39bc	18.36fg	23.32gh	34.28 i	19.38ef	20.50 f	35.31fg	13.56 bc
T_6	22.04de	16.01 g	25.51 b	32.73 a	37.73h	21.65 d	18.61 g	40.92de	12.65cde
T_7	24.25cde	23.81 c	18.12fg	30.61 b	47.50f	25.58 b	20.58 f	34.73fg	14.00 b
T_8	24.45cd	19.75 f	19.44ef	26.13ef	50.57de	19.03fg	21.00 f	36.38 f	13.43 bc
T_9	26.66bc	22.25 d	20.66de	28.41cd	49.33 e	23.54 c	23.77cde	37.41 f	11.64efg
T_{10}	28.29 b	21.59 d	21.93cd	24.93fg	51.23 d	18.28fgh	22.64 e	43.38cd	12.59cde
T_{11}	23.05 de	12.60 h	22.37 c	29.67bc	52.87 c	18.11fgh	24.03 cd	46.48bc	11.20 fg
T_{12}	31.32 a	29.17 a	27.25 a	34.47 a	73.54 a	28.00 a	28.07 a	56.21 a	15.10 a
T_{13}	22.73 de	18.89 f	18.05fg	22.15hi	49.71 e	19.35 ef	24.38 c	49.59 b	14.07 b
T_{14}	27.61 b	21.35de	19.33ef	29.45bc	50.33de	20.65 de	26.00 b	54.81 a	14.33 ab
T_{15}	28.73 ab	25.91 b	27.40 a	34.27 a	64.46 b	27.97 a	28.30 a	54.45 a	14.24 ab
$LSD_{0.05}$	0.52	0.29	0.28	0.35	0.27	0.26	0.26	0.60	0.19
CV (%)	8.89	7.47	6.60	9.80	11.60	10.89	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

T_1 = 40 cm × 15 cm, T_2 = 40 cm × 20 cm, T_3 = 40 cm × 25 cm, T_4 = 45 cm × 15 cm, T_5 = 45 cm × 20 cm, T_6 = 45 cm × 25 cm, T_7 = 50 cm × 15 cm, T_8 = 50 cm × 20 cm, T_9 = 50 cm × 25 cm, T_{10} = 55 cm × 15 cm, T_{11} = 55 cm × 20 cm, T_{12} = 55 cm × 25 cm, T_{13} = 60 cm × 15cm, T_{14} = 60 cm × 20 cm, T_{15} = 60 cm × 25 cm

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 55 cm × 25 cm 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 40 cm × 15 cm. Ibeawuchi and Matthews-Njoku (2008) achieved highest dry matter with the plant spacing of 25 cm × 75 cm and found that higher nutrient efficiency showed higher dry matter accumulation in plants. Under the present study higher plant spacing 55 cm × 25 cm showed higher dry matter content compared to others which was supported by the finding of Ibeawuchi and Matthews-Njoku (2008).

Cob length

Significant influence was recorded on cob length of maize as affected by different planting configurations (Table 4).

Table 4. 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-grain weight (g)
T_1	9.19 g	9.62 f	8.22 i	6.89 j	61.21 k	23.38 e
T_2	9.58 g	10.03 ef	8.83 hi	10.56 hi	93.58 j	24.04 e
T_3	9.31 g	10.10 ef	8.67 hi	9.66 i	86.86 j	25.46 d
T_4	10.78 f	10.69 e	9.22 gh	11.33 h	107.40 i	27.77 c
T_5	11.80 ef	11.52 d	10.00 f	14.00 f	140.20 g	28.29 bc
T_6	11.05 f	12.22 c	11.67 b	14.11 ef	164.10 e	25.73 d
T_7	11.51 ef	10.68 e	10.67 de	15.55 d	165.60 e	27.38 c

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-grain weight (g)
T_8	13.13 cd	12.08 cd	11.11 bcd	15.33 de	170.30 e	27.55 c
T_9	13.51 bcd	12.94 ab	11.33 bc	12.67 g	140.30 g	28.43 bc
T_{10}	12.35 de	12.54 abc	9.22 gh	13.11 fg	121.60 h	29.95 a
T_{11}	13.49 bcd	12.27 bc	9.66 fg	15.56 d	154.10 f	28.08 bc
T_{12}	13.77 bc	13.06 a	12.33 a	18.67 b	231.50 a	29.99 a
T_{13}	14.39 b	12.46 abc	11.00 cd	17.34 c	189.50 c	27.96 bc
T_{14}	15.94 a	12.01 cd	10.78 cde	20.00 a	218.50 b	29.51 a
T_{15}	14.28 bc	12.13 cd	10.22 ef	17.44 bc	181.20 d	28.94 ab
$LSD_{0.05}$	0.23	0.13	0.12	0.24	1.34	0.20
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

T_1 = 40 cm × 15 cm, T_2 = 40 cm × 20 cm, T_3 = 40 cm × 25 cm, T_4 = 45 cm × 15 cm, T_5 = 45 cm × 20 cm, T_6 = 45 cm × 25 cm, T_7 = 50 cm × 15 cm, T_8 = 50 cm × 20 cm, T_9 = 50 cm × 25 cm, T_{10} = 55 cm × 15 cm, T_{11} = 55 cm × 20 cm, T_{12} = 55 cm × 25 cm, T_{13} = 60 cm × 15cm, T_{14} = 60 cm × 20 cm, T_{15} = 60 cm × 25 cm

The highest cob length (15.94 cm) was recorded from the treatment 60 cm × 20 cm which was significantly different from all other treatments followed by the treatment 60 cm × 15 cm. The lowest cob length (9.19 cm) was found from the treatment 40 cm × 15 cm which was statistically identical with the treatment 40 cm × 20 cm and 40 cm × 25 cm. 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.

Cob breadth

Significant influence was recorded on cob breadth of maize as affected by different planting configurations (Table 4). The highest cob breadth (13.06 cm) was recorded from the treatment 55 cm × 25 cm which was statistically similar with the treatment 50 cm × 25 cm, 55 cm × 15 cm and 60 cm × 15 cm. On the other hand, the lowest cob breadth (9.62 cm) was found from the treatment 40 cm × 15 cm. Under the present study, the highest cob breadth (13.06 cm) from 55 cm × 25 cm which might be due to cause of higher nutrient uptake from lower plant population due to less competition of nutrients.

Number of rows cob^{-1}

Significant influence was recorded on number of rows cob^{-1} of maize as affected by different planting configurations (Table 4). The highest number of rows cob^{-1} (12.33) was recorded from the treatment 55 cm × 25 cm which was significantly different from all other treatments followed by 45 cm × 25 cm, 50 cm × 25 cm and 55 cm × 15 cm. The lowest number of rows cob^{-1} (8.22) was found from the treatment 40 cm × 15 cm which was statistically similar with the treatment 40 cm × 20 cm and 40 cm × 25 cm. 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).

Number of grains row^{-1}

Significant influence was recorded on number of grains row^{-1} of maize as affected by different planting configurations (Table 4). The highest number of grains row^{-1} (20.00) was recorded from the treatment 60 cm × 20 cm which was significantly different from all other treatments followed by 55 cm × 25 cm and 60 cm × 25 cm. The lowest number of grains row^{-1} (6.89) was found from the treatment 40 cm × 15 cm which was significantly different from all other treatments. Similar result was also observed by Rahman *et al*. (2016) and Kunjir (2007).

Number of grains cob^{-1}

Significant influence was recorded on number of grains cob^{-1} of maize as affected by different planting configurations (Table 4). The highest number of grains cob^{-1} (231.50) was recorded from the treatment 55 cm × 25 cm which was significantly different from all other treatments followed by 60 cm × 20 cm. The lowest number of grains cob^{-1} (61.21) was found from the treatment 40 cm × 15 cm which was significantly different from all other treatments. The result obtained from the present study was similar with the findings of Rahman *et al*. (2016), Kunjir (2007) and Bairagi *et al*. (2015).

Weight of 100-seeds

Significant influence was recorded on 100-seed weight of maize as affected by different planting configurations (Table 4). The highest 100-seed weight (29.99 g) was recorded from the treatment 55 cm × 25 cm which was statistically similar with the treatment 55 cm × 15 cm, 60 cm × 20 cm and 60 cm × 25 cm. The lowest 100-seed weight (23.38 g) was found from the treatment 40 cm × 15 cm which was statistically identical with the treatment 40 cm × 20 cm. 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 × 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.

Grain weight cob^{-1}

Significant influence was recorded on grain weight cob^{-1} of maize as affected by different planting configurations (Table 5). The highest grain weight cob^{-1} (59.81 g) was recorded from the treatment 55 cm × 25 cm which was statistically identical with the treatment 60 cm × 25 cm. The lowest grain weight cob^{-1} (17.42 g) was found from the treatment 40 cm × 15 cm which was significantly different from all other treatments. The treatment 40 cm × 20 cm, 40 cm × 25 cm and 45 cm × 15 cm also showed lower result on grain weight cob^{-1} which was closer to 40 cm × 15 cm 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 × 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).

Shell weight cob^{-1}

Significant influence was recorded on shell weight cob^{-1} of maize as affected by different planting configurations (Table 5). The highest shell weight cob^{-1} (15.33 g) was recorded from the treatment 60 cm × 20 cm which was statistically similar with the treatment 55 cm × 25 cm whereas the lowest shell weight cob^{-1} (7.76 g) was found from the treatment 40 cm × 15 cm which was statistically similar with the treatment 40 cm × 20 cm, 45 cm × 15 cm and 50 cm × 15 cm.

Chaff weight cob^{-1}

Significant influence was recorded on chaff weight cob^{-1} of maize as affected by different planting configurations (Table 5). The highest chaff weight cob^{-1} (8.24 g) was recorded from the treatment 55 cm × 25 cm which was statistically identical with the treatment 60 cm × 20 cm and 60 cm × 25 cm and 60 cm × 15 cm. The lowest chaff weight cob^{-1} (4.00 g) was found from the treatment 40 cm × 15 cm which was statistically similar with the treatment but 40 cm × 20 cm, 40 cm × 25 cm and 45 cm × 15 cm also showed closer result on chaff weight cob^{-1} compared to 40 cm × 15 cm.

Grain yield ha^{-1}

Significant influence was recorded on grain yield ha^{-1} of maize as affected by different planting configurations (Table 5). The highest grain yield (4.77 t ha^{-1}) was recorded from the treatment 55 cm × 20 cm which was statistically identical with the treatment 45 cm × 20 cm, 50 cm × 15 cm, 60 cm × 15 cm and 60 cm × 20 cm followed by 55 cm × 15 cm. The lowest grain yield ha^{-1} (2.11 t ha^{-1}) was found from the treatment 40 cm × 25 cm which was significantly different from all other treatments. The treatment 40 cm × 15 cm and 50 cm × 25 cm also showed lower result on which was closer to 40 cm × 25 cm 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.

Stover yield ha^{-1}

Significant influence was recorded on stover yield ha^{-1} of maize as affected by different planting configurations (Table 5). The highest stover yield (10.60 t ha^{-1}) was recorded from the treatment 40 cm × 20 cm which was statistically identical with the treatment 40 cm × 15 cm, 45 cm × 15 cm and 60 cm × 15 cm followed by 50 cm × 15 cm and 55 cm × 15 cm, 55 cm × 15 cm. The lowest stover yield ha^{-1} (5.66 t ha^{-1}) was found from the treatment 50 cm × 25 cm 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.

Biological yield ha^{-1}

Significant influence was recorded on biological yield ha^{-1} of maize as affected by different planting configurations (Table 4). The highest biological yield (14.48 t ha^{-1}) was recorded from the treatment 60 cm × 15 cm which was statistically similar with the treatment 40 cm × 20 cm, 45 cm × 15 cm and 50 cm × 15 cm. The lowest biological yield ha^{-1} (8.68 t ha^{-1}) was found from the treatment 50 cm × 25 cm which was significantly different from all other treatments. The treatment 40 cm × 25 cm and 45 cm × 25 cm also showed lower result on biological yield ha^{-1} which was closer to 50 cm × 25 cm but significantly different Stephanus *et al.* (2018) and Rahman *et al.* (2016) also found similar result with this study.

Harvest index

Harvest index influenced significantly by different planting configurations (Table 5). The highest harvest index (40.52%) was recorded from the treatment 55 cm × 20 cm which was significantly different from all other treatments followed by 45 cm × 20 cm, 50 cm × 20 cm, 55 cm × 20 cm and 60 cm × 25 cm. The lowest harvest index (22.63%) was found from the treatment 40 cm × 15 cm which was significantly same with the treatments 40 cm × 25 cm. The treatment 40 cm × 20 cm and 60 cm × 15 cm also showed lower result on harvest index which was closer to 40 cm × 15 cm but significantly different. Similar result was also observed by Stephanus *et al.* (2018) and Hasan *et al.* (2018).

Table 5. Yield parameters of maize as influenced by different planting configurations

Treatment	Grain weight cob^{-1} (g)	Shell weight cob^{-1} (g)	Chaff weight cob^{-1} (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	17.42 k	7.75 i	4.00 g	2.99 f	10.21 a	13.19 b	22.63 k
T_2	26.12 i	8.32 hi	5.33 f	3.36 e	10.60 a	13.96 ab	24.06 j
T_3	21.09 j	8.81 h	5.13 f	2.11 g	7.13 e	9.24 i	22.82 k
T_4	25.53 i	8.53 hi	5.34 f	3.89 c	10.24 a	14.13 ab	27.52 i
T_5	40.87 e	9.69 g	6.81 c	4.67 a	7.93 cd	12.60 cd	37.07 b
T_6	40.32 ef	9.96 g	6.11 e	3.58 d	6.42 fg	10.00 h	35.84 cd
T_7	35.26 h	8.51 hi	6.24 e	4.70 a	9.24 b	13.94 ab	33.72 f
T_8	41.94 e	12.19 ef	6.91 c	4.19 b	7.08 e	11.28 f	37.20 b
T_9	38.81 fg	12.70 de	6.36 de	3.02 f	5.66 h	8.68 j	34.77 e
T_{10}	37.99 g	11.70 f	6.70 cd	4.34 b	8.98 b	13.33 b	32.58 g
T_{11}	55.67 b	13.20 cd	7.67 b	4.77 a	7.00 e	11.78 e	40.52 a
T_{12}	59.81 a	14.57 ab	8.24 a	3.99 c	6.63 f	10.61 g	37.57 b
T_{13}	40.42 e	12.82 de	8.05 ab	4.62 a	10.06 a	14.68 a	31.47 h
T_{14}	55.47 b	15.33 a	8.19 a	4.75 a	8.15 c	12.91 c	36.83 bc
T_{15}	58.32 a	13.81 bc	8.13 a	3.89 c	6.47 fg	10.35 gh	37.55 b
$LSD_{0.05}$	0.32	0.16	0.08	0.04	0.40	0.49	1.03
CV (%)	12.83	8.39	11.03	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

T_1 = 40 cm × 15 cm, T_2 = 40 cm × 20 cm, T_3 = 40 cm × 25 cm, T_4 = 45 cm × 15 cm, T_5 = 45 cm × 20 cm, T_6 = 45 cm × 25 cm, T_7 = 50 cm × 15 cm, T_8 = 50 cm × 20 cm, T_9 = 50 cm × 25 cm, T_{10} = 55 cm × 15 cm, T_{11} = 55 cm × 20 cm, T_{12} = 55 cm × 25 cm, T_{13} = 60 cm × 15cm, T_{14} = 60 cm × 20 cm, T_{15} = 60 cm × 25 cm

Conclusion

Considering the above results, it may be concluded 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 per ha yield, lower planting density showed better result compared to higher planting density. With this respect, the highest grain weight cob^{-1} (59.81 g) was found from the treatment 55 cm × 25 cm whereas the highest grain yield (4.77 t ha^{-1}) was recorded from the treatment 55 cm × 20 cm. From the above findings, it can be concluded that the spacing 55 cm × 20 cm showed highest grain yield (4.77 t ha^{-1}) and harvest index (40.52%). So, the plant spacing 55 cm × 20 cm could be considered for higher grain yield as compared to other planting configurations.

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