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AGROECONOMIC PERFORMANCE OF MAIZE IN ZERO TILLAGE AS RELAY AND AFTER HARVEST OF TRANSPLANTED AMAN RICE

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Abstract

A field trial was conducted at the multi-location testing (MLT) site, Moulvibazar, Bangladesh during two consecutive years of 2017-2018 and 2018-2019 located in Agro Ecological Zone (AEZ)-20; under Eastern Surma Kushiyara Floodplain to introduce maize in zero tillage as relay and after harvest of T. aman rice. Four sowing dates of maize seed viz. T_1: 10 November as relay with T. aman rice, T_2: 20 November as relay with T. aman rice, T_3: 30 November in T. aman harvested fallow land and T_4: 10 December in T. aman harvested fallow land were used as treatment variables. The trial was laid out in a randomized complete block design with three replications. Maize var. BARI Hybrid Maize-9 and short duration T. aman rice var. BRRI dhan56 /BRRI dhan57 were used. Sowing time is critical for maximizing yield for both grain and biomass yield of maize. Yield and yield attributes of maize varied significantly due to different sowing dates. The result showed that grain yields of maize 8.48, 11.20, 8.22 and 7.98 t ha^{-1} were achieved with seed sown on 10 November as relay with T. aman rice, 20 November as relay with T. aman rice, 30 November in T. aman harvested fallow land and 10 December in T. aman harvested fallow land, respectively. The highest grain yield (11.20 t ha^{-1}) was obtained when sowing on 20 November as relay with T. aman rice, which showed an increase of grain yield of 40, 36 and 32 % than 10 December in T. aman harvested fallow land, 30 November in T. aman harvested fallow land and 10 November as relay with T. aman rice, respectively. The highest gross return (Tk. 2,30,095 ha^{-1}), net return (Tk. 1,33,845 ha^{-1}) and benefit cost ratio (2.39) were noted in the same treatment indicated the profitability of maize in zero tillage as relay with T. aman rice in AEZ 20.

Keywords: Zero tillage, relay maize, relay inter crop maize, winter maize

Introduction

Maize (*Zea mays*) has become an emerging crop in Bangladesh with the highest productivity. The crop is grown on 4.00 lakh hectares of land with productivity of 9.05 tons per hectare (BBS, 2019). It is a very common and popular cereal crops multiple uses over the world. Every year a huge amount of maize grain is required as feed and fodder for poultry and livestock sector and most of them are imported (Pandey and Koirala, 2017). Maize can be used as alternative crop of rice or wheat to fulfill the food demand for the increasing population in our country. It can be grown as winter maize mainly after harvesting of T. Aman rice. Shortly after harvest of transplanted aman rice, the soil quickly becomes dry

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which hampers the germination of rabi crops (Nazrul *et al.*, 2013). At present major maize based cropping pattern viz. potato intercropped with maize (Ifenkwe and Odurukwe, 1990; Begum *et al.*, 2016), maize-vegetables and spices (Nazrul, 2018) intercropping, potato-maize-T. aman rice, maize-relay with T. aman rice (Islam *et al.*, 2017), maize-pre monsoon aus rice-T.aman rice, maize- bushbean (Islam, 2002) are being practiced by the farmers. However, maize-fallow-T. aman rice cropping patterns are being disseminated day by day in other maize growing areas of Bangladesh (Yusuf *et. al.*, 2009). Relay/Intercropping has already been recognized as a potentially beneficial system of crop production as traditional practice in Bangladesh (Nazrul and Shaheb, 2015). It increases total productivity by judicious choice of compatible crops by adopting appropriate planting geometry, considering inter/intra specific competition and minimizing efficient use of natural resources.

In Sylhet region, mainly fallow - T. aus - T. aman rice cropping pattern is widely practiced by farmers under rainfed condition and cultivate long durated transplanted aman rice varieties, which are harvested mid-November to early December. Late planting (from 20 December onwards) may cause yield losses of 12 - 22% (Ali, 2006). The later harvesting of the late-planted crops makes it vulnerable to early monsoon rain, when post-harvest processing becomes difficult. This raises the moisture content of maize and the incidence of cob rot diseases resulting in poor quality grain and a low market price. Early planting within the optimum time period is important to achieve high yield with rabi season hybrid maize. Relay practice makes the best use of the residual moisture of rice field and also beneficial in terms of utilizing residual moisture from the previous crop and reduced planting cost (Saleem *et al*., 2000; Malik *et al.*, 2002; Jabbar *et al*., 2005). Considering the above facts, this study was undertaken in order to introduce maize under zero tillage as relay and after harvest of T. Aman rice for having optimum growth and yield.

Materials and Methods

Descriptions of the Experimental Locations

The experiment was conducted at the farmer’s field under the multi-location testing (MLT) site, Moulvibazar (24° 28' N latitudes and 91° 46' E longitude), Bangladesh during two consecutive years of 2017-2018 and 2018-2019 located in Agro Ecological Zone (AEZ)-20 under Eastern Surma-Kushiyara Floodplain.

Soil and climate

The climate and soil of the selected plot was under subtropical climate having heavy rainfall during monsoon and scanty or very little shower during prolonged dry winter season, high to medium high land, and well drained grey floodplain fertile soils of acidic in nature. The soil of the experimental field is clay loam in texture with low organic matter content (1.63%). The soil of the trial field was acidic in nature (pH 4.1-5.63). The initial status of N (0.07%), P (7.59 µg/soil), K (0.18 meq/100g soil), S (10.80 µg/soil), B (0.34 µg/soil) and Zn (1.27 µg/soil) was very low, low, low, low, medium and medium, respectively. During four different seed sowing time of maize under zero tillage at before and after harvest of T. aman rice, the initial soil moisture was 30-32, 22-25, 20-22 and 17-19 % in each year, respectively. Field capacity and bulk density of the soil were 31% and 1.22 g/cc, respectively.

The monthly air temperature and rainfall during the study period are presented in Figure 1. The monthly mean minimum and maximum temperature was 19.37 ^{0}C and 26.67 ^{0}C during the crop season, respectively. During experimentation the crop received 3416 mm total rainfall; whereas the lowest rainfall 10.9 mm and the highest rainfall 2212 mm were occurred in January and April, respectively.

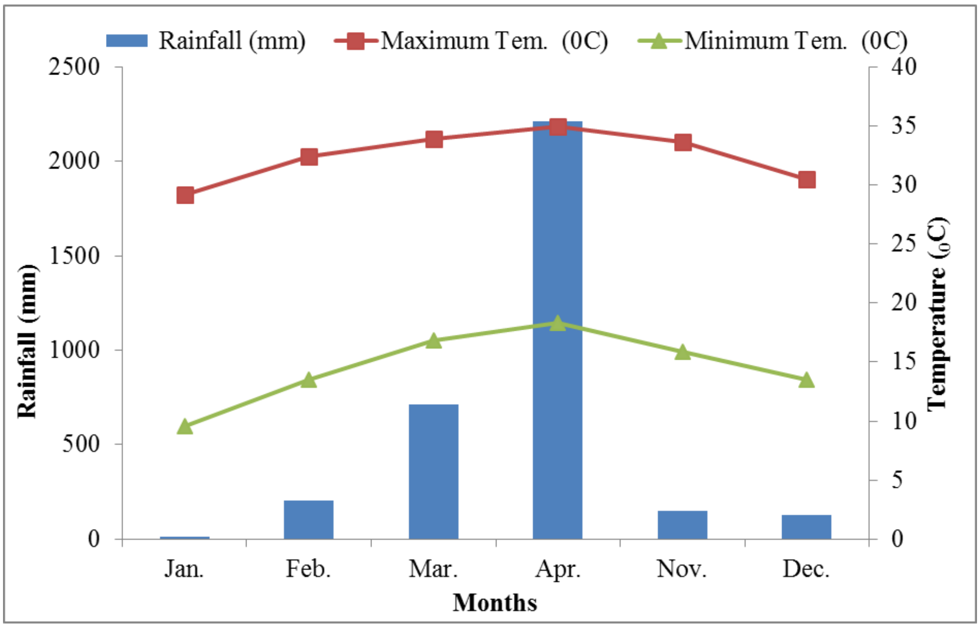

Fig. 1. Average of two years monthly maximum and minimum air temperature and total rainfall during study period *(Source: Metrological Department, Sylhet)*.

Experimental materials and design

Four different times of seed sowing viz. T_1: 10 November as relay with T. aman rice, T_2: 20 November as relay with T. aman rice, T_3: 30 November in T. aman harvested fallow land and T_4: 10 December in T. aman harvested fallow land were used as treatments in this trial. The unit plot size was 5 m × 4 m. The trial was laid out in a randomized complete block design with three replications. Three plots of 80 m^2 were selected for each replication. Maize var. BARI Hybrid Maize-9 and short duration T. aman rice var. BRRI dhan56/BRRI dhan57 were used in the trial. The aman rice was transplanted on 10 July to 20 August in each year as per treatment need. Fertilizer was applied @ 290-62-100-44-5-1 kg ha^{-1} of N-P-K-S-Zn-B (FRG, 2012). One third nitrogen and full amount of other fertilizer were applied as basal dose at the time of first application during earthing-up of zero tillage as relay treatments and during final land preparation after harvest of transplanted aman rice treatments. Rest nitrogen was top dressed in two equal splits at 60 and 90 days after sown (DAS). Three irrigations were applied at 30, 60 and 120 DAS, respectively. Two hand weeding were done at 55-60 and 85-90 days after emergence, respectively in both the year.

Data collection and analysis

The maize was harvested treatment wise on 5-7, 15-17, 19-21 and 25-28 April in each year when outer cover of cobs turns green to straw color and leaves become drying to some extent. The data collection on morphological attributes was started at 70 days after sowing and continued with an interval of 20 days until final harvest. At harvest, plant height, ear height, grains cob^{-1}, weight of single cob and 1000- grain weight were recorded. Data on yield components and yield of maize for two consecutive years showed similar trend. So, the collected data were pooled and means were adjusted by Least Significant Difference (LSD) test at 5% level of significance. Benefit cost analysis was also done.

Results and Discussion

Sowing dates significantly affected plant height, ear height, cob breath, grains cob^{-1}, 1000-grain weight and grain yield t ha^{-1}(Table 1). The plant height significantly influenced by different planting dates and it ranged from 198.47 to 216.90 cm; while the tallest plants were measured at 20 November sowing as relay with T. aman rice. Ear height decreased with plant height and the tallest plants had higher ear height. Significantly maximum ear height (88.25 cm) was measured from the plants sowing at 20 November as relay with T. aman rice. The lowest ear height (79.63 cm) was recorded from plants sown at 10 December in T. aman harvested fallow land. From the result it is clearly revealed that normal sowing (mid-November) in a specific planting geometry is critical for maximizing plant and ear height. The cob length was non-significant (Table 1). Cob breath increased with the increase of plant height and the maximum cob length (6.28 cm) were obtained from the plants sown at 20 November as relay with T. aman rice and minimum cob length (5.38 cm) was noticed from the plants sown at 10 December in T. aman harvested fallow land. These results are in agreement with the finding of Konuskan (2000). Significant difference was found in weight of single cob. The plants from the seeds sown at 20 November as relay with T. aman rice also gave maximum weight (155.17 g) of single cob, whereas plants from 10 November as relay with T. aman rice and 30 November in T. aman harvested fallow land provided the statistically similar weight of single cob. The lowest weight of single cob (136.16 g) was recorded from the sowing of 10 December in T. aman harvested fallow land (Table 1).

A significant difference was observed in number of grains cob^{-1} due to variation in sowing dates (Table 2). However, the highest number of grains cob^{-1} (631.33) was obtained from the sowing date at 20 November as relay with T. aman rice, while the lowest (575) number of grains cob^{-1} was noticed from 30 November in T. aman harvested fallow land. Grain weight cob^{-1} significantly affected by different sowing dates. Maximum grain weight cob^{-1} was recorded in plants grown from the seeds sown at 20 November as relay with T. aman rice followed by 30 November sowing in T. aman harvested fallow land and 10 November sowing as relay with T. aman rice. The lowest grain weight cob^{-1} 93.87 g was when seeds were sown at 10 December in T. aman harvested fallow land. Sowing dates significantly affected the 1000-grain weight of maize (Table 2). Among the different sowing dates 1000-grain weight ranged from 192.50 - 217.33 g, while the 20 November sowing as relay with T. aman rice produced heavier grain compared to 10 December sowing in T. aman harvested fallow land, where it showed an increase of 12.50 %.

Grain yield ha^{-1} was influenced due to the changing sowing dates (Table 2). The highest grain yield (11.20 t ha^{-1}) was obtained from sowing at 20 November as relay with T. aman rice, which shown an increased grain yield of 40, 36 and 32 % than 10 December in T. aman harvested fallow land, 30 November in T. aman harvested fallow land and 10 November as relay with T. aman rice, respectively. With 20 November sowing the phonological phase of the plant, vulnerable to high thermal regimes favorably considered with temperature condition (33.67 0^{C}) that helped to enhance more number of grains cob^{-1}, weight of single cob, grain weight cob^{-1} and 1000 grain weight and resulted in increased yield. However, late sowings increased crop growth rate during the vegetative period because of high radiation use efficiency and higher percent radiation interception. Conversely, late sowings decreased crop growth rate during grain filling because of low radiation use efficiency and low incident radiation. Late sowings affected grain yield by decreasing grain weight and grain number per unit area (Maresma *et al.*, 2019). Similar trend was found in case of stover yield ha^{-1}.

Table 1. Effect of sowing dates on vegetative growth and yield contributing characters of hybrid maize (pooled of two years)

Treatments	Plant height (cm)	Ear height (Cm)	Cob length (cm)	Cob breadth (cm)	Weight of single cob (g)
T_1	210.60	82.40	17.95	5.78	143.90
T_2	216.90	88.25	19.65	6.28	155.17
T_3	200.17	80.35	19.87	5.43	144.83
T_4	198.47	79.63	17.80	5.38	136.16
CV (%)	3.16	4.60	9.77	6.80	2.03
LSD $_{(0.05)}$	8.13	4.78	NS	0.49	5.25

T_1: 10 November sowing as relay with T. aman rice, T_2: 20 November sowing as relay with T. aman rice, T_3: 30 November sowing in T. aman harvested fallow land and T_4: 10 December sowing in T. aman harvested fallow land.

Table 2. Effect of sowing dates on grain and yield contributing characters and yield of hybrid maize (pooled of two years).

Treatments	Grains/cob (No.)	Grain weight cob^{-1} (g)	1000-grain weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	592.83	104.83	208.43	8.48	9.69
T_2	631.33	112.00	217.33	11.20	12.19
T_3	575.00	100.50	192.50	8.22	8.90
T_4	578.00	93.87	193.17	7.98	8.68
CV (%)	3.40	4.99	4.20	7.23	10.64
LSD $_{(0.05)}$	25.38	6.45	10.72	0.82	2.07

T_1: 10 November sowing as relay with T. aman rice, T_2: 20 November sowing as relay with T. aman rice, T_3: 30 November sowing in T. aman harvested fallow land and T_4: 10 December sowing in T. aman harvested fallow land.

Table 3. Cost benefit analysis of maize in zero tillage as relay and after harvest of transplanted aman rice

Treatments	Gross return (Tk. ha^{-1})	Cost of cultivation (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Benefit cost ratio (BCR)
T_1	174445	96250	78195	1.81
T_2	230095	96250	133845	2.39
T_3	168850	94700	74150	1.78
T_4	163940	94700	69240	1.73

T_1: 10 November sowing as relay with T. aman rice, T_2: 20 November sowing as relay with T. aman rice, T_3: 30 November sowing in T. aman harvested fallow land and T_4: 10 December sowing in T. aman harvested fallow land. Farm gate price (Tk.kg^{-1}) of maize 20.00 and Stover 0.50

Cost benefit analysis

An analysis on cost and return of maize with different sowing dates are presented in Table 3. The highest gross return (Tk. 2,30,095 ha^{-1}) was obtained from the sowing date 20 November as relay with T. aman rice (T_2) followed by 10 November as relay with T. aman rice, whereas delayed sowing at 10 December in T. aman harvested fallow land contributed lower gross return (Tk. 163940 ha^{-1}). The economic return was influenced due to grain yields with the changing sowing dates. Maximum net return (Tk. 1,33,845 ha^{-1}) was obtained from the sowing date at 20 November as relay with T. aman rice, which shown an increased net return of 93, 81 and 71 % than 10 December in T. aman harvested fallow land, 30 November in T. aman harvested fallow land and 10 November as relay with T. aman rice, respectively. The lower net return (Tk. 69,240 ha^{-1}) was obtained from sowing at 10 December in T. aman harvested fallow land. The highest benefit-cost ratio (2.39) was also recorded from 20 November sowing as relay with T. aman rice followed by 10 November sowing as relay with T. aman rice. Monetary advantage revealed that maize grown as relay with T. aman rice performed better as compared to maize grown in T. aman harvested fallow land.

Conclusion

The result showed that maize could be grown as relay with T. Aman rice on 20 November for achieving higher grain yield and economic return under Eastern Surma-Kushiyara Floodplain (AEZ 20).

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