International Journal of Natural and Social Sciences
IJNSS
Print: 2617-6637 < ISSN > Online: 2313-4461

Combined output value in hybrid maize and squash intercropping system

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ARTICLE INFO

Article history

Accepted: 27 August 2020
Online release:17 September 2020

Keyword

Maize, Squash, intercropping, Land equivalent ratio, Benefit-cost

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ABSTRACT

The experiment was conducted in the research field of Agricultural Research Station, BARI, Rajbari, Dinajpur during the *rabi* season of 2016-17 and 2017-18 to know the suitability of squash intercrop with maize in which row arrangement could be useful to farmers and the economic performance of the maize-squash intercropping systems. Five different intercropping combinations along with sole cropping of maize and squash were employed in the study following randomized complete block design. Different intercropping combinations were evaluated by performed on basis of several intercropping indices such as land equivalent ratio (LER), system productivity index (SPI), competitive ratio (CR), monetary advantages index (MAI), replacement value of intercropping (RVI) and economics performance. The monetary return of intercropping of maize with squash with different planting ratio was significantly higher as compared to sole cropping. The highest maize equivalent yield (18.35 t ha-1), gross return (Tk.275250 ha-1), gross margin (Tk.188930 ha-1), BCR (3.19), LER (1.65), SPI (11.03), RVI (2.92), MAI (108431) were in T5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) compared to other intercropping combination and sole cropping of maize. The results revealed that Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row (T5) combination could be suitable for total productivity and economic return.

INTRODUCTION

Bangladesh is a densely populated country with lower per capita arable land (15 decimal head^{-1}) usage annual loss of agricultural land is about 0.73% per annum due to construction of houses, roads and industrial infrastructure (BBS, 2011). So, Bangladesh has to produce additional food for millions of people every year. The main challenge of the new millennium is to increase per unit yield by at least 50% through manipulating the limited land resource. In this regard, the challenges for the agronomist are to understand crop production problems and process to develop the best ways of production technologies for the management of problems and sustain production. About 80-85% peoples are directly involved in agriculture. Small farmers constitute 79.4% of our farming community and their cultivated lands (0.05-2.49 acres) are shrinking day by day (MOA, 2014). Intercropping offers a possible solution to raise productivity through temporal intensification in a country like Bangladesh where the possibility of bringing more land under cultivation is limited. Yield advantages through intercropping have been reported by many workers (Willey, 1979). The advantages is often attributed to the fact that different crops complement each other and make better use of resources when grown together rather than separately (Ahmed et al., 2018). Besides, intercropping also acts as insurance for resource poor farmers if one crop fails, they get some yield of another crop (Islam et al., 2014).

Maize (*Zea mays*) is a versatile photo insensitive crop which can give high yield relatively in a

How to cite this article: Khanum MM, Bazzaz MM, Nuruzzaman M, Akther MA and Ahmed K (2020). Combined output value in hybrid maize and squash intercropping system. International Journal of Natural and Social Sciences, 7(3): 79-88. DOI: 10.5281/zenodo.4065165

shorter period of time due to its unique photosynthetic mechanism as C_4 plant (Hatch and Slack, 1998). Maize is the third important cereal crop in Bangladesh (BBS, 2015). The area coverage under maize in Dinajpur is expanding rapidly instead of wheat. Due to development of some potential hybrid maize and its availability in this region, farmers tend to shift their cultivation with maize crop in Rabi season (Shaheenuzzaman et al., 2015 and Khanum et al., 2019). In addition to that, favorable agro-climatic conditions have made this crop suitable for greater adoption in winter season in Dinajpur region as well as in the country. Being row and spaced crop, some short duration vegetables may have access to grow with maize as intercrop for extra quick cash generation without hampering maize yield. Growing of short duration vegetables specially squash as intercrop with maize in between row may offer considerable yield advantage over sole cropping due to efficient utilization of growth resources. Squash is a newly arrival vegetable crop that cultivated mainly *rabi* season in Bangladesh and its cultivation is gradually gaining popularity in various parts of Bangladesh. It is easy to cultivate and requires limited resources and time, which makes cultivating squash very profitable. Like other cucurbits, squash is recognized as an excellent source of vitamins A, C, B_1, B_3, and B_5 and minerals. Squash contains Beta carotene which is a powerful anti-oxidant and anti-inflammatory. It is also beneficial in preventing cancer, lung diseases, high blood pressure and oxidation of cholesterol in the body. It also contains potassium which reduces urinary calcium excretion. Mixed or intercropping can increase total productivity of land through maximum utilization of natural resources (Thayamini et al., 2010). Higher total productivity per unit area in intercropping is achieved over sole cropping (Boras et al., 2006). Intercropping practices lead to more monetary return and better utilization of land and inputs (Quayyum et al., 1985). Considering the above issues, the proposed study was undertaken to increase total productivity per unit area in order to sustain food security, poverty reduction, resource management and livelihood improvement of ever increasing populations. Increasing farmer's income, access to food and nutrition, employment opportunity and woman's participation in agriculture are also aimed in this study.

MATERIALS AND METHODS

Study area

The experiment was conducted in the research field of Agricultural Research Station, BARI, Rajbari, Dinajpur AEZ-1 (UNDP & FAO, 1988) during two consecutive *rabi* season of 2016-17 and 2017-18. Initial soil nutrient status, temperature and rainfall during cropping season are presented in Table 1 and Figure 1, respectively.

The experiment

The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 4.5m × 4m. Seven different treatments were employed in the study viz. T_1= Maize normal planting (75cm × 25cm), T_2= Maize normal planting (100%) + 1 row squash (Pl. to Pl. 80cm) (100%) in between two row maize, T_3= Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 80cm) (50%) in between maize paired row, T_4= Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 1m) (40%) in between maize paired row, T_5= Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row, T_6 = Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash(Pl. to Pl. 80cm) (80%) in between maize paired row and T_7 = Sole squash (1m × 80cm).

Land preparation

The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Squash (var. Hybrid Bulam House) and maize (var. BARI Hybrid Bhutta-9) were used in the experiment. Maize (BARI hybrid Bhutta-9) seeds were sown and squash (var. Hybrid Bulam House) 15 days seedlings were transplanted on 21 November 2016 and 15 November 2017 according to treatments. Sole hybrid maize and intercropping treatments were fertilized with @ $N_{270}P_{70}K_{135}S_{45}Zn_4B_2$ kg/ha while sole squash with @ $N_{100}P_{40}K_{180}S_{10}Zn_5B_{1.2}$ kg/ha, respectively (FRG, 2012). The source of N, P, K, S, Zn and B were urea, triple super phosphate (TSP), Muriate of potash (MoP), gypsum, zinc sulphate and boric acid, respectively. Cowdung @ 10 tha^{-1} was applied as a blanket dose during final land preparation. The full amount of P K S Zn B and $^{1}/_{3}$ N were applied at the time of final land preparation. The remaining N was top dressed in two equal splits at 30 and 55 days after sowing (DAS). Two irrigations were provided after top dressing of urea. Earthing up and other intercultural operations were done when required. Other plant protection measures were taken when required. Squash was harvested from 05-15 February and maize was harvested from 20-22 April during 2016-17 and 2017-18.

Data collection

Yield contributing characters of squash and maize were measured from ten randomly selected plants of the sampling area of each treatment avoiding border plants. Maize grain yield and squash fruit yield were measured from the whole plot and then calculated per hectare basis maintaining standard moisture content. 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:

$$Meq = Yim + \frac{Yis \times Ps}{Pm}$$

Where, Meq= Maize equivalent yield
Yim= Yield of intercrop maize, Yis= Yield of intercrop squash
Pm= Price of maize, Ps= Price of squash

The land equivalent ratio (LER) was calculated using the following formula:

LER = (Yim/Ysm) + (Yis / Yss) Here, Yim = intercrop yield of maize; Ysm = sole crop yield of maize; Yis = intercrop yield of squash; Yss = sole crop yield of squash (Ofori and Stern, 1987 and Willy, 1979)

Replacement value of intercropping (RVI) and monetary advantage index (MAI) was calculated according to Moseley (1994) and Ali and Mishra, (1993), respectively.

$$RVI = \frac{Yim \times Pm + Yis \times Ps}{Ysm \times Pm - Csm}$$

Where, Yim & Yis are the yield of intercrops, Pm & Ps are the respective market price of these crops, Ysm & Csm are the yield and input cost of the main crop in sole stand.

The Monetary advantage index was calculated as described by (Ghosh, 2004).

MAI= Value of combined intercrop yield × (LER-1)/LER

Aggresssivity Index (A) was calculated using the following formula:

$A_{maize} = Yim/(Ysm \times Zmp) - Yis/(Yss \times Zsp)$ and
$A_{squash} = Yis/(Yss \times Zsp) - Yim/(Ysm \times Zmp)$
where, Yim & Yis are the yield of intercrops, Ysm & Yss are yield of sole crops and Zmp and Zsp are the proportion of maize and squash , respectively (Banik et al., 2006 and Khan et al., 2018)

System productivity index (SPI) was calculated using the following formula:

System productivity index (SPI) = (Ysm / Yss) × (Yis + Yim)
where, Ysm & Yss are yield of sole crops and Yim & Yis are the yield of intercrops (Willey, 1979)

The competitive ratio (CR) among different combinations was calculated using the following formula (Willey and Rao, 1980):

$$CR_{maize} = \frac{\text{LER maize}}{\text{LER squash}} \times \frac{Zsp}{Zmp} \text{ and}$$

$$CR_{squash} = \frac{\text{LER squash}}{\text{LER maize}} \times \frac{Zmp}{Zsp}$$

Where, Zmp and Zsp are the proportion of maize and squash in the mixture respectively.

Collected data were statistically analyzed by using R software packages and mean differences for each character were compared by Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

Table 1: Initial status of soils of the experimental plots at ARS, BARI, Rajbari, Dinajpur

Soil characteristics	Experimental plot
Land type and soil	Medium High land
texture	Loamy
pH	6.07(Slightly acidic)
Organic Matter (%)	2.20(Medium)
N (%)	0.11(Low)
P (µg/g soil)	48.16 (very high)
K (meq/100g of soil)	0.14(Medium low)
S (µg/g soil)	8.16(Low)
Zn (µg/g soil)	0.89(Medium)
B (µg/g soil)	0.35(Medium)

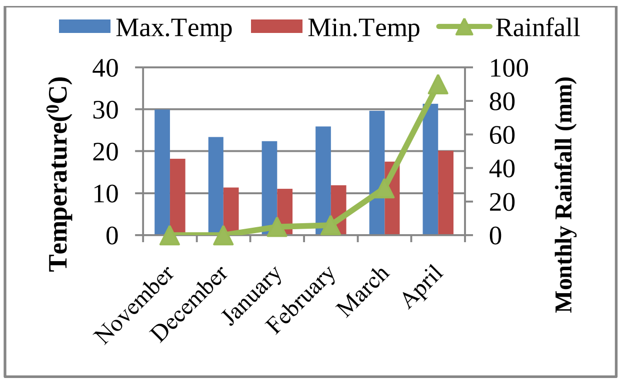

Figure 1: Monthly average maximum temperature, minimum temperature and rainfall during the cropping period from 2016-18 at ARS, BARI, Dinajpur

RESULTS AND DISCUSSION

Yield contributing characters and yield of maize:

Yield contributing characters and yield of maize were showed insignificant variation among the treatments. It was apparent that all the yield contributing characters and yields in the intercrops increased gradually with the decreased of squash population. This might be due to competition between maize and squash crop for moisture, light and nutrients. Sole crop of maize showed higher yield and yield contributing characters which might be no competition with squash. The results were in an agreement with the findings of Islam (2002) who reported that plants having more space, light and nutrients grow luxuriously to produce higher yield than respective intercropping treatments. Results showed that maize plant height was not statistically significant among the treatments (Table 2). The highest cob length (19.13 cm), cob diameter (5.43 cm), 1000-grain weight (352.89g) and grain yield (10.18 tha^{-1}) were recorded from treatment T_1 (sole maize). In intercropping system, the highest cob length (18.53 cm), cob diameter (4.78 cm), 1000-grain weight (341.45g) and grain yield (9.72 tha^{-1}) were obtained from treatment T_4 (maize paired row(37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 1m) (40%) in between maize paired row intercropping system and the lowest cob length (16.53 cm), cob diameter (4.47cm), 1000-grain weight (313.16g) and grain yield (8.50 tha^{-1}) were obtained from treatment T_5 (maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row intercropping system in both the years. This might be due to more squash population per unit area that compete resources (moisture, light and nutrients) which slightly suppressed the growth of maize and ultimately poorly reduced the maize yield. The yield reduction of maize in intercropping combinations was 4.52-16.50% as compared to sole crops. The maximum reduction (16.50%) occurred in treatment T_5 (maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row intercropping combination. This findings was supported by Rahman et al., 2015 and Khanum et al., 2019 reported that maize growth and yield components were higher in sole cropping than intercropping with short duration vegetables viz. red amaranth, radish, spinach, potato and cabbage.

Table 2: Yield contributing characters and Grain yield of maize in maize-squash intercropping system (Pooled data of 2 years)

Treatments	Plant height (cm)	Cob length (cm)	Cob diameter (cm)	1000-grain wt. (gm)	Yield (tha^{-1})
T_1	251.00	19.13	5.43	352.89	10.18
T_2	245.67	17.93	4.48	333.61	8.60
T_3	240.00	18.20	4.77	335.83	9.03
T_4	247.67	18.53	4.78	341.45	9.72
T_5	244.67	16.53	4.47	313.16	8.50
T_6	245.33	17.80	4.52	318.25	8.69
T_7	-	-	-	-	-
$LSD_{(0.05)}$	9.87	1.18	1.00	18.43	1.04
CV (%)	2.21	3.58	11.48	3.05	6.23

Table 3: Yield contributing characters and fruit yield of squash in maize-squash intercropping system (Pooled data of 2 years)

Treatments	Plant height (cm)	Fruit length (cm)	Fruit diameter (cm)	Fruits/plant (no.)	Fruit wt./plant (kg)	Yield (tha^{-1})
T_1	-	-	-	-	-	-
T_2	19.67	35.67	18.91	3.56	2.16	20.04
T_3	20.80	37.43	19.85	3.17	3.35	18.74
T_4	21.03	38.26	20.19	3.77	2.80	21.28
T_5	25.13	43.55	22.87	3.67	3.77	29.55
T_6	23.50	37.05	21.11	3.76	2.87	25.04
T_7	27.83	44.54	24.76	4.03	4.41	35.59
$LSD_{(0.05)}$	3.00	4.43	2.47	0.28	0.38	3.30
CV (%)	7.18	6.19	6.37	4.22	6.50	7.35

Yield and yield contributing characters of squash

Yield contributing characters and fruit yield of squash were significantly influenced by the intercropped of different squash population in between paired rows of maize (Table 3). The highest plant height (27.83 cm), fruit length (44.54cm), fruit diameter (24.76cm), fruits/plant (4.03), fruit weight/plant (4.41kg) were recorded in (T_7) Sole squash (1m × 80cm). In case of intercropping system, The highest plant height (27.83 cm), fruit length (43.55cm), fruit diameter (22.87cm), fruits/plant (3.67), fruit weight/plant (3.77kg) were obtained from T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) possibly due to less intercrop competition and the lowest values were obtained from T_2 (Maize normal planting (100%) + 1 row squash (Pl. to Pl. 80cm) (100%) in between two row maize) in both the years. The highest fruit yield ($35.59tha^{-1}$) was obtained from T_7 (sole squash). Significant yield differences in different intercropping combinations were due to the different plant population of squash in per unit area. Increase of squash population with maize, increased the fruit yield of squash. Among the intercropping situations, the highest fruit yield was recorded from T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) and the lowest fruit yield was recorded from T_3 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 80cm) (50%) in between maize paired row) in two consecutive years.

Maize equivalent yield (MEY)

In favor of comparative efficiency of different treatments, the produced all the component crop was converted into maize equivalent yield on the basis of existing market price. The maximum maize equivalent yield (18.35 tha^{-1}) was produced under T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) which was followed by T_6 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 80cm) (80%) in between maize paired row) (17.04 tha^{-1}). Though highest grain yield was recorded from sole maize but equivalent yield and economic return was much lower than other treatments. Similar results were observed by researchers Rahaman et al., 2015, Hossain et al., 2015 and Khanum et al., 2019. Sole crop of maize gave the lowest maize equivalent yield of 10.18 t/ha (Table 4). Maize equivalent yield from T_2, T_3, T_4, T_5, and T_6 treatments showed 50%, 50%, 58%, 80% and 67% higher yield advantage over the sole maize.

Economic performance

All the intercropping system gave the highest monetary return compared to sole stands. The highest gross return (Tk. 275250ha^{-1}), gross margin (Tk.188930 ha^{-1}) and BCR (3.19) was found in T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) followed by T_4 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 1m) (40%) in between maize paired row) (3.02). The lowest gross return (Tk. 152700 ha^{-1}), gross margin (Tk.94270 ha^{-1}) and BCR (2.61) were found in sole maize (Table 4). These results are in agreement with the findings of Rahaman et al., 2015, Hossain et al., 2015 and Khanum et al., 2019 who reported that higher gross margin or net return in intercropping system than sole crop.

Table 4: Maize equivalent yield (MEY) and economics of intercropping maize with squash

Treatments	Maize yield (tha^{-1})	Squash yield (tha^{-1})	Maize equivalent yield (tha^{-1})	Gross return ($Tk.ha^{-1}$)	Total variable cost ($Tk.ha^{-1}$)	Gross margin ($Tk.ha^{-1}$)	BCR
T_1	10.18	-	10.18	152700	58430	94270	2.61
T_2	8.60	20.04	15.27	229050	85620	143430	2.68
T_3	9.03	18.74	15.28	229150	84532	144618	2.71
T_4	9.72	21.28	16.18	252200	83525	168675	3.02
T_5	8.50	29.55	18.35	275250	86320	188930	3.19
T_6	8.69	25.04	17.04	255550	87800	167750	2.91
T_7	-	35.59	11.85	177950	76000	101950	2.34

maize= Tk. 15 kg^{-1}, squash= Tk. 5 kg^{-1}

Table 5: Land equivalent ratio(LER), System Productivity Index(SPI), Replacement Value of Intercropping (RVI) and Monetary Advantage Index (MAI) of maize with squash intercropping system (average 2 years)

Treatments	LER values			SPI	RVI	MAI ($Tk.ha^{-1}$)
	Maize	Squash	total			
T_1	1.00	-	1.00	-	1.61	-
T_2	0.84	0.56	1.40	8.30	2.42	65442
T_3	0.89	0.53	1.42	8.05	2.43	67776
T_4	0.95	0.60	1.55	8.99	2.68	89490
T_5	0.82	0.83	1.65	11.03	2.92	108431
T_6	0.85	0.70	1.55	9.78	2.71	90679
T_7	-	1.00	1.00	-	-	-

Land equivalent ratio (LER)

LER is the relative area of single crops required to produce the yield achieved in intercropping (Ahmad and Ibrar, 1996). The LER is an accurate assessment of the biological efficiency of the intercropping situation and reflected the extra advantage of intercropping system over sole cropping system. In this study the LER values in all the intercropping systems were strictly efficient having LER values more than 1.0 (Table 5) indicating the yield advantage of intercropping over sole cropping of maize. Hence, intercropping better productivity than their sole stand. The results were in agreement with the findings of Seran and Brintha (2009). Based on the average of two years and regardless of different planting combinations, the maximum LER value (1.65) was found in T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) intercropping system against the minimum for T_2 (Maize normal planting (100%) + 1 row squash (Pl. to Pl. 80cm) (100%) in between two row maize) (1.40) indicating that the yield advantages ranged between 42-66%. The LER value 1.65 indicated that by intercropping maize and squash, a farmer could produce 8.50 (av. of two years) tons of maize and 29.55 (av. of two years) tons of squash from one hectare of land instead of growing them separately in 1.65 hectares of land to obtain the same combined yield.

System productivity index (SPI)

The system productivity index (SPI) helps to standardize the yield of the secondary crop (squash) in terms of the primary crop (maize) and also identify the combinations that utilized the growth resources most effectively and maintained a stable yield performance (Tajudeen, 2010). The results showed that Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row (T_5) intercropping system gave the highest SPI value (11.03) than other intercropping systems (Table 5).

Replacement value of intercropping (RVI)

The range of RVI values were between 1.61 to 2.92. The lowest RVI value was observed from sole maize (T_1) (1.61). Whereas, highest RVI value (2.92) was observed in T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) (Table 5), which implies that this combination was more profitable than sole crop of maize and other intercropping treatments. It was found that intercropping of squash with maize was about 80% more profitable than sole maize crop.

Monetary advantage index (MAI)

The monetary advantage index (MAI) is the most important tool of recommending a cropping pattern is the cost: benefit ratio more specifically total profit, because farmers are mostly interested in the monetary value of return (Mahapatra, 2011).The yield of all the crops in different intercropping systems and also in sole cropping system and their economic return in terms of monetary value were evaluated to find out whether sole and additional component crop yield are profitable or not. The monetary advantage index (MAI) values were positive in all intercropping treatments (Table 5). The highest MAI (Tk. 108431 ha^{-1}) was obtained in T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row), which indicates this combination was highly profitable and advantageous, which is due to higher LER value. The results are in agreement with the finding of Islam et al., (2016) who reported that higher MAI values found in turmeric-sesame intercropping systems compared to sole cropping system.

Aggressivity (A)

The competitive ability of the component crops in an intercropping system is determined by its aggressivity value. Regardless of the intercropping system, there was a positive sign for maize and a negative sign for squash indicating that maize was dominant crop (+ve) while squash appeared as dominated crop (-ve). Higher aggressivity value (0.004) was calculated in T_3 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 80cm) (50%) in between maize paired row) (Table 6). Results showed positive aggressivity for T_4 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 1 row squash (Pl. to Pl. 1m) (40%) in between maize paired row) and T_5 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row) while it proved less competitive and was dominated by squash at T_6 (Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash(Pl. to Pl. 80cm) (80%) in between maize paired row). These results are in agreement with the findings of Islam et al., 2016

Competitive ratio (CR)

The competitive ratio values showed variation among the intercropping treatments indicating differential competitive ability of component crop as influenced by intercrops of squash (Table 6). Squash showed higher CR value (range: 0.65-1.58) than maize (range: 0.63-1.53) indicating squash as the best competitor than maize. Consequently, Maize normal planting (100%) + 1 row squash (Pl. to Pl. 80cm) (100%) in between two row maize (T_2) intercropping system with higher difference of CR (0.88) exhibited dissimilarities in competitiveness between the component crops. However, Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row (T_5) intercropping system with lower difference of CR (0.03) showed merely similar competitiveness between the component crops. The results expressed that similar competitiveness with minimum CR between component crops provided complementary utilization of growth resources for better performance of intercropping with higher productivity. These results are in agreement with the findings of Islam et al., 2016.

Table 6: Aggressivity index (A) and Competitive ratio (CR) of maize and squash in maize-squash intercropping system (average 2 years)

Treatments	Aggressivity index (A)		Competitive ratio (CR)		
	Maize	Squash	Maize	Squash	Differences
T_1	-	-	-	-	-
T_2	0.002	-0.002	1.53	0.65	0.88
T_3	0.004	-0.004	0.84	1.19	0.35
T_4	0.003	-0.003	0.63	1.58	0.95
T_5	0.001	-0.001	0.98	1.01	0.03
T_6	-0.003	0.003	0.97	1.03	0.06
T_7	-	-	-		-

CONCLUSION

From the experimental findings it can be concluded that the productivity of unit land area is increased by intercropping rather than monocultures. Maize intercropped with squash produced higher maize equivalent yield than maize sole crop. The competitive functions also showed that intercropping had a major advantage over sole cropping. So, for optimum and sustainable productivity and profitability of maize-squash intercrop combinations, a planting pattern comprising of Maize paired row (37.5cm/150cm/37.5cm) (100%) + 2 rows squash (Pl. to Pl. 1m) (100%) in between maize paired row (T_5) could be suitable combination to increase land use efficiency and maximum profit.

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