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EFFECT OF IRRIGATION INTERVALS AND MULCHING MATERIAL ON THE GROWTH AND YIELD OF MAIZE

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Abstract

An experiment was conducted at Habiganj Agricultural University's research field to study the effects of irrigation and mulching on the yield of maize cultivation in the Sylhet region of Bangladesh. The study analyzed the effects of different irrigation intervals, i.e., irrigation at 15, 30, and 60 days after sowing (DAS); at 15, 30, and 85 DAS; and at 15, 30, 60, and 85 DAS; along with polythene and jute sack as mulching materials on maize performance. The experiment was laid out in a pot experiment with a randomized complete block design with three replications. Results showed that irrigation at 15, 30 and 85 DAS gave the highest cob length (cm), cob weight plant^{-1} (g), number of grain cob^{-1}, 100-grain weight (g), and grain yield (t ha^{-1}) while jute sack performed better than mulching with polythene. The interaction effect of irrigation intervals and mulching treatments showed a significant difference in all yield contributing parameters except the number of cob plant^{-1}. The highest cob length (16.57 cm), cob weight plant^{-1} (143.33 g), number of grain cob^{-1} (316.65), 100-grain weight (34.33 g), grain weight cob^{-1} (118.9 g) and grain yield (8.77 t ha^{-1}) were obtained from the interaction of at 15, 30 and 85 DAS intervals with jute sack mulching whereas the lowest from the no irrigation (control) with jute sack mulching.

Introduction

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In Bangladesh, maize is second in production after rice and is ranked third as a staple cereal (Islam *et al.*, 2020). 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). Bangladesh covers about 0.478 million hectares with a production of 4.26 million tonnes of grains (BBS, 2023). The national average yield is only 6.45 t ha^{-1}, which is very low compared with leading maize-growing countries, whereas the newly released varieties can produce more than 8.0 t ha^{-1} (AIS, 2015).

Proper growth and development of maize need favourable soil moisture up to its root zone. Limited water supply during the growing season results in soil and plant water deficits and reduces maize yields (Gordon *et al.*, 1995; Patel *et al.*, 2006). Maize is a crop that requires less water than *Boro* rice and produces consistently much higher yields (Ali *et al.*, 2008). The optimum use of irrigation water should be an important strategy for increasing maize production.

Using mulch in irrigated fields is another crucial element for supporting soil moisture and fostering the growth of plants and yield production (Ramalan and Nwokeocha, 2000; Acharya *et al.*, 2005). Plastic film mulch is widely used as a low-cost measure to improve water retention in the soil (Wang *et al.*, 2009), increase soil temperature (Yi *et al.*, 2010), and reduce soil evaporation (Shengxiu and Ling, 1992). Besides, sack farming, where maize is grown in sacks or bags, can be used as an alternative to mulching. The sacks help maintain soil moisture by reducing evaporation, suppressing weed growth by blocking sunlight and regulating soil temperature to protect maize roots.

The main objectives of this research were to determine the effects of different irrigation and mulching materials on the yield and productivity of maize, as well as to identify the most effective combination of irrigation interval and mulching material that maximizes maize yield.

Materials and Methods

The experiment was conducted at the Agronomy farm of Habiganj Agricultural University, Sylhet, from March 2023 to July 2024. The experimental field located in Sylhet division falls under a tropical monsoon climate. During the season (October to March), the region experiences relatively dry conditions with moderately low temperatures. Average temperatures during this period range from 13-18°C (lowest in January) to around 25°C in the daytime. Rainfall is significantly reduced compared to the *Kharif-1* season, with only light and sporadic showers.

The experiment consisted of two factors viz., factor A: Irrigation (4), i.e., I_0 = no irrigation, I_1 = irrigation at 15, 30 and 60 days after sowing (DAS), I_2 = irrigation at 15, 30 and 85 DAS, and I_3 = irrigation at 15, 30, 60 and 85 DAS and Factor B: Mulching materials (2) i.e., M_1 = mulching with polythene, M_2 = jute sack mulching. The experiment was laid out in a randomized complete block design with three replications within 24 pots., Maize var. BARI Hybrid Bhutta-17 was used as plant material, and the seeds were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur. The pots were prepared for the experiment in the first week of March 2024, where the soil textural class was sandy clay loam, having a pH of 5.5. Fertilizers and manures were applied for the cultivation of crops as recommended by BARI, 2014. The seeds were sown in the pots, having two seeds hole^{-1}. All intercultural operations, like gap filling, thinning, weeding and plant protection, were taken as per recommendation. The thinning was done at 7 DAS for obtaining one plant pot^{-1}, after that, mulching was done accordingly. The cobs of tested plants of each pot were separately harvested for recording data on yield attributes and other parameters like cob plant^{-1}, cob weight, grain cob^{-1}, test grain weight, and grain yield. The data were analysed, and the means were separated by least significant difference (LSD) at 5% level of significance using the statistical computer package program Statistix-10.

Results and Discussion

Cob length

The combined effect of different intervals of irrigation and mulching materials did not significantly influence the cob length (Table 1). However, numerically higher cob length of 16.57 cm was observed in I_2M_2 statistically similar to I_3M_2 (16.31 cm) and I_3M_1 (16.02 cm).

Cob circumference

The combined effect of different intervals of irrigation and mulching materials significantly influenced the cob circumference (Table 1). Results showed that the highest cob circumference (16.57 cm) was observed with the treatment I_2M_2 (irrigation at 15, 30 and 85 DAS with jute sack mulching). Conversely, the lowest cob circumference (14.27 cm) was found from I_0M_2 (no irrigation with jute sack mulching), which was statistically similar to I_0M_1 (14.36 cm).

Cob weight

The combined effect of different intervals of irrigation and mulching materials significantly influenced the cob weight (Table 1). Considering the interaction effect, the highest cob weight (143.33 g cob^{-1}) was observed for the I_2M_2 (irrigation at 15, 30 and 85 DAS with jute sack mulching) closely followed by I_3M_2 (134.67 g cob^{-1}). In contrast, the lowest cob weight of 63.00 g cob^{-1} was recorded for the combination I_0M_2 (no irrigation with jute sack mulching).

Grains number cob^{-1}

The number of grains cob^{-1} was maximum in I_2M_2 (316.65), closely followed by IM_2 and I_3M_1. Islam *et al.* (2022) also concluded that the grains number cob^{-1} was significantly influenced by mulching and irrigation, with the highest from three irrigations combined with mulching.

100-seed weight

The combined effect of different intervals of irrigation and mulching materials as was non-significantly influenced the 100-seed weight (Table 1). 100-seed weight was observed to be almost the same in all the combinations of treatments, in which the slightly higher seed weight was found for the treatment $I_2 M_2$ (34.33 g).

Table 1. Interaction effect of different intervals of irrigation and mulching materials on the yield parameters of yellow maize

Treatments	Cob length (cm)	Cob circumference (cm)	Cob weight (g cob^{-1})	Grains number cob^{-1}	100-grain weight (g)	Grain weight (g cob^{-1})
I_0M_1	14.68 ab	14.36 c	77.00 bc	254.66 c	30.67 a	51.48 f
I_0M_2	14.23 b	14.27 c	63.00 c	241.98 c	30.33 a	40.88 g
I_1M_1	15.59 ab	15.33 bc	101.33 a-c	264.42 bc	31.33 a	67.48 e
I_1M_2	15.35 ab	15.51 ab	110.33 a-c	266.97 bc	31.33 a	72.59 de
I_2M_1	15.25 ab	15.30 bc	126.67 ab	292.86 ab	32.00 a	90.46 c
I_2M_2	16.57 a	16.57 a	143.33 a	316.65 a	34.33 a	118.90 a
I_3M_1	16.02 ab	15.54 ab	127.67 ab	298.47 a	32.00 a	80.20 d
I_3M_2	16.31 ab	15.76 ab	134.67 a	299.87 a	32.33 a	105.29 b
LSD $_{(0.05)}$	2.2410	1.13	52.44	31.05	4.43	7.69
CV%	8.26	4.22	27.10	6.34	7.96	5.60

In a column, means having a similar letter(s) are statistically similar, and those having dissimilar letters (s) differ significantly at the 0.05 level of probability. I_0 = no irrigation; I_1 = irrigation at 15, 30 and 60 DAS; I_2 = irrigation at 15, 30 and 85 DAS; and I_3 = irrigation at 15, 30, 60 and 85 DAS; M_1 = mulching with polythene, M_2 = jute sack mulching

Grain weight cob^{-1}

Grain weight was significantly influenced by the integrated effect of different intervals of irrigation and mulching materials (Table 1). The highest grain weight per cob of 118.90 g was from I_2M_2 (irrigation at 15, 30 and 85 DAS with jute sack mulching), while the lowest grain weight per cob of 40.88 g was associated with $I_0 M_2$ (no irrigation with jute sack mulching). The research findings are similar to Mahajan *et al.* (2007), who described that mulch contributes to maintaining the high yield of plants by increasing the grain weight cob^{-1}.

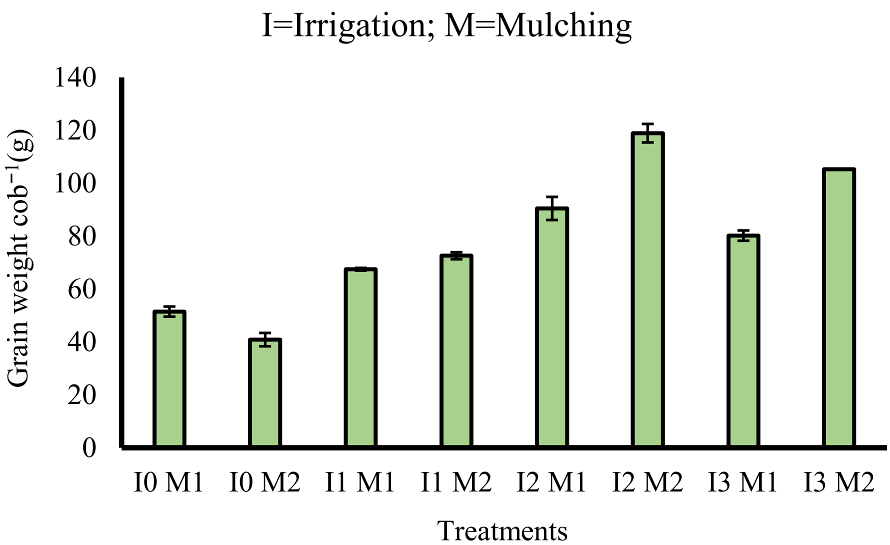

Fig 1. Effect of irrigation intervals and mulching materials on grain weight of per yellow maize cob.

Grain yield

Grain yield was significantly influenced by the integrated effect of different intervals of irrigation and mulching materials (Table 1). Results showed that the maximum grain yield of 8.77 t ha^{-1} was found from I_2M_2 (irrigation at 15, 30 and 85 DAS with jute sack mulching) while the minimum grain yield 2.87 t ha^{-1} was observed in I_0M_2 (no irrigation with jute sack mulching), which was statistically similar to I_0M_1 (3.37 t ha^{-1}). Limited soil moisture hinders crop growth, reducing grain yields. Just six days of irrigation affect grains per cob, weight, length, and leaf area. Shorter grain-filling and faster ripening result in small, wrinkled seeds. Water stress restricts photosynthesis for fertilized grains due to grain abortion, leading to fewer and atrophied grains. It also causes premature male flowering, shortens growth stages, forcing plants to mature and produce grains faster. These results support conclusions drawn by numerous other researchers (Ferdoush *et al.,* 2017). The combined application of frequent irrigation and organic mulch produced the highest yields, indicating a synergistic interaction between the two practices. This combination likely optimized soil moisture availability while minimizing losses due to evaporation, leading to favourable conditions for root growth and nutrient uptake. Between the mulching materials tested, jute sack mulch was found to be more effective than inorganic plastic in maintaining soil moisture, moderating temperature fluctuations, and suppressing weeds. Organic mulch also contributes to soil organic matter upon decomposition, thus enhancing soil fertility in the long term. Plastic mulch, while effective in reducing surface evaporation and promoting early growth, had limitations related to soil aeration and long-term environmental sustainability.

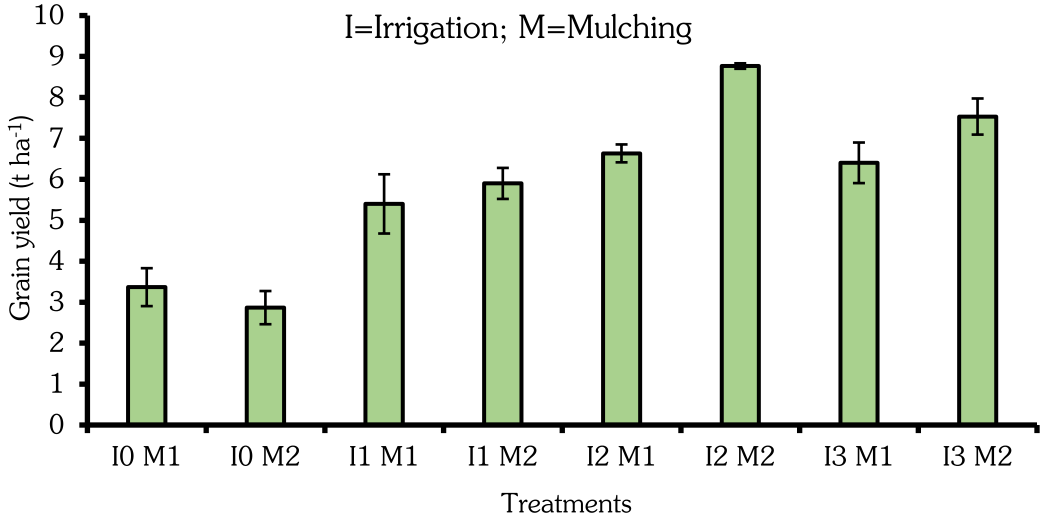

Fig 2. Effect of irrigation intervals and mulching materials on grain yield (t ha^{-1}) of yellow maize.

Conclusion

The study was found that the combination of irrigation and mulching materials significantly influenced grain yield. The maximum yield was 8.77 t ha^{-1} with the irrigation at 15, 30 and 85 DAS with jute sack treatment. Limited soil moisture and water stress can reduce grain yields, leading to smaller corn cob size and reduced grain production. Jute sack mulch was found to be more effective than inorganic plastic in maintaining soil moisture, reducing weeds, and enhancing soil fertility. This finding was generated from pot trial so it should be done at on-station as well as on-farm trial for validation with cost-benefit analysis.

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