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INFLUENCE OF PLANTING METHOD AND LEAF CLIPPING ON THE YIELD PERFORMANCE OF WHITE MAIZE

M. R. Bepary[1*], M. J. Ullah[1], M. H. Mahmud[2], M. Hassan[1] and M. D. Hossain[1]

[1]Department of Agronomy, Sher-e-Bangla Agricultural University (SAU), Dhaka; [2]Project Implementation Unit (PIU), Bangladesh Agricultural Research Council (BARC), Farmgate. Dhaka. Bangladesh.

Abstract

An experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during January to June 2018 to evaluate the influence of planting method and leaf clipping on the yield performance of white maize. The experiment was laid out in a split plot design with three replications. The experiment comprised of two factors. Factor A: Planting method - 2 types [P_1 = Sowing, P_2 = Transplanting] and Factor B: Leaf clipping - 4 levels [C_1 = no leaf clipping, C_2 = all leaf clipping, C_3 = clipping of four leaves above cob, C_4 = clipping of four leaves below cob]. White Maize Yungnuo 3000 was used for the experiment. Significant difference was observed on growth, yield and yield contributing parameters. In the case of planting method, all growth and yield attributes were showed better performance in treatment P_1 than treatment P_2. In the case of leaf clipping, C_1 treatment performed best on the plant height (89.31, 168.32 and 217.21 cm, respectively) at different days after planting, leaf length (41.87 cm), cob length (19.77 cm), cob breadth (18.42 cm), number of row cob^{-1} (14.67), number of grain row^{-1} (34.65), grain yield (8.69 t ha^{-1}), 100 seed weight (28.47 g), oven dried shell weight (17.87 g) and oven dried chaff weight (10.88 g), whereas poor performance was found in C_2. In case of interaction, P_1C_1 treatment gave the highest performance in all aspect of growth and yield parameters and lowest found from P_2C_2.

Keywords: Leaf clipping, Maize, Planting method, Yield.

Introduction

Maize (*Zea mays* L.) belongs to the family Poaceae and it is the third important cereal crop of the World after wheat and rice. It is grown extensively in temperate, subtropical and tropical regions of the world. Maize is used as a staple food for human consumption and feed for livestock. Maize is produced primarily as an energy source crop, but specialized versions for protein, oil, wax, sweet corn and popcorn are also available (Akbar *et al*., 2016). Maize (*Zea mays* L.) is an important cereal crop over the world, is now well-fitted in diversified cropping systems in the Indo-Gangetic Plains (Gathala *et al*., 2015).

[*]Corresponding author: h.mahmud193@gmail.com

Maize is one of the most important food crop in the world and, together with rice and wheat, provides at least 30% of the food calories to more than 4.5 billion people in 94 developing countries (FAOSTAT 2016). Like many other parts in the world, market demand for maize in South Asia and Bangladesh has significantly increased in the last decade and the trend has been especially remarkable in Bangladesh, where cultivated land area with maize jumped from 0.05 M ha in (2000) to > 0.33 M ha in 2021 (FAOSTAT, 2021).

Maize currently grown in Bangladesh is of yellow type and are used in the feed industry. White maize covers only 12% of the total acreage of the world which is mostly used as human food (FAO-CIMMYT, 1997). With the advanced breeding approaches worldwide, recent reports demonstrate that the yield productivity of white maize is almost at par with those of the yellow ones. Inappropriate planting method caused reduction in germination, growth and development, ear size and increased susceptibility to diseases and lodging (Bakht *et al*., 2011). It is suggested to improve planting techniques for suitable seed bed preparation in order to ensure optimum plant population (Buttar *et al*., 2006). Maize biometrical parameters are significantly affected by planting methods. Rasheed *et al*. (2003) observed increased leaf area, leaf area index, crop growth rate and net assimilation rate in different planting methods. Khaliliaqdam *et al*. (2012) found that mutual shading, particularly at high population density, reduces number of grains per cob. After anthesis, the staminate inflorescence, the tassel may have very little or no effect on grain filling (Leakey *et al*., 2006).

Very few or no research finding are available in our country on leaf clipping in white maize field. So, there is a wide scope to conduct research activities on the efficacy of leaf clipping in white maize and to relate with varietal performance of white maize. Considering the above facts, the study was under taken to evaluate the influence of planting methods and leaf clipping on the yield performance of white maize.

Materials and Methods

The experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka during the period from 04 January 2018 to 28 June 2018. The geographical location of the site is 90°33′E longitude and 23°77′N latitude which belongs to "The Modhupur Tract", AEZ-28.

Experimental design

The experiment was laid in split plot design with three replications (block). Each replication was first divided into 8 subplots where treatment combinations were assigned. Thus the total number of unit plots was 8×3=24. The size of the individual plot was 3 m x 1.4 m. The inter plot spacing was 0.20 m and inters block spacing was 0.60 m. The following treatments were included in this experiment: Factor A: Planting method - 2 types, P_1 = Sowing, P_2 = Transplanting and Factor B: Leaf clipping - 4 levels, C_1 = No leaf clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Crop management

Seeds of white maize variety Yungnuo 3000 were collected from Personal communication, Prof. Dr. Md. Jaffor Ullah, Department of Agronomy, SAU, Dhaka. Land prepared with recommended fertilizer dose of well rotten cowdung manure and chemical fertilizers were mixed with the soil of each unit plot. For each treatment; dry, clean and homogenous air dried seeds were used. Seeds were treated with Provax 200FF @ 0.3% of seed weight. Some seeds were planted in lines each having a line to line distance of 60 cm and plant to plant distance of 20 cm having 3 seeds hole-1 under direct sowing in the well prepared plot. The seedlings were raised in seedbed. The plot was kept ready through tractor drawn cultivator for preparing seedbeds. The seeds were sown in line keeping the 20 cm apart and covered with soil. The seedlings (4 weeks of age) were transplanted keeping the row to row distance of 60 cm and plant to plant 20 cm in each plot and frequent irrigation was given to survive the seedlings.

Intercultural operations

Weeding were done to keep the plots free from weeds, easy aeration of soil and to conserve soil moisture, which ultimately ensured better growth and development. The excess plants were thinned out from all of the plots at 35 days after sowing (DAS) for maintaining optimum population of the experimental plots. First irrigation was given on 20 days after sowing. Second irrigation was given on 40 days after sowing. Third irrigation was given on 70 days after sowing and fourth irrigation was given on 90 days after sowing. Plant protection measures were taken as and when necessary.

Data collection

Crops were harvested when 90% of the cob became golden in color. Grains were separated from the ears. Grain and stovers thus collected were dried in the sun for a couple of days. Dried grain and stovers of each plot were weighed and subsequently converted into t ha^{-1} weight.

Plant height (cm) and leaf length (cm) were recorded at 40 DAS, 80 DAS and at harvest as the average of 5 plants selected at random from the inner rows of each plot and then it converted to whole plot. Randomly selected 10 cobs were considered for taking data of cob length (cm) and cob diameter (cm) using slide calipers. The number of rows and the number of grains of five cobs was counted at each of the five randomly selected plants in each plot and then averaged. Grains obtained from each plot were sun-dried and weighed of the respective plot was recorded carefully and converted to t ha-1. One hundred (100) seeds from 5 cobs were counted randomly from each plot and then weighed. Shells and Chaff were collected from 5 kernels of each plot; dried in an oven at 600 C for 72 hours and then weighed.

Statistical analysis

The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance was done following the computer package MSTAT-C program developed by Russel (1986). The mean differences among the treatments were adjusted by Least Significant Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

Results and Discussion

Plant height (cm)

Significant variation was observed on plant height at 40, 80 DAP and at harvest due to differences in planting method, leaf clipping and its interaction (Table 1 and 2). The results revealed that at 40, 80 DAP and at harvest, the treatment P_1 produced the tallest plant (85.43, 163.56 and 212.34 cm, respectively) and the treatment P_2 produced the shortest plant (82.87, 152.59 and 202.68 cm, respectively). This result is supported by Maiti and Sen (2003) who reported that delay in transplanting reduced plant height and other biomass related factors (number of tillers produced, leaf area index). At 40 DAP, the highest plant height (89.31 cm) was recorded from C_1 and the lowest (74.12 cm) from C_2. At 80 DAP, the highest plant height (168.32 cm) was recorded from C_1 and the lowest (135.87 cm) from C_2. At harvest, the highest plant height (217.21 cm) was recorded from C_1 and the lowest (172.29 cm) from C_2. At 40 DAP, the highest plant height (91.38 cm) was recorded from P_1C_1 and the lowest (74.21 cm) from P_2C_2. At 80 DAP, the highest plant height (172.34 cm) from P_1C_1 and the lowest (142.87 cm) from P_2C_2. At harvest, the highest plant height (219.36 cm) was recorded from P_1C_1 and the lowest (181.66 cm) from P_2C_2.

Table 1. Effects of planting method and leaf clipping on plant height, leaf length and leaf breadth at different days after sowing and transplanting of white maize

Treatments	Plant height (cm)			Leaf length (cm)	Leaf breadth (cm)
	40 DAP	80 DAP	At harvest		
	Effect of planting method				
P1	85.43a	163.56a	212.34a	39.87a	5.17
P2	82.87b	152.59b	202.68b	36.44b	4.67
LSD (0.05)	0.68	0.46	0.65	0.53	0.57
CV (%)	2.39	6.40	4.47	2.76	2.38
	Effect of leaf clipping				
C1	89.31 a	168.32 a	217.21 a	41.87 a	5.83
C2	74.12 d	135.87 d	172.29 d	33.82 c	4.93
C3	79.51 c	154.89 c	180.44 c	37.93 b	5.09
C4	84.37 b	162.38 b	191.56 b	38.76 b	5.36
LSD (0.05)	0.68	0.64	0.67	1.13	0.96
CV (%)	3.86	5.95	5.74	3.58	4.81

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Leaf length (cm)

Leaf length showed significant variation due to differences in planting method, leaf clipping and treatment interaction (Table 1 and 2). The results revealed that, the treatment P_1 produced the highest leaf length (39.87 cm) and P_2 produced the lowest (36.44 cm). The findings of Liu *et al.* (2020) who stated that leaf clipping at early season significantly decreased the stem and leaf length. The treatment C_1 produced the highest leaf length (41.87 cm) and C_2 produced the lowest (33.82 cm). The highest leaf length (42.19 cm) was recorded from P_1C_1 which was statistically similar with P_1C_4 (40.95 cm) and the lowest (31.14 cm) from P_2C_2.

Leaf breadth (cm)

Non-significant variation was observed on leaf breadth due to differences in planting method and leaf clipping (Table 1), but significant at interaction of treatment (Table 2). The highest leaf breadth (6.08cm) was recorded from P_1C_1 which was statistically similar with P_1C_4 (5.81 cm) and the lowest (4.08 cm) from P_2C_2.

Table 2. Interaction effect of planting method and leaf clipping on plant height, leaf length and leaf breadth at different days after sowing and transplanting of white maize

Treatments	Plant height (cm)			Leaf length (cm)	Leaf breadth (cm)
	40 DAS	80 DAS	At harvest		
P_1C_1	91.38 a	172.34 a	219.36 a	42.19 a	6.08 a
P_1C_2	80.11 d	161.25 d	202.39 c	37.12 b	4.91 c
P_1C_3	83.62 c	162.59 c	202.87 c	39.02 b	5.33 b
P_1C_4	86.74 b	167.84 b	209.55 b	40.95 a	5.81 a
P_2C_1	85.97 b	152.20 e	190.88 d	36.86 c	4.82 c
P_2C_2	74.21 f	142.87 g	181.66 f	31.14 e	4.08 e
P_2C_3	77.29 e	147.66 f	184.74 e	34.11 d	4.51 d
P_2C_4	82.92 c	151.83 e	187.21 d	36.22 c	4.66 c
$LSD_{(0.05)}$	0.72	0.58	0.63	1.92	0.37
CV (%)	2.58	5.22	3.67	3.10	4.26

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Cob length (cm)

Significant variation was found on cob length due to differences in planting method, leaf clipping and its combination treatment (Table 3 and 4). The treatment P_1 produced the highest cob length (17.63 cm) and P_2 produced the lowest (14.08 cm). The treatment C_1 produced the highest cob length (19.77 cm) and C_2 produced the lowest

(13.28 cm). The highest cob length (20.57 cm) was recorded from P_1C_1 which was statistically similar with P_1C_4 (19.91 cm) and the lowest (12.19 cm) from P_2C_2.

Cob breadth (cm)

Variation was found significantly on cob breath due to differences in planting method, leaf clipping and its combination treatment (Table 3 and 4). The treatment P_1 produced the highest cob breadth (12.45 cm) and P_2 produced the lowest (10.79 cm). The treatment C_1 produced the highest cob breadth (18.42 cm) and C_2 produced the lowest (11.91 cm). The highest cob breadth (18.79 cm) was recorded from P_1C_1 and the lowest (10.44 cm) from P_2C_2. Dry-matter production has been closely related to photosynthesis capacity, especially post-silking dry matter accumulation (Ma, *et al.,* 2010).

Number of cob bearing node

Significant variation was observed on number of cob bearing node due to differences in planting method, leaf clipping and interaction treatment (Table 3 and 4). The treatment P_1 produced the highest number of cob bearing node (7.67) and P_2 produced the lowest (5.33). The treatment C_1 produced the highest number of cob bearing node (9.33) which was statistically similar with C_4 (8.93) and C_2 produced the lowest (6.33). The highest number of cob bearing node (10.67) was recorded from P_1C_1 which was statistically similar with P_1C_4 (9.93) and the lowest (5.33) from P_2C_2. Number of cob bearing of maize depends on the variety. Similar result found by Mtyobile (2021).

Table 3. Effect of planting method and leaf clipping on cob length, cob breadth, number of cob bearing node and number of row cob^{-1} of white maize

Treatments	Cob length (cm)	Cob breadth (cm)	Number of cob bearing node	Number of row cob^{-1}
		Effect of planting method		
P1	17.63 a	12.45 a	7.67 a	13.67 a
P2	14.08 b	10.79 b	5.33 b	10.33 b
LSD (0.05)	0.88	0.67	0.73	0.92
CV (%)	4.45	3.59	6.26	4.16
		Effect of leaf clipping		
C1	19.77 a	18.42 a	9.33 a	14.67 a
C2	13.28 c	11.91 c	6.33 c	11.33 c
C3	17.22 b	15.48 b	7.67 b	12.57 b
C4	17.67 b	16.34 b	8.93 a	13.33 b
LSD (0.05)	0.74	0.96	0.46	0.89
CV (%)	3.58	4.82	3.11	5.59

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Number of row cob^{-1}

Significant variation was observed on number of row cob^{-1} due to differences in planting method, leaf clipping and interaction effect (Table 3 and 4). The treatment P_1 produced the highest number of row cob^{-1} (13.67) and P_2 produced the lowest (10.33). The treatment C_1 produced the highest number of row cob^{-1} (14.67) and C_2 produced the lowest (13.33). The highest number of row cob^{-1} (16.33) was recorded from P_1C_1 and the lowest (10.67) from P_2C_2.

Table 4. Interaction effect of planting method and leaf clipping on cob length, cob breadth, number of cob bearing node and number of row cob^{-1} of white maize

Treatments	Cob length (cm)	Cob breadth (cm)	Number of cob bearing node	Number of row cob^{-1}
P_1C_1	20.57 a	18.79 a	10.67 a	16.33 a
P_1C_2	18.15 b	15.72 c	8.79 b	15.33 b
P_1C_3	18.67 b	16.96 b	9.33 b	14.67 c
P_1C_4	19.91 a	17.31 b	9.93 a	15.67 b
P_2C_1	15.24 c	13.23 d	8.67 b	14.34 c
P_2C_2	12.19 e	10.44 f	5.33 e	10.67 e
P_2C_3	13.48 d	11.08 e	6.67 d	13.33 d
P_2C_4	14.69 c	13.06 d	7.63 c	13.67 d
LSD $_{(0.05)}$	0.75	0.42	0.87	0.53
CV (%)	6.54	4.29	3.66	5.41

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Number of grain row^{-1}

Significant variation was found on number of grain row^{-1} due to differences in planting method, leaf clipping and interaction (Table 5 and 6). The treatment P_1 produced the highest number of grain row^{-1} (26.61) and P_2 produced the lowest (23.87) due to delay in transplanting resulted in decreasing grain yield due to delayed seeding might be associated with the significantly lower number of productive tillers per meter, less number of filled grains per panicle and low 1000 grain weight (Baloch *et al*. (2006). The treatment C_1 produced the highest number of grain row^{-1} (34.65) and C_2 produced the lowest (29.44). The highest number of grain row^{-1} (36.89) was recorded from P_1C_1 and the lowest (24.37) from P_2C_2.

Table 5. Effect of planting method and leaf clipping on cob length, cob breadth, number of cob bearing node and number of row cob^{-1} of white maize

Treatments	Number of grain row^{-1}	Grain yield (t ha^{-1})	100 seed weight (g)	Shell weight (g)	Chaff weight (g)
Effect of planting method					
P1	26.61a	7.46a	21.58a	15.72a	7.29a
P2	23.87b	6.49b	19.03b	13.37b	5.57b
LSD (0.05)	0.88	0.67	0.73	0.92	0.85
CV (%)	4.45	3.59	6.26	4.16	5.62
Effect of leaf clipping					
C1	34.65a	8.69a	28.47a	17.87a	10.88a
C2	29.44d	6.07d	23.89bc	14.32c	5.79c
C3	31.22c	7.26	25.20b	15.57b	7.12b
C4	32.80b	7.95	26.35a	16.91a	8.62a
LSD (0.05)	0.74	0.66	2.13	0.96	1.27
CV (%)	4.85	4.61	4.21	5.35	5.90

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Grain yield (t ha^{-1})

Planting method, leaf clipping and treatment interaction had showed significant variation on grain yield (Table 5 and 6). The treatment P_1 produced the highest grain yield (7.46 t ha^{-1}) and P_2 produced the lowest (6.49 t ha^{-1}). The treatment C_1 produced the highest grain yield (8.69 t ha^{-1}) and C_2 produced the lowest (6.07 t ha^{-1}). This result is supported by Cheema *et al.* (2010) who reported that maize leaf clipping caused the seed yield reduction because of the seed number decrease. The highest grain yield (8.70 t ha^{-1}) was recorded from P_1C_1 and the lowest (4.92 t ha^{-1}) from P_2C_2. Reduction in yield with defoliation treatment in maize was reported by Gaias *et al.* (2017) and Heidari (2017).

100 seed weight (g)

Significant variation was found on 100 seed weight due to differences in planting method, leaf clipping and its interaction (Table 5 and 6). The treatment P_1 produced the highest 100 seed weight (21.58 g) and P_2 produced the lowest (19.03 g). The treatment C_1 produced the highest 100 seed weight (28.47 g) which was statistically similar with C_4 (26.35 g) and C_2 produced the lowest (23.89 g). This results are in conformity with Ahmadi *et al.* (2009) who reported that clipping significantly affect remobilization of grain yield and 1000-grain weight. The highest 100 seed weight (29.45 g) was recorded from P_1C_1 and the lowest (20.37 g) from P_2C_2.

Shell weight (g)

Significant variation was found on oven dried shell weight due to differences in planting method, leaf clipping and treatment interaction (Table 5 and 6). The results revealed that, P_1 produced the highest oven dried shell weight (15.72 g) and P_2 produced the lowest (13.37 g). The treatment C_1 produced the highest oven dried shell weight (17.87 g) which was statistically similar with C_4 (16.91 g) and C_2 produced the lowest (14.32 g). The highest oven dried shell weight (18.11 g) was recorded from P_1C_1 which was statistically similar with P_1C_4 (17.32 g) and the lowest (13.39 g) from P_2C_2.

Table 6. Interaction effect of planting method and leaf clipping on number of grain row^{-1}, grain yield and 100 seed weight of white maize

Treatments	Number of grain row^{-1}	Grain yield ($t\ ha^{-1}$)	100 seed weight (g)	Shell weight (g)	Chaff weight (g)
P_1C_1	36.89 a	8.70 a	29.45 a	18.11 a	11.05 a
P_1C_2	31.66 c	6.86 d	25.38 c	15.72 b	6.65 d
P_1C_3	33.85 b	7.46 c	27.12 b	16.36 b	7.87 c
P_1C_4	34.28 b	8.16 b	27.66 b	17.32 a	9.22 b
P_2C_1	29.72 d	6.81 d	25.19 c	15.29 c	7.43 c
P_2C_2	24.37 f	4.92 g	20.37 e	13.39 e	5.61 e
P_2C_3	26.19 e	5.51 f	22.96 d	13.76 d	6.22 d
P_2C_4	29.41 d	6.19 e	23.57 d	14.64 c	6.51 d
$LSD_{(0.05)}$	0.56	0.48	0.64	0.83	0.65
CV (%)	4.97	6.61	2.43	5.39	4.12

P_1 = Sowing, P_2 = Transplanting, C_1 = No leaf Clipping, C_2 = All leaf clipping, C_3 = Clipping of four leaves above cob, C_4 = Clipping of four leaves below cob

Chaff weight (g)

Significant variation was observed on oven dried chaff weight due to differences in planting method, leaf clipping and their treatment combination (Table 5 and 6). The results revealed that, the treatment P_1 produced the highest oven dried chaff weight (7.29 g) and P_2 produced the lowest (5.57 g). The treatment C_1 produced the highest oven dried chaff weight (10.88 g) which was statistically similar with C_4 (8.62 g) and C_2 produced the lowest (5.79 g). The highest oven dried chaff weight (11.05 g) was recorded from P_1C_1 and the lowest (5.61 g) from P_2C_2.

Conclusion

The experiment was conducted to study the effect of planting methods and leaf clipping on yield performance of white maize. Considering the above results, it may be concluded that leaf clipping adversely affects all the yield related attributes.

Sowing showed better result in all aspects than transplanting. No leaf clipping produced better yield and yield contributing attributes than all leaf clipped. Seed sowing with no leaf clipping showed the best performance in terms of yield of white maize. However, further experimentation need to be executed in different agro-ecological zones with more varieties.

Author's contribution

M. R. Bepary performed the experiment, gathered, analyzed and interpreted the data and drafted the manuscript. M. J. Ullah developed the research idea, objectives, methodology and guided and oversighted throughout the research process. M. H. Mahmud reviewed, revised and edited the content. M. Hassan and M. D. Hossain helped in performing research, gathering and analyzing the data.

Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this manuscript.

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