J. Bangladesh Agril. Univ. 5(1): 37–41, 2007 ISSN 1810-3030

Maize-pea intercropping as influenced by planting system and row arrangement

S.S. Kakon, R.R. Saha, F. Ahmed and M.A.H.S. Jahan[1]
Agronomy Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh
[1]Wheat Research Institute, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh

Abstract

An experiment on maize/pea intercropping was conducted during rabi season of 2004-05 to find out suitable planting system for higher productivity and economic return. Two and four rows of pea (BARI motorshuti-1 and IPSA motorshuti-1) were intercropped with normal and paired row maize, respectively. Planting systems and row arrangement significantly influenced pea yield in intercropping. Significantly highest maize (8.81 t/ha) and pea yields (7.57 t/ha and 4.47 t/ha) were obtained from their respective sole crops. BARI motorshuti-1 gave higher yield than IPSA motorshuti-1 both in sole and intercrop treatments. Although intercropping reduced maize yields by 20 to 30 % in different treatments but with the addition of pea yields intercropping increased total productivity, which is expressed through higher maize equivalent yield (MEY) and land equivalent ratio (LER). The highest MEY (12.74 t/ha) was obtained when 4 rows of BARI motorshuti-1 was intercropped with paired row maize. This treatment also gave highest LER (1.20), gross return (Tk. 106375/ha), net return (Tk. 79365/ha), and benefit cost ratio (3.85).

Keywords: Intercropping, Planting systems, Maize, Pea and Yield

Introduction

Intercropping is an important production system in the tropical and subtropical regions (Myaka, 1995). Intercropping is a traditional practice in Bangladesh. Cereal/legume intercropping is extensively practiced for its many advantages such as higher productivity (Subasinghe and Senarantne, 2002), greater land use efficiency (Saha *et al.*, 2001); labour and resources (Evans, 1980). Maize is a tall stature cereal crop, which is used as food, feed and fodder. Maize is grown in line with wide space and the inter row space can be used for growing another short duration crop. Among the different short duration crops, pea is one of them. Its green pod has high demand as vegetable in the urban area. Pea contains all the essential amino acids, which are needed for our health. Combination of pea and maize in intercropping system therefore may increase total productivity and improve human nutrition as well. Therefore, the present experiment was undertaken to find out the suitable intercrop combination of maize with pea for higher yield and better economic return.

Materials and Methods

The experiment was conducted at the Central Research Station of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during rabi season of 2004-2005. The soil was silty clay loam with a pH of 6.1 under Chhiata series of Agro-Ecological Zone-28. The soil is low in organic matter (1.2%) and deficient in total nitrogen (0.07%), available phosphorus (13 ppm), exchangeable potassium ((0.15 meq 100^{-1}g soil) and available sulphur (12 ppm). Total amount of rainfall during cropping periods was 195.6 mm. Monthly mean maximum and minimum temperature was 28.8 °C and 17.24 °C, respectively.

Seven treatments were tested in a randomized complete block design with three replications. The treatments were: T_1 = Sole Maize (75 cm x 25 cm), T_2 = Sole BARI motorshuti-1 (30 cm x 10 cm), T_3 = Sole IPSA motorshuti-1 (30 cm x 10 cm), T_4 = Maize normal row (MNR) + 2 rows of BARI motorshuti-1, T_5 = Maize normal row (MNR) + 2 rows of IPSA motorshuti-1, T_6 = Maize paired row (MPR) + 4 rows of BARI motorshuti-1 and T_7 = Maize paired row (MPR) + 4 rows of IPSA motorshuti-1. The unit plot size was 4.5 m x 4.5 m. Maize (cv. Pacific 984) and Pea (cv. BARI motorshuti-1 and IPSA motorshuti-1) seeds were sown on 25 November 2004. Fertilizers were applied at the rate of N_{250}-P_{55}- K_{110}-S_{55} kg/ha for maize and N_{20}, P_{40} K_{20} and S_{10} kg/ha for sole pea in the form of urea, triple superphosphate (TSP), muriate of potash (MOP) and gypsum. One third of N, full amount of TSP, MOP, and gypsum were applied as basal in all the plots except pea sole plot. All fertilizers were applied as basal for sole pea. Two-split application of urea was done at 35 and 65 days after sowing (DAS) in maize plots (sole and intercrop). Cowdung (5 t/ha) were applied as basal in all the plots. In normal row maize, inter row spacing was 75 cm while in paired row maize, inter row distance was 37.5 cm within pair and distance from one pair to another was 150 cm. In both cases, plant-to-plant distance was 25 cm. Pea spacing was 30 cm x 10 cm both in sole and intercropping. A light irrigation was given to the field for uniform emergence just after sowing. Subsequently, three more irrigations were provided to the crop at 35, 65 and 90 DAS. Edible green pods of IPSA motorshuti-1 were harvested at 50 and 65 DAS; and BARI motorshuti-1 at 75 and 90 DAS. Maize was harvested as whole plot basis at 155 DAS. At harvest, 10 randomly selected plants were uprooted for yield components. The collected data were analyzed statistically and the means were adjudged by DMRT at 5% level of significance. Land equivalent ratio (LER) was computed according to Shaner *et al.* (1982). Yield of individual crop was converted into maize equivalent yield (MEY) on the basis of the market price of individual crop.

$$\text{LER} = \frac{\text{Intercropped yield of maize}}{\text{Sole crop yield of maize}} + \frac{\text{Intercropped yield of pea}}{\text{Sole crop yield of pea}}$$

$$\text{MEY} = \text{Yield of intercrop maize} + \frac{\text{Yield of intercrop pea x Selling price of pea}}{\text{Selling price of maize}}$$

Results and Discussion

Yield and yield components of maize

Yield and yield components of maize were significantly influenced by intercropping except plant height and 1000-grain weight (Table1). Plant height range from 211 to 214 cm in different treatments. Significantly highest number of grains per cob (594 grains/cob) was recorded in sole maize while the lowest (556 grains/cob) in T_4 treatment. Among the intercrop treatments, significantly higher number of grains per cob (578 grains/cob) was observed in T_6 treatment. Although comparatively higher weight of 1000-grain (386.30g) was observed in sole maize but that was statistically identical to all other treatments. Haque (1995) also reported higher grain weight in sole maize when sweet potato was intercropped with maize. The highest grain yield (8.81 t/ha) was obtained from sole maize due to higher number of grains/cob and 1000-grain weight, which was significantly higher than other treatments. Among the intercrop treatments, the highest grain yield (6.99 t/ha) was recorded in T_6 treatment that was significantly higher than other treatments. The lowest yield of maize (6.22 t/ha) was obtained from maize normal row + 2 rows of IPSA motorshuti-1 (T_5) followed by T_4 and T_7. Francis *et al.* (1982) also reported similar results in maize-bush bean intercropping systems. The yield of maize in intercropping situation was reduced by 20 to 30% at various treatments. Stover yield followed almost similar trend where sole maize produced significantly highest stover yield (10.04 t/ha) followed by T_6, T_7 and T_4 treatments.

Table 1. Yield and yield components of maize in maize/pea intercropping system

Treatments	Plant height (cm)	Number of grains/ cob	1000-grain weight (g)	Grain yield (t/ha)	Stover yield (t/ha)
Sole Maize (T_1)	212.87	594 a	386.30	8.81a	10.04 a
Sole BARI motorshuti -1 (T_2)	-	-	-	-	-
Sole IPSA motorshuti -1 (T_3)	-	-	-	-	-
MNR + 2 rows BARI motorshuti -1 (T_4)	214.13	568 c	342.53	6.51c	8.52b
MNR + 2 row of IPSA motorshuti-1(T_5)	213.10	556 d	357.73	6.22c	7.9c
MPR+ 4 rows BARI motorshuti-1(T_6)	213.00	578 b	380.60	6.99b	8.75b
MPR+ 4 rows IPSA motorshuti-1(T_7)	211.80	559 cd	340.95	6.67c	8.63b
Level of significance	NS	*	NS	*	*
CV (%)	3.06	5.47	8.73	8.56	7.17

MNR and MPR indicate maize normal row and maize paired row, respectively. In a column means followed by common letter(s) are not significantly different at 5% level by DMRT
*indicates significant at 5% level

Yield and yield components of pea

Different treatment combinations had a significant effect on the plant height, pod length, number of pods/plant, 100 pods weight and green pod yield except number of seeds/pod (Table 2). Plant height of BARI motorshuti-1 was significantly higher than IPSA motorshuti-1. Among the treatment combinations, significantly tallest pea plant (71.23cm) was obtained from maize paired row + 4 rows of BARI motorshuti-1 and the shortest (32.07 cm) from sole IPSA motorshuti-1. Pod length of pea significantly varied between two varieties. The maximum pod length (7.40cm) was recorded from sole BARI motorshuti-1 (T_2), which was identical to that of T_6 and T_4.The minimum pod length (5.57 cm) recorded from sole IPSA motorshuti-1 (T_3), which was similar to that of T_5 and T_7. Number of pods per plant is an important attribute to yield formation of grain legumes. Significantly more number of pods/plant (17) was recorded from T_2 treatment followed by T_6 treatment (15). Number of seeds per pod of grain legumes is assumed as genetically controlled trait. Comparatively higher number of seeds /pod (7) was observed in sole BARI- motorshuti-1 that was identical to all other treatments. Hundred pod weights indicated the green pod size. Green pod size was significantly affected by planting system. Highest weight of 100-pods (375g) was obtained from T_2 (sole BARI motorshuti-1), which was identical to T_6 treatment but significantly higher than all other treatments. The lowest 100-pods weight was recorded in T_7 treatment, which was statistically similar to T_5 treatment. BARI motorshuti-1 gave higher yield than IPSA motorshuti-1 both in sole and intercropping. Significantly highest green pod yield (7.57 t/ha) was obtained from the sole BARI motorshuti-1 due to higher number of pods/plant, number of seeds/pod and 100-pods weight, which was significantly higher than other treatments. The lowest green pod yield (2.01t/ha) was recorded in maize paired row + 4 rows of IPSA motorshuti-1 (T_7). Among the intercrop combination maize paired row + 4 rows of BARI motorshuti-1 produced the highest green pod yield (3.07 t/ha) and the lowest in T_7 treatment (2.01 t/ha).

Table 2. Yield and yield component of BARI motorshuti -1 and IPSA motorshuti-1 in intercropping with maize

Treatments	Plant height. (cm)	Pod length (cm)	No. of Pods/plant (no.)	No. of Seeds/ pod	100 pods wt. (g)	Green pod yield (t/ha)
Sole Maize (T_1)	-	-	-	-	-	-
Sole BARI motorshuti -1(T_2)	62.03a	7.4a	17a	7.00	375a	7.57 a
Sole IPSA motorshuti -1 (T_3)	32.07 c	5.57b	11b	5.00	338bc	4.47 b
MNR + 2 rows BARI motorshuti -1(T_4)	71.13 a	7.00a	15a	6.00	358b	2.89 d
MNR + 2 row of IPSA motorshuti-1 (T_5)	32.53 c	5.88b	11b	5.00	325cd	2.17 e
MPR+ 4 rows BARI motorshuti-1 (T_6)	71.23 a	7.34a	15a	6.00	369ab	3.07 c
MPR+ 4 rows IPSA motorshuti-1(T_7)	32.87 c	5.65b	11b	4.00	323d	2.01 f
Level of significance	*	*	*	NS	*	*
CV (%)	10.26	9.11	13.02	13.26	5.44	13.37

MNR and MPR indicate maize normal row and paired row, respectively. In a column means followed by common letter(s) are not significantly different at 5% level by DMRT
*indicates significant at 5% level

Evaluation of intercrop productivity

The performance of maize + pea intercropping system was evaluated on the basis of equivalent yield (Bandyopadhyay, 1984). All the intercropped combinations showed the higher maize equivalent yield over sole crop (Table 3). Among the intercrops, the maize equivalent yield varied from 4.47 to 12.74t/ha. The highest maize equivalent yield (12.74t/ha) was obtained from maize paired row + 4 rows of BARI motorshuti-1. The LER (land equivalent ratio) is the total land required by the sole crop to produce as much yield as can be obtained from intercropping systems. All the intercrop combinations showed higher LER than sole treatment (Table 3). The highest LER (1.20) was obtained from maize paired row + 4 rows of BARI motorshuti-1. The LER value of 1.20 indicates that by intercropping maize with pea, the productivity of maize could be increased up to 20% over the sole maize. It also indicates that by intercropping maize with pea, a farmer could produce 6.99 t/ha maize and 3.07 t/ha pea from one hectare of land instead of growing them separately in 1.20 hectare of land to obtained the same yield.

Table 3. Equivalent yield, LER values and economic analysis of maize pea intercropping

Treatments	Yield (t/ha)		LER	MEY (t/ha)	Gross return (Tk/ha)	Total cost (Tk./ha)	Net return (Tk/ha)	BCR
	Maize	Pea						
Sole Maize (T_1)	8.81a	-	1.00	8.81	75495	24900	50595	3.03
Sole BARI motorshuti -1(T_2)	-	7.57a	1.00	7.57	60560	16760	43800	3.61
Sole IPSA motorshuti -1 (T_3)	-	4.47b	1.00	4.47	35760	16760	19000	2.13
MNR + 2 rows BARI motorshuti -1(T_4)	6.51 d	2.89d	1.12	11.52	96415	26230	70185	3.67
MNR + 2 row of IPSA motorshuti-1(T_5)	6.22 e	2.17e	1.18	10.28	86190	26230	59960	3.28
MPR+ 4 rows BARI motorshuti-1(T_6)	6.99 b	3.07c	1.20	12.74	106375	27575	79365	3.85
MPR+ 4 rows IPSA motorshuti-1(T_7)	6.67 c	2.01f	1.19	10.43	87755	27575	61745	3.18

MNR and MPR indicate maize normal row and paired row, respectively. Price: Maize: TK 8/kg, Pea: TK 15/kg, Maize stover : TK 0.5/kg

Economic evaluation

Economic analysis is an important consideration in evaluating the economic feasibility of intercropping systems for subsistence farming. Among the intercropped combinations, maize paired row + 4 rows of BARI motorshuti-1 produced higher gross return (Tk. 106375/ha) than sole maize or sole pea (Table 3). Similar economic advantages of intercropping have been reported by Myaka (1995) in maize with cowpea and Shivay *et al.* (1999) in maize based intercropping. The highest benefit cost ratio (3.85) was obtained when 4 rows of BARI-motorshuti-1 was intercropped with paired row maize followed by T4 treatment (3.67).

Conclusion

Results revealed that pea grown as intercrop with maize is more profitable than sole maize. The result also suggests that 4 rows of BARI motorshuti-1 intercropped with paired row maize is the most suitable intercrop combination for higher economic benefit.

References

Bandyopadahyay S.N. 1984. Nitrogen and water relations in grain sorghum - legume intercropping system. Ph.D. Dissertation. Indian Agril. Res. Ins. New Delhi.

Evans A.C. 1980. Studies of intercropping of maize or soybean with groundnut. E. Agr. Agric. J. 26: 1-10.

Francis C.A., Prager M. and Tejada G. 1982. Effects of relative planting dates in bean (*Phaseolus vulgaris* L.) and maize (*Zea mays* L.) intercropping patterns. Field Crops Res. 5 : 45 - 54

Haque M.M. 1995. Productivity of maize / sweet potato intercropping in relation to planting system. Population density and application of nitrogen and potassium fertilizers. Ph. D Dissertation. Institute of post graduates studies in Agriculture, Salna, Gazipur - 1703.

Myaka F.A. 1995. Effect of time of planting and planting pattern of different cowpea cultivars on yield of intercropped cowpea and maize in tropical and subhumid environment. Trop. Sci. 35 : 274-279.

Saha R.R., Rahaman M.S. and Golder P.C. 2001. Maize legume intercropping and effect of detoppring of maize after silking. Bangladesh J. Agril Res. 26: 445-451.

Shaner W.W., Philipp P.F and Schemehl W.B. 1982. The equivalent ratio. Farming systems research and development. West View Press. USA. pp. 323-324.

Shivay Y.S., Singh R.P. and Panday C.S. 1999. Response of nitrogen in maize (*Zea mays*)-based intercropping. Indian J. Agron. 44: 261-266.

Subasinghe S. and Senaratne R. 2002. Effect of groundnut genotypes on interactions in maize + groundnut intercropping system. Bangladesh J. Agril. Res. 27 : 25-33.