INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 12, No. 6, p. 281-291, 2018

RESEARCH PAPER OPEN ACCESS

Effect of indigenous and artificial mulches on yield attributes and yield of white maize (*Zea mays L.*)

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Key words: Maize, Mulches, Grain yield.

http://dx.doi.org/10.12692/ijb/12.6.281-291 Article published on June 24, 2018

Abstract

Maize (*Zea mays* L.) is one of the most promising cereal grains in the world but yield of maize is significantly limited by availability of water in different seasons. Mulching is widely used to improve the maize yields. The present study was conducted to find out the effect of indigenous and artificial mulches on yield attributes and yield of white maize under Bangladesh conditions. This experiment was carried on plant materials for white maize varieties such as Shuvra and KS-510 (hybrid variety) and on mulch materials such as control (without mulch), water hyacinth, rice straw, black polythene, white polythene, transparent polythene etc. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. It was found that the grain yields for Shuvra and KS-510 white maize was obtained to be 21.4 t ha $^{-1}$ and 19.7 t ha^{-1} with rice straw mulch. On the other hand, the grain yield for Shuvra and KS-510 white maize was estimated to be 6.02 t ha^{-1} and 6.707 t ha^{-1} with control treatment. The obtained results suggest that the rice straw mulch is useful to obtain the highest grain yield of white maize as compared to other mulches.

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Introduction

Maize (*Zea mays* L.) has been considered as one of the most promising cereal grains for human consumption in the world. Recently, maize has become to be the highest grain yielder in comparison to other cereals (FAO, 2015). The average global production of maize in 2013 was 10,16,740tonnes as compared to 7,45,710 tonnes of rice and 7,13,183 tonnes of wheat and other crops (FAO, 2015).

In the last few years, the global climates such as severity of temperature, rainfall, high humidity and wind have been fluctuating without maintaining any synchrony and harmony. Rice and wheat are very sensitive to the irregular fluctuations of climatic factors. On the other hand, maize has wide adaptability to the stress environment. It has been reported that maize is a C4 plant and can tolerate the extreme climatic situations (Ward *et al.*, 1999). In recent years, maize has been spread widely in Bangladesh. In Bangladesh, maize is cultivated in about 376 thousand acres land and total annual production is 887 thousand MT with average of 2,359 kg per acre (BBS, 2016). In the previous study, it has been reported that the nutritional value of maize is considerable as it contains 79.6% CHO, 12.1% protein, 4.2% fat, 1.4 % fiber, vitamin A 2270 USP IU, vitamin E 14 mg/kg and 3320 ME K cal/kg, whereas wheat contains 72.4% CHO, 12% protein, 1.9% fat, 2% fiber, vitamin A 125 USP IU, vitamin E 17 mg/kg and 3060 ME K cal/kg (Satter *et al.*, 2002).

In Bangladesh, cultivation of yellow maize has been practiced successfully. Unfortunately, white maize is not cultivated widely yet. Therefore, to maximize the maize yield, introduction of white maize as well as improvement of cultivation procedure are important. There are some limitations in Bangladesh such as non-equal distribution of rainfall in different seasons and irrigation needs high cost. Therefore, water saving cultivation procedures would be an effective way to get higher yield.

Maize is significantly affected by mulching in respect of yield contributing characters. Mulching affects soil temperature, reducing evaporative humidity, good weed control, earliness effects on yield with better qualitative quantitative trait (Candido and Miccolis, 2003. The water hyacinth can be used for mulching plant and shrubs. It is considered as a valuable source of macronutrients such as phosphorus, nitrogen and potassium which are essential for plant nutrition. Rice straw mulch acts as mulch-cum-manure and improves the soil properties because it contains about 0.6% N, 0.10% each P and S, 1.5% K, 5% Si, and 40% C. The water hyacinth and rice straw mulches reduced the maximum soil temperatures at the day time and increased the minimum temperature at late night providing favourable soil temperature as well as maintained better soil moisture during the entire growing period. Consequently, maize yield was tremendously influenced by mulches. On the other hand, artificial mulches, such as plastic mulches, prevent direct evaporation of moisture from the soil and thus limit the water losses and conserves moisture. Black polythene is the most commonly used artificial mulch. Black polythene mulch increased the grain yield by upto 145.5%. In addition, maturity period can be reduced using white polythene mulch as compared to the black polythene mulch. As a result, the transparent polythene mulches advanced the date of harvest of maize. Therefore, the understanding of effect of mulches on yield attributes and yield of white maize is important. However, very limited number of experiments were conducted to find out the effect of mulches on yield attributes and yield of white maize in Bangladesh. In this paper, we have investigated the yield attributes and yield of white maize using indigenous and artificial mulches.

Materials and methods

Experimental site andsoil of the experimental field

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh. The soil of the experimental field belongs to the Modhupur Tract (UNDP, 1988) corresponding AEZ no. 28 and was shallow red brown terrace soil.

Planting materials, varieties and treatments of the experiment

In the present study, white maize cv. Shuvra and KS-510 (hybrid variety) were used as plant materials. These varieties are recommended for Robi season. The purity and germination percentage were leveled as around 98 and above 95, respectively. This experiment consists two factors: 1) White maize varieties: V_1 = Shuvra, V_2 = KS-510 (hybrid variety). 2) Mulch materials: T_1 = Control (without mulch), T_2 = Water hyacinth dry (10 t/ha), T_3 = Rice straw dry (10 t/ha), T_4 = Black polythene (4m x 3m), T_5 = White polythene (4m x 3m), T_6 = Transparent polythene (4m x 3m).

Layout and land preparation of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD). The field was divided into 3 blocks to represent 3 replications. There were 36 unit plots altogether in the experiment. The size of each unit plot was 6 m² (3m x 2m). Distance maintained between replication to replication 1m and plots to plots were 0.5m. Plant to plant distance 0.25 m and row to row distance 0.75m. The treatments were assigned in plot at random. The land was ploughed four times followed by laddering to have fine tilth of the soil.

Fertilizer application

Cow-dung was used as decomposed organic matter @ 6.0 ton /hectare before final land preparation. The recommended doses of chemical fertilizer were applied as Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid at the rate of 172-168-96-144-10 and 5 kg/ha in case of Shuvra and 500-240-180-240-10 and 5 kg/ha in case of KS-510 (hybrid variety) (BARI, 2014). The whole amount of all the fertilizers except urea were applied at the time of final land preparation and thoroughly incorporated with soil with the help of a spade. Rest of the Urea was applied after 30 DAS and 60 DAS at two installments.

Seed treatment and sowing

Seeds were treated with Bavistin at the rate of 0.2% to 0.3% of seed weight. The maize seeds were planted in lines each having a line to line distance of 75 cm and plant to plant distance of 25 cm having 2 seeds per hole under direct sowing in the well-prepared plot on 13 November 2015.

Mulch application

Mulches were applied as per treatment in each plot just after sowing to maintaining an equal thickness throughout the plot. Mulches were dried and clean before use.

Intercultural operations

Some intercultural operations are thinning, gap filling, weeding and spraying of insecticides and fungicides, protection of crops from other pests.

Harvesting

At maturity, plants with cob were harvested from 3 m²area which represents a uniform area. Data were taken from 10 representative samples according to requirement. The seeds were dried in the sun and the per plot yield was recorded on 14% moisture basis and then converted to t/ha.

Yield contributing attributes

The data on yield contributing attributes yield were recorded at final harvest from 18 plants (3 m²area) of each plot. To asses yield performances the following yield and yield contributing characters were recorded: Number of cob per plant, Cob or Ear length, Cob diameter, Cob weight per plant and per cob weight, Number of seeds per cob, Number of seed rows per cob, Number of seeds per row, Number of seeds per plant, Seed weight per cob, Seed weight per plant, 1000 Seed weight, Seed weight per 3 m² (Seed weight per hectare), Harvest Index (HI). Data obtained from the experiments for each parameter were analyzed following MSTAT-C package programme to obtain the level of significance. The significant difference among the treatment means was estimated by the Least Significant Difference (LSD) test at 5% level of probability.

$$\text{HI} = \frac{\text{Economic yield (i.e.grain yield)}}{\text{Biological yield (i.e.Total dry matter or TDM)}}$$

$$\text{or} = \frac{\text{Seed weight (kg/ha)}}{\text{Biological yield (kg/ha)}} \times 100$$

Both seed and biological yields were estimated on the basis of absolute moisture content.

Results and discussion

Yield attributes

Cob length (cm)

Table 1 shows the effect of varieties and mulch materials on yield and yield attributes of white maize. It was seen that cob length varied significantly for white maize varieties. The highest cob length (18.81 cm) was observed from KS-510 (V_2), whereas the lowest (16.26 cm) was observed from Shuvra variety (V_1). Statistically significant variation was also observed for cob length due to different treatment used in the experiment. The highest cob length (21.67 cm) was observed from rice straw mulch materials (T_3), which were significantly superior, compare to all treatments, whereas the lowest (10.55 cm) was recorded from control treatment (T_1).

Table 1. Effect of varieties and mulch materials on yield attributes of white maize.

Variety	Cob length (cm)	Cob diameter (cm)	Per cob weight (g)	No. of cobs/plant	Weight of cob(dry)/ Plant (g)	Seed weight(g) /cob	Seed weight(g) /plant
V_1	16.26 b	4.39 b	250.30 b	1.58	424.3 b	137.3 b	228.5 b
V_2	18.81 a	4.56 a	281.50 a	1.63	486.3 a	156.4 a	267.2 a
LSD $_{0.05}$	0.26	0.08	4.68	NS	19.04	2.22	7.77
Mulch materials							
T_1	10.55 f	3.61 f	176.6 f	0.9667c	159.3 e	110.3 f	106.1 f
T_2	17.95 d	4.383 d	277.9 d	1.600 b	472.3 c	143.1 d	243.3 d
T_3	21.67 a	5.200 a	315.0 a	1.950 a	629.3 a	175.7 a	348.0 a
T_4	19.75 b	4.888 b	298.6 b	1.800 a	569.9 b	163.8 b	300.1 b
T_5	18.88 c	4.692 c	289.4 c	1.817 a	553.2 b	153.5 c	273.4 c
T_6	16.40 e	4.067 e	237.9 e	1.483 b	348.2 d	135.0 e	216.0 e
LSD $_{0.05}$	0.45	0.13	8.1	0.15	32.97	3.84	13.45
CV %	2.16	2.44	2.54	7.79	6.05	2.18	4.53

V_1=Shuvra, V_2=KS-510, T_1=Control (without mulch), T_2=Water hyacinth, T_3=Rice straw, T_4=Black polythene, T_5=White polythene, T_6=Transparent polytene, NS=non-significant.

The yield and yield attributing characters such as cobs per plant, cob length, cob breadth, number of seed rows per cob, number of seeds per row, number of seeds per cob and 1000-seed weight significantly increased by water hyacinth and rice straw mulches the number of compared to the control and sawdust. It was also obtained higher yield components in mulched plants (Kalaghati *et al*., 1988).

Table 2 shows the interaction effect of varieties and mulch materials on yield and yield attributes of white maize. Interaction effect of different treatments and white maize varieties showed significant variation on cob length. The highest cob length (23.57 cm) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (10.23 cm) was recorded from the combination of KS-510 variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_1T_2 (10.87 cm).

Cob diameter (cm)

In Table 1, it was also seen that cob diameter varied significantly for different white maize varieties. The highest cob diameter (4.56 cm) was observed from KS-510 (hybrid variety), whereas the lowest (4.39 cm) was observed from Shuvra variety. Statistically significant variation was observed for cob diameter due to different treatment used in the experiment. The highest cob diameter (5.2 cm) was observed from rice straw mulch materials (T_3), which was significantly superiorcompared to all

treatments, whereas the lowest (3.61 cm) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on cob diameter, as shown in Table 2. The highest cob diameter (5.4 cm) was found from the combination of hybrid variety with rice straw mulch materials (V_2T_3). On the other hand, the lowest (3.53 cm) was recorded from the combination of KS-510 variety with control treatment (V_2T_1) which was statistically similar to the interaction effect of V_1T_1 (3.7 cm).

Table 2. Interaction effect of varieties and mulch materials on yield attributes of white maize.

Variety + Mulch materials	Cob length (cm)	Cob diameter (cm)	Per cob weight (g)	No. of cobs/ plant	Weight of cob(dry)/plant (g)	Seed weight/ Cob (g)	Seed weight/plant (g)
V_1T_1	10.87 i	3.700 h	157.6 j	0.9333 e	147.5 g	98.67 h	100.4 g
V_1T_2	16.37 g	4.267 f	263.5 g	1.567 cd	436.4 e	135.0 f	231.7 e
V_1T_3	19.77 d	5.000 b	304.2 bc	1.967 a	608.0 ab	164.8 c	339.2 a
V_1T_4	18.00 e	4.733 cd	281.7 ef	1.667 c	519.4 d	155.1 d	262.3 c
V_1T_5	17.10 f	4.583 de	276.1 f	1.900 ab	535.4 cd	143.1 e	244.0 cde
V_1T_6	15.43 h	4.033 g	218.8 h	1.433 d	299.4 f	127.3 g	193.2 f
V_2T_1	10.23 i	3.533 h	195.5 i	1.000 e	170.8 g	122.0 g	111.8 g
V_2T_2	19.53 d	4.500 e	292.4 de	1.633 cd	508.1 d	151.1 d	255.0 cd
V_2T_3	23.57 a	5.400 a	325.8 a	1.933 ab	650.7 a	186.5 a	356.8 a
V_2T_4	21.50 b	5.043 b	315.6 ab	1.933 ab	620.5 a	172.4 b	337.9 a
V_2T_5	20.67 c	4.800 c	302.7 cd	1.733 bc	570.9 bc	163.8 c	302.7 b
V_2T_6	17.37 ef	4.100 fg	257.1 g	1.533 cd	397.0 e	142.7 e	238.9 de
LSD $_{0.05}$	0.643	0.19	11.46	0.214	46.63	5.43	19.02
CV %	2.16	2.44	2.54	7.79	6.05	2.18	4.53

V_1=Shuvra, V_2=KS-510, T_1=Control (without mulch), T_2=Water hyacinth, T_3=Rice straw, T_4=Black polythene, T_5=White polythene, T_6=Transparent polytene.

Per cob weight (g)

Per cob weight varied significantly for different white maize varieties, as also shown in Table 1. The highest per cob weight (281.50 g) was observed from KS-510 (hybrid variety), whereas the lowest (250.30 g) was observed from Shuvra variety. In Table 1, statistically significant variation was observed for per cob weight due to different treatment used in the experiment. The highest per cob weight (315 g) was observed from rice straw mulch materials (T_3), which were significantly superior compare to all treatments, whereas the lowest (176.6 g) was recorded from control treatment (T_1). In Table 2, interaction effect of different treatments and white maize varieties showed significant variation on per cob weight. The highest per cob weight (325.8 g) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (157.6 g) was recorded from the combination of Shuvra variety with control treatment (V_1T_1).

Number of cobs/plant

As shown in Table 1, there is no significant variation in case of number of cobs/plant for different white maize varieties. The maximum number of cobs/plant (1.63) was observed from KS-510 (hybrid variety), whereas the lowest (1.58) was observed from Shuvra variety. In Table 1, statistically significant variation was also observed for number of cobs/plant due to different treatment used in the experiment.

The highest no. of cobs/plant (1.95) was observed from rice straw mulch materials (T_3), which were statistically similar to black polythene (T_4) and white polythene (T_5), mulch materials, whereas the lowest (0.97) was recorded from control treatment (T_1). A

field experiment was conducted at Central Agriculture Research Institute, Andaman on maize and reported that mean cob yield and stover yield were significantly higher under rice straw mulch than saw dust, coirdust, rice husk and control treatment (Pramanik, 1999).

Interaction effect of different treatments and white maize varieties showed significant variation on number of cobs/plant, as shown in Table 2.

Table 3. Effect of varieties and mulch materials on yield attributes, yield and Harvest Index of white maize.

Variety	No. of seed rows/cob	No. of seeds/row	No. of Seeds /cob	1000 seed weight(g)	Seed weight(g)/3m²	Seed weight(ton)/ha	Harvest Index
V_1	13.93 b	30.65 b	453.8b	289.7 b	4071.75 b	13.55 b	0.558 b
V_2	14.17 a	33.57 a	474.2a	306.0 a	4868.71 a	16.36 a	0.639 a
LSD $_{0.05}$	0.12	0.68	6.91	8.27	119.70	0.51	0.022
Mulch materials							
T_1	12.40 f	26.53 e	341.0e	226.9 e	1932.97f	6.365 f	0.508 c
T_2	14.15 d	31.28 c	481.4c	288.4 d	4506.53 d	15.31 d	0.581 b
T_3	15.09 a	37.00 a	525.7a	362.9 a	5971.83 a	20.55 a	0.656 a
T_4	14.72 b	34.68 b	514.7a	325.5 b	5413.57 b	18.02 b	0.604 b
T_5	14.39 c	33.55 b	494.5b	307.4 c	4995.48 c	16.53 c	0.590 b
T_6	13.55 e	29.60 d	426.5d	275.8 d	4001.00 a	12.96 e	0.599 b
LSD $_{0.05}$	0.21	1.18	11.97	14.32	207.4	0.88	0.38
CV %	2.15	1.27	3.07	4.02	3.87	4.9	3.84

V_1=Shuvra, V_2=KS-510, T_1=Control (without mulch), T_2=Water hyacinth, T_3=Rice straw, T_4=Black polythene, T_5=White polythene, T_6=Transparent polytene.

The highest number of cobs/plant (1.97) was found from the combination of Shuvra variety with rice straw mulch materials (V_1T_3), which was statistically similar to the interaction effect of V_2T_3, V_2T_4 and V_1T_5. On the other hand, the lowest (0.93) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1.

Weight (g) of cob/plant (dry weight)

Weight of cob/plant varied significantly for white maize varieties, as shown in Table 1. The highest weight of cob/plant (486.3 g) was observed from KS-510 (hybrid variety), whereas the lowest (424.3 g) was observed from Shuvra variety. In Table 1, statistically significant variation was also observed for weight of cob/plant due to different treatment used in the experiment. The highest weight of cob/plant (629.3 g) was observed from rice straw mulch materials (T_3), which were significantly superior compare to all treatments, whereas the lowest (159.3 g) was recorded from control treatment (T_1). In the previous study, it was found that straw mulch increased the cob yield by 60.5% as compared to non-mulched treatment (Bhatt *et al.*, 2004). Interaction effect of different treatments and white maize varieties showed significant variation on weight of cob/plant, as shown in Table 2. The highest weight of cob/plant (650.7 g) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3) which was statistically similar with the combination of KS-510 with black polythene (V_2T_4). On the other hand, the lowest (147.5 g) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1 (170.8 g).

Seed weight/cob (g)

Seed weight/cob varied significantly for different white maize varieties (Table 1). The highest seed

weight/cob (156.4 g) was observed from KS510 (hybrid variety), whereas the lowest (137.3 g) was observed from Shuvra variety. Statistically significant variation was observed for seed weight /cob due to different treatment used in the experiment (Table 1). The highest seed weight /cob (175.7 g) was observed from rice straw mulch materials (T_3), which was significantly superior compare to all treatments, whereas the lowest (110.3 g) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on seed weight/cob (Table 2). The highest seed weight /cob (186.5 g) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (98.67 g) was recorded from the combination of Shuvra variety with control treatment (V_1T_1).

Table 4. Interaction effect of varieties and mulch materials on yield attributes, yield and Harvest Index of white maize.

Variety + Mulch materials	No. of seed rows/cob	No. of seeds/row	No. of seeds /cob	1000 seed weight (g)	Seed weight/3m² (g)	Seed weight/ha (ton)	Harvest Index
V_1T_1	12.27 g	26.65 f	332.4 j	218.8 g	1807 .20 i	6.023 h	0.504 e
V_1T_2	13.93 e	30.33 e	474.7 f	292.7 e	3953.07 g	12.97 f	0.528 e
V_1T_3	14.92 b	34.40 c	505.4bcd	337.0 b	5623.33 c	19.70 b	0.606 cd
V_1T_4	14.70 bc	32.50 d	509.4 bc	319.5bcd	4820.33de	16.05 d	0.542 e
V_1T_5	14.30 d	32.03 d	491.1def	300.8 de	4577.23ef	14.86de	0.557 de
V_1T_6	13.47 f	27.97 f	409.6 h	269.0 f	3649.33 h	11.69 g	0.555 de
V_2T_1	12.53 g	26.40 f	349.6 i	235.1 g	2058.73 i	6.707 h	0.512 e
V_2T_2	14.37 d	32.23 d	488.2 ef	284.1 ef	5060.00 d	17.65 c	0.627bc
V_2T_3	15.27 a	39.60 a	546.0 a	388.7 a	6320.33 a	21.40 a	0. 709 a
V_2T_4	14.73 bc	36.87 b	520.0 b	331.4 bc	6006.80 b	19.98 b	0.665 ab
V_2T_5	14.48 cd	35.07 c	497.9cde	314.0 cd	5413.73 c	18.21 c	0.608 cd
V_2T_6	13.63 ef	31.23 de	443.4 g	282.5 ef	4352.67 f	14.23 e	0.641bc
LSD $_{0.05}$	0.3	1.67	16.93	20.26	293.3	1.24	0.054
CV %	1.27	3.07	2.15	4.02	3.87	4.9	3.84

V_1=Shuvra, V_2=KS-510, T_1=Control (without mulch), T_2=Water hyacinth, T_3=Rice straw, T_4=Black polythene, T_5=White polythene, T_6=Transparent polytene.

Seed weight /plant (g)

Seed weight/plant varied significantly for different white maize varieties (Table 1). The highest seed weight /plant (267.2 g) was observed from KS-510 (hybrid variety), whereas the lowest (228.5 g) was observed from Shuvra variety. Statistically significant variation was observed for seed weight /plant due to different treatment used in the experiment (Table 1). The highest seed weight /plant (348 g) was observed from rice straw mulch materials (T_3), which was significantly superior compare to all treatments, whereas the lowest (106.1 gm) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on seed weight /plant (Table 2). The highest seed weight /plant (356.8 g) was found from the combination of hybrid variety with rice straw mulch materials (V_2T_3), which was statistically similar to the interaction effect of V_1T_3 and V_2T_4. On the other hand, the lowest (100.4 g) was recorded from the combination of Shuvra variety with control treatment (V_1T_1).

No. of seed rows/cob

Table 3 summarizes the effect of varieties and mulch materials on yield attributes, yield and Harvest Index of white maize. The number of seed rows/cob varied significantly for different white maize varieties (Table

3). The highest no. of seed rows/cob (14.17) was observed from KS-510 (hybrid variety), whereas the lowest (13.93) was observed from Shuvra variety. Statistically significant variation was observed for number of seed rows/cob due to different treatment used in the experiment (Table 3). The highest number of seed rows/cob (15.09) was observed from rice straw mulch materials (T_3), which were significantly superior compare to all treatments, whereas the lowest (12.40) was recorded from control treatment (T_1). Table 4 shows the combined effect of varieties and mulch materials on yield attributes, yield and Harvest Index of white maize. Interaction effect of different treatments and white maize varieties showed significant variation on number of seed rows/cob (Table 4). The highest number of seed rows/cob (15.27) was found from the combination of hybrid variety with rice straw mulch materials (V_2T_3). On the other hand, the lowest (12.27) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1 (12.53).

Number of seeds/ row

Number of seeds/ row varied significantly for different white maize varieties (Table 3). The highest number of seeds/row (33.57) was observed from KS-510 (hybrid variety), whereas the lowest (30.65) was observed from Shuvra variety. Statistically significant variation was observed for number of seeds/row due to different treatment used in the experiment (Table 3). The highest number of seeds /row (37) was observed from rice straw mulch materials (T_3), which were significantly superior compare to all treatments, whereas the lowest (26.53) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on number of seeds/ row (Table 4). The highest number of seeds/ row (39.60) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (26.65) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1 (26.40) and V_1T_6 (27.97).

Number of seeds/cob

Number of seeds/cob varied significantly for different white maize varieties (Table 3). The highest number of seeds/cob (474.2) was observed from KS-510 (hybrid variety), whereas the lowest (453.8) was observed from Shuvra variety. Statistically significant variation was observed for number of seeds/cob due to different treatment used in the experiment (Table 3). The highest no. of seeds/cob (525.7) was observed from rice straw mulch materials (T_3), which were statistically similar to black polythene, mulch materials (T_4), whereas the lowest (341) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on number of seeds/cob (Table 4). The highest number of seeds/cob (546) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (332.4) was recorded from the combination of Shuvra variety with control treatment (V_1T_1).

1000 seed weight (g)

1000 seeds weight varied significantly for different white maize varieties (Table 3). The highest 1000 seed weight (306 g) was observed from KS-510 (hybrid variety), whereas the lowest (289.7 g) was observed from Shuvra variety. Statistically significant variation was observed for 1000 seed weight due to different treatment used in the experiment (Table 3). The highest 1000 seed weight (362.9 g) was observed from rice straw mulch materials (T_3), which was significantly superior compare to all treatments, whereas the lowest (226.9 g) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on 1000 seed weight (Table 4). The highest 1000 seed weight (388.7 g) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (218.8 g) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1 (235.1 g).

Seed weight (g/3m²)

Seed weight varied significantly for different white maize varieties (Table 3). The highest seed weight (4868.71 g/3m²) was observed from KS-510 (hybrid variety), whereas the lowest (4071.75 g/3m²) was observed from Shuvra variety. Statistically significant variation was observed for seed wt. due to different treatment used in the experiment (Table 3). The highest grain yield (5971.83 g/3m²) was observed from rice straw mulch materials (T_3), which was significantly superior compare to all treatments, whereas the lowest (1932.97 g/3m²) was recorded from control treatment(T_1). Application of straw mulch also helps in providing optimum soil temperature resulting in better growth and yield (Bhardwaj&Sindwal, 1998). Interaction effect of different treatments and white maize varieties showed significant variation on grain yield (Table 4). The highest grain yield (6320.33 g/3m²) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (1807.20 g/3m²) was recorded from the combination of Shuvra variety with control treatment (V_1T_1), which was statistically similar to the combination of KS-510 with control treatment (V_2T_1).

Seed yield (ton/ha)

Seed weight varied significantly for different maize varieties (Table 3). The highest seed wt. (16.36 t ha^{-1}) was observed from KS-510 (hybrid variety), whereas the lowest (13.55 t ha^{-1}) was observed from Shuvra variety. Statistically significant variation was observed for seed weight due to different treatment used in the experiment (Table 3). The highest grain yield (20.5 t ha^{-1}) was observed from rice straw mulch materials (T_3), which was significantly superior compare to all treatments, whereas the lowest (6.36 t ha^{-1}) was recorded from control treatment(T_1). Straw mulching can improve soil nitrogen availability, increase plant growth and influence the physical and chemical properties of the soil. Hence, many researchers consider straw mulching for enhancing maize productivity (Govaerts *et al*., 2007). Mulching with white and black polythene or semi–permanent plastic mulch significantly increased the grain yield compare to control treatment (Wang *et al*., 1994). Maize yield with polythene mulch treatment was 127.5% of those of direct sown maize (Chen and Chen, 1996). Interaction effect of different treatments and white maize varieties showed significant variation on grain yield (Table 4). The highest grain yield (21.4 t ha^{-1}) was found from the combination of KS-510 (hybrid variety) with rice straw mulch materials (V_2T_3). On the other hand, the lowest (6.02 t ha^{-1}) was recorded from the combination of Shuvra variety with control treatment (V_1T_1), which was statistically similar to the combination of hybrid variety with control treatment (V_2T_1).

Harvest Index

Harvest Index varied significantly for different white maize varieties (Table 3). The harvest index (0.639) was observed from KS510 (hybrid variety), whereas the lowest (0.558) was observed from Shuvra variety. Statistically significant variation was observed for Harvest Index due to different treatment used in the experiment (Table 3). The highest Harvest Index (0.656) was observed from rice straw mulch materials (T_3), which were statistically similar to black polythene (T_4), whereas the lowest (0.508) was recorded from control treatment (T_1). Interaction effect of different treatments and white maize varieties showed significant variation on Harvest Index (Table 4). The highest harvest Index (0.709) was found from the combination of hybrid variety with rice straw mulch materials (V_2T_3). On the other hand, the lowest (0.504) was recorded from the combination of Shuvra variety with control treatment (V_1T_1) which was statistically similar to the interaction effect of V_2T_1 (0.512).

Conclusion

This paper focuses on the application of different mulches to have a better understanding about the yield of white maize. In case of white maize varieties, the highest seed weight/cob (156.4 g) was observed from V_2, while the lowest (137.3 g) was observed from V_1. The highest grain yield (16.36 t ha^{-1}) was observed from V_2, whereas the lowest (13.55 t ha^{-1}) was

observed from V_1. In case of mulch materials, the highest seed weight/cob (175.7 g) was observed from T_3, while the lowest (110.3 g) was observed from T_1. The highest grain yield (20.5 t ha^{-1}) was observed from T_3, while the lowest (6.36 t ha^{-1}) was observed from T_1. In case of interaction effect, the highest seed weight/cob (186.5 g) was observed from V_2T_3, while the lowest (98.67 g) was observed from V_1T_1. The highest grain yield (21.4 t ha^{-1}) was found from the V_2T_3, while the lowest (6.02 t ha^{-1}) was recorded from V_1T_1 treatment combinations. It is revealed that the rice straw mulch is useful to obtain the highest grain yield of white maize as compared to other mulches.

Acknowledgements

This study was part of thesis dissertation of the author. Authors humbly acknowledge the Sher-e-Bangla Agricultural University, Dhaka, Bangladesh for funding the research.

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