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INTERCROPPING OF JUTE AS LEAFY VEGETABLE WITH HYBRID MAIZE UNDER DIFFERENT PLANTING SYSTEMS

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Abstract

An experiments were conducted at Agronomy research field, Gazipur and Regional Agricultural Research Station, Jamalpur of Bangladesh Agricultural Research Institute during *kharif-1* season of 2018 and 2019 to find out the suitable combination of maize and jute (leafy vegetable) intercropping system for higher productivity and monetary advantage. Treatments included in the experiment were: T_1= Hybrid maize normal row (MNR) (60cm × 20cm) + 1 row jute (33%), T_2= MNR (60cm × 20cm) + 2 row jute (66%), T_3= MNR (60cm × 20cm) + 3 row jute (100%), T_4= MNR (60cm × 20cm) + jute broadcast (100%) and T_5= Sole maize (60 cm × 20 cm). The experiment was laid out in a randomized complete block design with three replications. At Gazipur, Light availability on jute decreased with the increase of shade produced by maize canopy over the time up to 40 DAS (at harvest of jute) under intercrop situation and the highest light availability was observed on jute in T_4 treatment. The maximum grain yield of maize was in sole crop and it was decreased by 1-6 % at Gazipur and 2-9 % at Jamalpur due to intercropping. Maize equivalent yield (MEY) of intercropping treatments showed better performance than sole maize. The highest MEY (19.28 t/ha at Gazipur and 17.41 t/ha at Jamalpur), gross margin (Tk. 252040/ha at Gazipur and Tk. 313380/ha at Jamalpur) and benefit cost ratio (3.65 and 3.33 at Gazipur and Jamalpur, respectively) were observed in T_4 treatment among the intercropping treatments. The results revealed that T_4 = MNR (60cm × 20cm) + jute broadcast (100%) could be agronomically feasible and economically profitable for maize and jute (leafy vegetable) intercropping system at Gazipur and Jamalpur.

Keywords: Planting system, Light availability, BCR; Maize, Jute (leafy vegetable)

Introduction

Intercropping is advanced agro technique of cultivating two or more crops in the same piece of land at the same time have been practiced in past decades and achieved the goal of agriculture.

It increases in productivity per unit of land via better utilization of resources, minimizes the risks, reduces weed competition and stabilizes the yield (Seran and Brintha, 2010). Higher productivity from intercropping depends on judicious

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choice of component crops, suitable planting system or proportion of component crops (Islam *et al*., 2006). Maize based intercropping is found profitable and suitable in many countries (Misra *et al*., 2021) as well as in Bangladesh. Maize is ideal for intercropping, especially with legumes, potato, onion, groundnuts and vegetables. Maize- legumes cropping system is a sustainable diversification for productivity, profitability and resource use efficiency (Islam *et al*., 2020). Besides, maize is C_4 plant which has higher yield potential (Ahmed, 2001) and greater land use efficiency (Bhuiyan, 2001). It has high potential for carbohydrate accumulation per unit area per day (Javier *et al*., 2020). Due to huge demand of maize, particularly in poultry feed industry; it is getting the special importance by the government of Bangladesh (Farid and Shil, 2006). Maize is an unbranched and erect cereal crop grown with wide spacing. Several short duration and short stature vegetable like jute (*patshak*) may be grown in association with hybrid maize. On the other hand, jute or *patsahak* is a very popular leafy vegetable. The jute leaf contains over 17 active nutrient compounds including protein, fat, carbohydrate, fiber, ash, calcium, potassium, iron, sodium, phosphorous, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid, food energy, Vit. A etc. Therefore jute leaf has a great importance in terms of human nutrition, health and beauty care. So, this experiment was conducted to find out the suitable planting systems of hybrid maize and jute (*patshak*) intercropping for higher productivity and monetary advantage.

Materials and Methods

The field experiment was conducted at Agronomy research field, Gazipur (AEZ-28) and Regional Agricultural Research Station, Jamalpur (AEZ-9) of Bangladesh Agricultural Research Institute during *kharif* season of 2018 and 2019. The physical and chemical properties of initial soil of the experimental plot has been presented in Table 1 and rainfall data (average of 2018 and 2019) for both sites during cropping period has been presented in Fig. 1. Treatments included in the experiment were: T_1= Hybrid maize normal row (MNR) (60cm × 20cm) + 1 row jute (33%), T_2= MNR (60cm × 20cm) + 2 row jute (66%), T_3= MNR (60cm × 20cm) + 3 row jute (100%), T_4= MNR (60cm × 20cm) + jute broadcast (100%) and T_5= Sole maize (60 cm × 20 cm). The experiment was laid out in a randomized complete block design with three replications and the unit plot size was 6m × 5m. Hybrid maize (var. BARI Hybrid maize-9) and jute (var. Binapatshak-1) were used in both locations. Seeds of both crops were sown on 10 March, 2018 and 12 March, 2019 at Gazipur and on 5 March, 2018 and 10 March, 2019 at Jamalpur. The seeds of both crops were treated with provex @ 3 g/ kg seed in both locations and both years. Fertilizers were applied at the rate of 250-76-121-72-5-1 kg/ ha of N, P, K, S, Zn, B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid for sole maize and intercrop. One third of N, whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3 N was top dressed at 20 and 40 days after sowing (DAS) of maize. In intercrop, extra N (40 kg/ha) was applied at 20 DAS as side dress to jute. Sole jute was fertilized at the rate of 30- 5-20 kg/ha of N, P, K.Two third of N and all other fertilizers were applied as basal. Rest N was applied at 20 DAS in both locations. Light availability or Photo synthetically active radiation (PAR) was measured only at Gazipur location by PAR Ceptometer (Model – LP-80, Accu PAR, Decagon, USA). The PAR was measured at 5-day intervals from 25 to 40 DAS at around 11:30 am to 13:00 pm. Four readings each of PAR inc and PAR t were recorded at different spots of each plot. PARt indicated the light availability above underneath crop (jute). The transmitted PAR (PAR t) was expressed in percentage (Ahmed *et al.*, 2010):

$$\text{Light availability, PARt (\%)} = \frac{\text{PAR t}}{\text{PAR inc}} \times 100$$

where, PARinc= Incident PAR,

PARt= Transmitted PAR

Data on yield contributing characters of maize were taken from randomly selected 5 plants from each plot. Yield of both crops were taken from whole plot area in both locations. Maize was harvested on 28 and 30 June in 2018 and 2019, respectively, and jute (*patshak*) was harvested on 20 April in both years at Gazipur. On the other hand, maize was harvested on 3 and 6 July 2018 and 2019, respectively) and *patshak* was harvested on 15 and 19 April in 2018 and 2019, respectively, at Jamalpur. In both locations, maize equivalent yield was computed by converting yield of intercrops on the basis of prevailing market price of individual crop following the formula of Bandyopadhyay (1984) as given below:

$$\text{Maize equivalent yield} = Yim + (Yij \times Pj)/ Pm$$

Where, Yim = Yield of intercropped maize, Yij = Yield of intercropped jute, Pm = Market price of maize and Pj = Market price of jute.

Collected data of both the crops were analyzed statistically and the means were adjudged by using LSD at 5% level of significance. Economic analysis was also done considering local market price of harvested crops. Monetary advantage was evaluated according to Shah *et al*. (1991) as follows:

$$\text{BCR} = \frac{\text{Gross return}}{\text{Cost of production}}$$

The physical and chemical properties of the soil of experimental field is given below:

Table 1. Soil analytical data of the experimental site at Gazipur and Jamalpur

Loacation	pH	OM (%)	Total N (%)	Exchangeable K (meq/ 100g soil)	P	S	Zn	B
					(µg/g)			
Gazipur	6.23	1.29	0.112	0.098	15.23	24.94	0.654	0.168
		VL	VL	VL	O	O	L	VL
Jamalpur	7.20	0.89	0.045	0.23	7.73	5.74	0.40	0.37
				L	O	VL	VL	L
Critical levels			0.12	0.12	7.0	10.00	0.60	0.20

L= Low, VL = Very low, O = Optimum

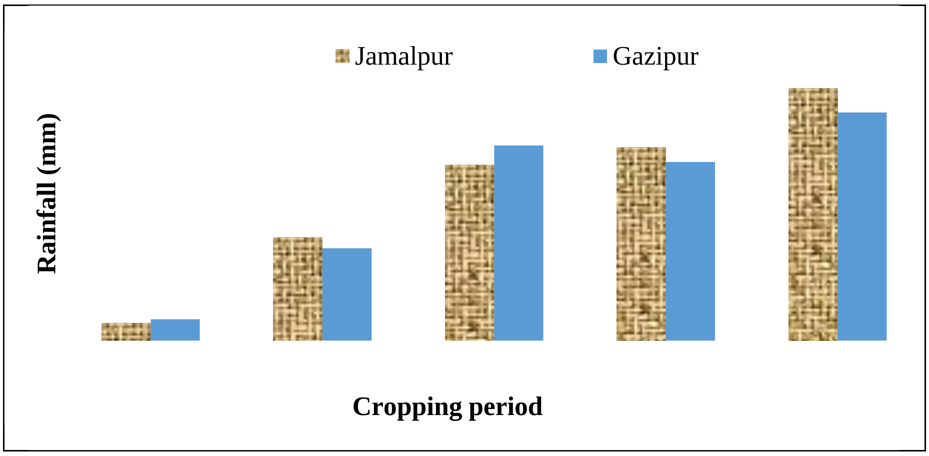

Fig.1 Rainfall data (average) for both sites during cropping period (*Kharif* 2018 and 2019)

Results and Discussion

Light availability

At Gazipur, Light availability on jute was measured from 25 to 40 DAS (Days After Seeding) . Jute was not affected by the shading of maize canopy. Because, jute was harvested at 40 DAS and in this time maize canopy did not produce much shade which affected jute plant. Under intercrop situation, availability of light on jute canopy was almost 100% at earlier growth stage (25 DAS) of jute and it was decreased with the increase of shade produced by maize canopy over the time up to 40 DAS (at harvest of jute). Light availability or transmitted PAR (PARt) on jute was more or less similar in all intercropping treatments. However, the lowest light availability on jute was observed at 40 DAS in T_1 (MNR + 1 row jute) followed by T_2 treatment and the highest light availability on jute was observed in T_4 treatment (MNR + jute broadcast) followed by T_3 treatment (Fig.2). It might be due to number of jute population was higher in T_4 than that of in T_1. Maize plant received more nutrients having comparatively bigger canopy in T_1 than that of in T_4 and that is why light availability on underneath jute crop was higher under smaller maize canopy (T_4) and light availability on underneath jute crop was lower under bigger maize canopy (T_1).

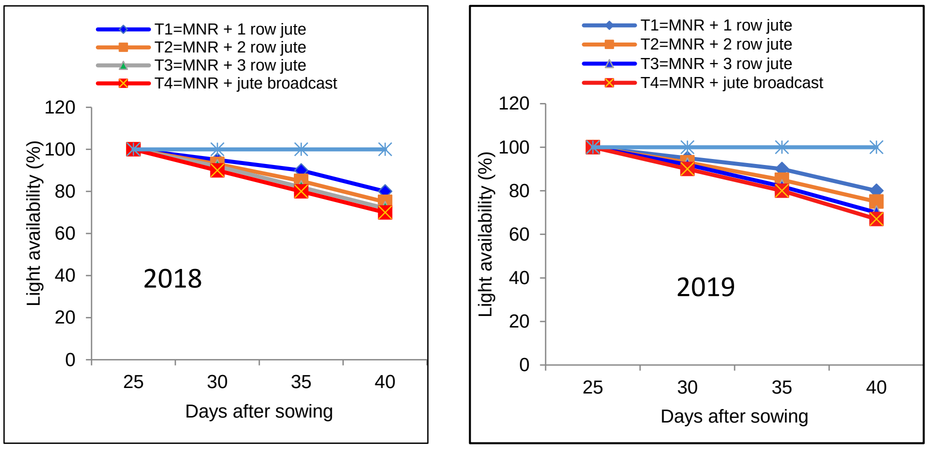

Fig.2. Light availability on jute (leafy vegetable) canopy in maize + jute intercropping systems at Gazipur (2018 and 2019)

Growth and yield performance of maize

Plant height, yield and yield contributing characters of maize at both locations during *kharif-1* of 2018 and 2019 (pooled) are presented in Table 2. Plant height, yield contributing characters (number of grains /cob and 1000- grain weight) and grain yield of maize were not significantly differed in both locations. Although the highest grain yield (8.98 and 9.19 t/ha at Gazipur and Jamalpur, respectively) were recorded in sole maize due to no intercrop competition for growth resources like light, nutrients, moisture and space in sole cropping. This result corroborates with the findings of Begum *et al.* (2016 and 2020). The lowest grain yield (8.41 and 8.40 t/ha at Gazipur and Jamalpur, respectively) were recorded in MNR + jute broadcast.

Table 2. Plant height, yield and yield components of maize in maize- jute (as leafy vegetable) intercropping under different planting system during *kharif* season (Pooled of 2018 and 2019)

Treatment	Plant height (cm)	Number of grains/cob	1000-grain wt. (g)	Grain yield (t/ha)	Yield decreased over sole (%)
Gazipur					
T_1= MNR + 1 row jute (33%)	233	589	283	8.85	1.4
T_2= MNR + 2 row jute (66%)	235	581	278	8.65	3.7
T_3= MNR + 3 row jute (100%)	234	575	279	8.50	5.3
T_4= MNR + jute broadcast (100%)	235	548	278	8.41	6.3
T_5= Sole maize (60 cm × 20 cm)	233	611	290	8.98	-
LSD $_{(0.05)}$	NS	NS	NS	NS	
CV (%)	7.37	7.88	8.39	8.81	
Jamalpur					
T_1= MNR + 1 row jute (33%)	219	584	289	9.03	1.7
T_2= MNR + 2 row jute (66%)	222	580	281	8.83	3.9
T_3= MNR + 3 row jute (100%)	217	544	280	8.56	6.9
T_4= MNR + jute broadcast (100%)	218	539	275	8.40	8.6
T_5= Sole maize (60 cm × 20 cm)	220	611	292	9.19	-
LSD $_{(0.05)}$	NS	NS	NS	NS	-
CV (%)	7.90	7.52	8.08	8.00	-

Grain yield level at Gazipur was lower than Jamalpur. It might be due to comparatively lower temperature prevailed in cropping period at Jamalpur than Gazipur (Fig. 3). Similar trend was observed in case of relative humidity during cropping period (Fig. 4). However, grain yield in different treatments were attributed to the cumulative effect of yield components.

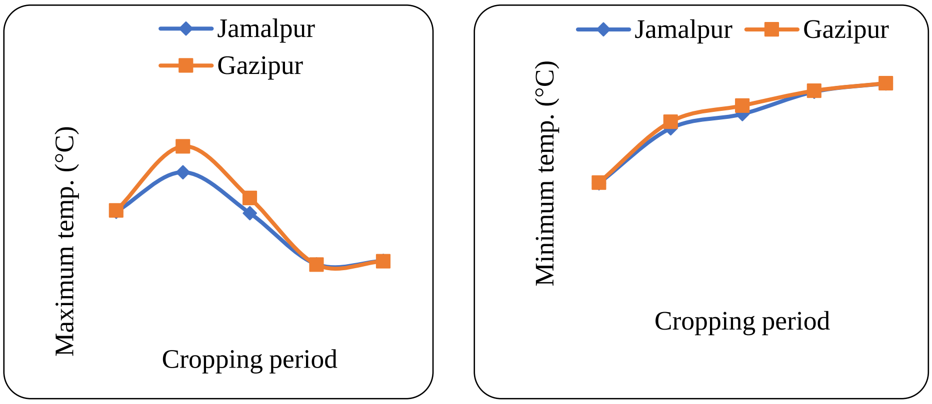

Fig.3. Maximum and minimum air temperature (average) for both sites during cropping period (*Kharif* -1, 2018 and 2019)

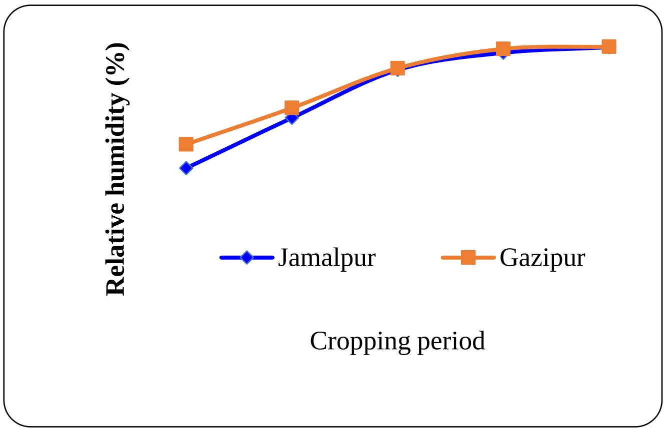

Fig.4. Relative humidity (average) for both sites during cropping period (Kharif -1, 2018 and 2019)

Effect on yield of jute (leafy vegetable)

Plant population, leafy vegetable yield of jute and MEY (Maize equivalent yield) in maize + jute (vegetable) intercropping is presented in (Table 3). Leafy vegetable yield and plant population of jute were significantly influenced by different planting systems. The highest plant population of jute (420 and 438 t/ha at Gazipur and Jamalpur, respectively) was found in MNR + jute broadcast treatment due to jute plant got higher space in broadcast treatment. Among the intercrop treatments, the highest vegetable yield (9.79 and 10.82 t/ha at Gazipur and Jamalpur, respectively) was observed in MNR + jute broadcast treatment due to the highest number of plant population per unit area. The lowest vegetable yield was observed in MNR + 1 row jute treatment in both locations due to the lowest number of plant population per unit area

Evaluation of intercrop productivity

Maize- jute intercrop productivity was evaluated on the basis of maize equivalent yield (MEY). MEY of maize- jute intercropping in both locations are presented in Table 3. MEY of all the intercropping systems was higher than sole maize in both locations indicating higher productivity of intercropping than sole maize. In intercropping, the highest maize equivalent yield (19.28 t/ha at Gazipur and 17.41 t/ha at Jamalpur) was observed in T_4 treatment (MNR + jute broadcast) which was 114.7 and 89.4% higher over sole maize at Gazipur and Jamalpur, respectively, followed by T_3 treatment. The lowest was observed in T_5 (sole maize) in both locations.

Table 3. Vegetable yield, jute population and MEY of maize- jute (as leafy vegetable) intercropping under different planting system during *kharif-1f*season (Pooled of 2018 and 2019)

Treatment	Number of jute plant//m^2 (no.)	Vegetable yield (t/ha)	MEY (t/ha)	% increased of MEY over sole maize
Gazipur				
T_1= MNR + 1 row jute (33%)	136	3.41	12.63	40.6
T_2= MNR + 2 row jute (66%)	266	6.29	15.64	74.2
T_3= MNR + 3 row jute (100%)	396	9.39	18.93	110.8
T_4= MNR + jute broadcast (100%)	420	9.79	19.28	114.7
T_5= Sole maize (60 cm × 20 cm)	-	-	8.98	-
LSD $_{(0.05)}$	56.58	1.45	-	-
CV (%)	9.29	13.96	-	-
Jamalpur				
T_1= MNR + 1 row jute (33%)	142	3.53	11.97	30.3
T_2= MNR + 2 row jute (66%)	272	6.41	14.17	54.2
T_3= MNR + 3 row jute (100%)	397	10.16	17.02	85.2
T_4= MNR + jute	438	10.82	17.41	89.4
T_5= Sole maize (60 cm × 20 cm)	-	-	9.19	-
LSD $_{(0.05)}$	45.49	1.50	-	-
CV (%)	7.18	9.17	-	-

Market price (Tk. /kg): Maize = Tk. 18 (in both locations), jute (leafy vegetable) = Tk. 20 at Gazipur and 15 at Jamalpur

Economic performance

Economic analysis is an important tool to evaluate the economic feasibility of intercropping systems and monetary advantage. Benefit cost analysis of maize + jute intercropping systems in both locations are presented in Table 4. Among intercropping treatments, the highest gross return (Tk. 347040/ha and Tk. 313380/ha at Gazipur and Jamalpur, respectively) was observed in T_4 treatment (MNR + jute broadcast) followed by treatment T_3 owing to higher MEY in both locations but the lowest cost of cultivation was found in T_4 treatment due to lower number of labours engaged in broadcast sowing. The highest cost of production was recorded in T_3 treatment followed by T_2 due to higher number of labours engaged in line sowing in both locations. The gross margin was followed the similar trend of gross return. Cost of production differed among the treatments. Among intercropping treatments, the highest benefit cost ratio (3.65 and 3.33 at Gazipur and Jamalpur, respectively) was obtained from T_4 (MNR + jute broadcast) followed by T_3 treatment. This result has been supported by the findings of Islam *et al.* (2013) and Begum *et al*. (2020).

Table 4. Cost- benefit analysis of hybrid maize- jute (leafy vegetable) intercropping during *kharif-1* season of 2018 and 2019 (Gazipur and Jamalpur)

Treatment	Gross return (Tk./ha)	Cost of cultivation (Tk./ha)	Gross margin (Tk./ha)	BCR
Location : Gazipur				
T_1= MNR + 1 row jute (33%)	227340	104000	123340	2.19
T_2= MNR + 2 row jute (66%)	281520	108000	173520	2.61
T_3= MNR + 3 row jute (100%)	340740	112000	228740	3.04
T_4= MNR + jute broadcast (100%)	347040	95000	252040	3.65
T_5= Sole maize (60 cm × 20 cm)	161640	96000	65640	1.68
Location : Jamalpur				
T_1= MNR + 1 row jute (33%)	215460	103000	120460	2.09
T_2= MNR + 2 row jute (66%)	255060	107000	210060	2.38
T_3= MNR + 3 row jute (100%)	306360	111000	306360	2.76
T_4= MNR + jute broadcast (100%)	313380	94000	313380	3.33
T_5= Sole maize (60 cm × 20 cm)	165420	95000	70420	1.74

Market price (Tk./ kg): Maize = Tk. 18 (in both locations), jute (leafy vegetable) = Tk. 20 at Gazipur and 15 at Jamalpur

Conclusion

Result revealed that all the intercropping systems showed better productivity than growing sole maize and sole jute as vegetables. Farmers can get diversified food while benefiting financially by intercropping jute + maize instead of sole maize. Hybrid maize normal row (60cm ×20cm) + jute broadcast (100%) intercropping might be agronomically feasible and economically profitable in Gazipur and Jamalpur.

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