PERFORMANCE OF BROADCAST AUS RICE+ MAIZE INTERCROPPING AS AFFECTED BY MAIZE POPULATION AND NITROGEN LEVEL

[1]J.C. MALAKER, [2]K.U. AHAMMAD, [3]N.Y. SHAIKH, [4]S. K. MALAKAR AND [5]M.A. SIDDIKY

[1]AAO, DAE, Khamarbari, Dhaka, [2]SSO, OFRD, BARI, RARS, Jessore, [3]SSO, ORC, BARI, Gazipur, [4]AFO, CARITAS, Jhenaigati, Sherpur and [5]SO, BARI, Gazipur, Bangladesh.

Accepted for publication: November 18, 2008

ABSTRACT

Malaker J.C., Ahammad K.U., Shaikh N.Y., Malakar S. K.and Siddiky M.A. 2009. *Performance of Broadcast Aus Rice+ Maize Intercropping as Affected by Maize Population and Nitrogen Level***. Int. J. Sustain. Crop Prod. 4(1):19-22**

An intercropping experiment involving maize and rice was conducted at On-Farm Research Division, Bangladesh Agricultural Research Institute, Mymensingh during kharif season of 2004 to determine effect of maize as base crop on the productivity and returns from maize-rice intercropping compared with maize and rice grown as monocultures. Broadcast aus rice + maize intercropping at 100 cm×25 cm and 150 cm×25 cm spacing of maize and 0, 4, 80 and 120 kg/ha of N were applied in the study field. The dry matter and grain yield of both intercropped rice and maize increased significantly with increase in N level but maize responded more applied N than rice. Increase in maize spacing reduced the dry matter and grain yield of maize but increased those rice. N uptake in both rice and maize increased significantly with each increment in N application. Wider spacing of maize increased the N uptake of rice with corresponding decrease in the N uptake of maize. The highest land equivalent ratio (1.62), rice equivalent yield (5.31 t/ha) and return above variable cost (Tk 26,840/ha) were obtained at 120 kg N/ha and 100 cm×25 cm spacing which higher than the return (Tk 25,375/ha) and rice equivalent yield of sole maize (4.94 t/ha). Intercropping produced higher return above variable cost than sole rice (Tk 7,523/ha) regardless of spacing and N level.

Keywords: Intercropping culture, nitrogen effect, economic performance

INTRODUCTION

Intercropping is a type of multiple cropping commonly practiced in most of the tropical countries. The frequently cited advantages of intercropping include higher productivity of land, better use of environmental resources, diversity of products, efficiency and spread of labor use, and minimization of risks of crop failure under unfavorable climate conditions. The diversity in the existing inter and mixed cropping practice in the tropics has been documented by Gomez and Gomez (1983).

Broadcast aus (B. aus) rice occupies about 1.9 million hectares in Bangladesh but the yield of this crop is very low, the average was only 1.174 t/ha in 2003-2004 (BBS, 2004).This low yield is attributable to frequent moisture stress caused by uncertain and uneven distribution of rainfall in the growing season, high infestation of weeds and use of local varieties which are less responsive to fertilizer application. Consequently, the production of this crop is not profitable. Attempts have been made to increase the profitability of B.aus rice by intercropping with maize (Shams and Quddus, 1990). Maize has been used for intercropping with a number of crops around the world (Chui and Madar, 1984). Results of maize+ B.aus rice intercropping studies in Bangladesh showed that the highest land equivalent ratio (LER) and gross return were obtained when maize was grown at 1.5 – 2.5 m row spacing with 25cm spacing between plants (Satter, 1991).

Maize is a versatile crop with wide range of adaptability. However, information on N requirement and maize population of B. aus rice + maize intercropping is not available. It is therefore, important that the utilization efficiency of applied N at different population levels be studied for this potential intercropping system. The present study was undertaken to examine the effect of nitrogen level and maize population on the performance of broadcast aus rice+maize intercropping.

MATERIAL AND METHODS

The experiment was conducted during the kharif season of 2004 in a randomized block design with 4 replications at OFRD, BARI, Mymensingh in a rainfed upland. The soil was alluvial (Aeric Haplaquept) with a silt loam texture having pH 6.3, total-N 0.9 g/kg, available P 8 kg/ha and available K 125 kg/ha. The plot size was 6.0m x 5-4.5 m. 'Hashikalmi' rice (*Oryza sativa* L.) and Barnali BARI maize were used as crop. Two spacing of maize i.e. 100cm× 25cm (40,000 plants/ha) and 150cm× 25cm (26,666 plants/ha) and four levels of nitrogen (o, 40, 80 and120kg/ha) were used in intercropping. Sole maize was grown at 75cm× 25cm spacing (53,333 plants/ha) and sole rice was broadcast. The treatment combinations were a) Intercrop: T_1 = Rice + maize at 100cm× 25cm spacing and o kg N/ha, T_2 = Rice + maize at 100cm× 25cm spacing and 40 kg N/ha, T_3 = Rice + maize at 100cm× 25cm spacing and 80 kg N/ha, T_4= Rice + maize at 100cm× 25cm spacing and 120 kg N/ha, T_5 = Rice + maize at 150cm× 25cm spacing and o kg N/ha, T_6 = Rice + maize at 150cm× 25cm spacing and 40 kg N/ha, T_7 = Rice + maize at 150cm× 25cm spacing and 80 kg N/ha, T_8 = Rice + maize at 150cm× 25cm spacing and 120 kg N/ha and b) Sole crop: T_9= Rice (broadcast at 100 kg/ha with 60-60-40 kg N, P_2O_5 and K_2O/ha, respectively), T_{10}=Maize (75cm× 25cm spacing and 120-60-40 kg N, P_2O_5 and K_2O/ha, respectively). A uniform seed rate of 100 kg/ha of B. aus rice was used in the both sole crop and intercrop. The seed rate of sole maize was 30 kg/ha and spacing of maize 100 cm x 25 cm (40,000 plants/ha) and sole rice was broadcast. In the intercropping plots nitrogen was applied from urea as required by the treatments. P and K fertilizers were applied at the rate of 60 P_2O_5 and 40 K_2O/ha from triple super phosphate (TSP) and muriate of potash (MP), respectively.

Sole maize was grown at 120-60-40 kg N, P_2O_5 and K_2O/ha and sole rice at 60-60-40 kg N, P_2O_5 and K_2O/ha, respectively. A blanket application of 60 kg P_2O_5 and 40 K_2O/ha was made before final land preparation. One-third of the N as indicated above was applied as basal dose. The rest of the N was applied in two equal splits 28 and 42 days after sowing (DAS). The top-dressing of N was made along the maize rows and mulching was done after each top-dressing. Both maize and rice matured 97 days after sowing. Both the crops were harvested on the same day. Using the estimates of N content and dry matter yield, nitrogen uptake was determined. LER values were computed from the grain yield data of the crops according to Shaner *et al* (1982) and Rice equivalent yield (REY) was determined according to Anjeneyula *et al*. (1982). Partial budgeting was done following Perrin *et al*. (1976) to determine the profitability of treatments. Analysis of variances of the data and mean separation were done following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Dry matter yield (DMY) of B. aus rice and maize at maturity was affected significantly by the level of N application (Table 1). There was also significant interaction between spacing and nitrogen in determining the DMY of intercropped maize. The highest DMY at maturity was obtained at 120 kg N/ha which were 3.38 and 3.42 t/ha with 100 cm x 25 cm and 150 cm x 25 cm spacing of maize, respectively. At wider spacing (150 cm x 25 cm) DMY of intercropped maize decreased regardless of N level compared to the closer spacing. The decrease in DMY of maize with wider spacing was due to decrease in plant population; the plant population of maize was 10,000 and 26,666 plants/ha with 100 cm x 25 cm and 150 cm x 25 cm, respectively. The highest DMY of maize at maturity was 7.23 and 5.11 t/ha at 100 cm x 25 cm and 150 cm x 25 cm, respectively. Intercropping significantly reduced the DMY of both rice and maize compared to their sole crops at maturity stages (Table 1). At maturity, the reduction in DMY of intercropped rice ranged from 18-34% compared to sole rice. In maize, the reduction in DMY due to intercropping was higher than in rice. The reductions in maize ranged from 10-66%. The large reduction in DMY of intercropped maize compared to sole maize can be attributed to both the density of population and the level of N application. The highest reduction (66%) was observed at 0 kg N/ha. Similar reduction in DMY of maize due to intercropping was reported by Chowdhury and Rosario (1992).

The grain yield of rice was significantly affected by the level of N but maize yield was affected by both spacing and N level with significant interactions (Table 1). Yield of rice increased gradually with each increment in N from 0.95 t/ha and 0.97 t/ha to 1.27 t/ha and 1.30/ha at 100 cm x 25 cm and 125 cm x 25 cm spacing, respectively. The increase was 34%. Sole rice yielded 1.62 t/ha which was significantly higher than that of intercropped rice. The decrease in grain yield due to intercropping ranged from 20-41% compared to sole rice. Satter (1991) reported 18% reduction in the grain yield of B. aus rice when intercropped with maize at 2.5 m row spacing.

Yield of maize showed more pronounced effects of N compared to rice. With 100 cm x 25 cm spacing maize yield increased from 1.12 t/ha to 3.70 t/ha, and with 150 cm x 25 cm spacing from 0.98 t/ha to 2.81 t/ha as the level of N was increased from 0 to 120 kg/ha. The yield of sole maize was 4.53 t/ha. Intercropping had more depressing effect on the yield of maize than that of rice. Maize yield decreased by 18-78% in intercropping compared to sole maize. This reduction in maize yield in intercropping is higher than what is usually reported (Chowdhury and Rosario, 1992). The high reduction in the yield of maize can be explained by the lower plant population of maize in intercropping (75% and 50% of sole maize at 100 cm x 25 cm and 150 cm x 25 cm spacing, respectively), and low level of nitrogen applied in some treatments. Shams and Quddus (1990) reported 32 and 38% reduction in the yield of intercropped maize at 1.5 and 2.0 m row spacing compared to sole maize.

Nitrogen had significant effect on the N uptake of rice but the N uptake of maize was affected significantly by both spacing and N level (Table 1). There were significant increases in N uptake with increase in the N level. Rice showed slightly higher N uptake when the spacing of maize was increased. Sole rice had significantly higher N uptake than intercropped rice. The N uptake o f intercropped maize increased significantly with the increase in N level.

While the reduction in DMY at maturity due to intercropping ranged from 18-34% in rice and 10-66% in maize, the corresponding reductions in N uptake due to intercropping ranged from 17-40% and 20-75% in rice and maize, respectively. Thus intercropping had more depressing effects on N uptake than on DMY in both rice and maize. Chowdhury and Rosario (1992) reported 5-37% reduction in N uptake of maize due to intercropping when population was maintained at the same level. The high reduction in N uptake in this study was due to lower maize population in intercropping compared to sole crop. At higher level of N (80 and 120 Kg N/ha) the total N uptake in intercropped plots was higher than either of the sole crops. Similar results have been reported by Chowdhury and Rosario (1992).

Intercropping efficiency was measured in terms of land equivalent ratio (LER). Commonly LER is calculated based on grain yield (Table 1). The LER was significantly different in intercropping compared to unity (LER of sole crop). The highest LER of 1.62 was obtained at 120 kg N/ha and 100 cm x 25 cm spacing of maize followed by 80 kg N/ha (1.45) at the same spacing. However, without nitrogen LER was below unity. This is because the yield of both rice and maize decreased significantly at 0 kg N/ha compared to their sole crops.

Table1. Dry matter yield, Grain yield, N uptake and Land equivalent ratio in the intercropping system of B.aus rice and maize as affected by spacing of maize and level of nitrogen

Treatment		Rice			Maize			Land equivalent ratio (LER)
Spacing (cm^2)	N level (kg/ha)	DMY at maturity (t/ha)	Grain yield (t/ha)	N uptake at maturity	DMY at maturity (t/ha)	Grain yield (t/ha)	N uptake at maturity	
100 × 25	0	2.75d	0.95d	37.66e	2.71f	1.12e	20.12e	0.84e
100 × 25	40	3.04c	1.11cd	44.58cd	4.22e	2.09d	34.29d	1.16c
100 × 25	80	3.24bc	1.21b	45.32cd	5.76c	3.13c	47.15c	1.45b
100 × 25	120	3.38b	1.27b	48.78bc	7.23b	3.70b	60.73b	1.62a
150 × 25	0	2.80d	0.97cd	39.36de	2.38r	0.98e	19.32e	0.82e
150 × 25	40	3.26bc	1.16bc	49.07bc	2.98r	1.31e	24.70e	1.01d
150 × 25	80	3.35b	1.25b	48.85bc	3.89e	2.10d	31.82d	1.25c
150 × 25	120	3.42b	1.30b	51.66b	5.11d	2.81c	42.80c	1.44b
Sole rice	-	4.16a	1.62a	62.59a	-	-	-	-
Sole maize	-	-	-	-	8.07a	4.53	76.13a	-
SE(±)	-	0.11	0.09	2.78	0.28	0.22	2.62	0.07
CV (%)	-	4.84	10.87	8.26	8.46	12.73	9.35	8.28

Figure in a column followed by same or no letter(s) do not differ significantly at 5% level of probability following Duncan's Multiple Range Test (DMRT)

The economic performance was measured in terms of rice equivalent yield and by partial budget analysis. From Table 2 it was found that B. aus rice + maize at 100 cm x 25 cm spacing and 120 kg N/ ha had the highest rice equivalent yield (5.31 t/ha) followed by 80 kg N/ha at the same spacing (4.62 t/ha). The same treatments also produced the highest and the second highest LER (Table 2). The economic performance in teams of return above variable cost (RAVC) was also highest at 120 kg N/ ha with 100 cm x 25 cm spacing. The highest RAVC was Tk 26,840 / ha. The RAVC in sole rice and sole maize was Tk 7,523/ha and Tk 25,375/ha, respectively. Although it has frequently been reported by Chowdhury and Rosario, (1992) that nitrogen use, yield advantage and profitability of maize + legume intercropping were higher at low levels of nitrogen, in the present study on rice + maize intercropping higher LER, total N uptake (LER based on N uptake) and return above variable cost obtained at higher levels of nitrogen. This may be because both the crops were cereals and responded to N application. When both components respond to a particular nutrient, the intercrop system requirement may be higher than the sole crop needs; higher nitrogen requirement in cereal + cereal intercropes has been reported by Kassam and Stockinger (1973).

Since the yield and profitability of broadcast aus rice are low, rice+ maize intercropping at 80 to 120 kg N/ha with 100 cm x 25 cm or 150 cm x 25 cm spacing may be recommended for the B. aus rice growing areas of Bangladesh.

Table 2. Economic performance of B.aus rice +maize intercropping as influenced by spacing of maize and level of nitrogen

Treatment		Grain yield (t/ha)		Rice equivalent yield (t/ha)	Gross return (Tk/ha)	Total variable cost(Tk/ha)	RAVC (Tk/ha)
Spacing (cm^2)	N level (kg/ha)	Rice	Maize				
100 × 25	0	0.95	1.12	2.17	11945	780	11165
100 × 25	40	1.11	2.09	3.39	18645	1302	17343
100 × 25	80	1.21	3.13	4.62	25436	1823	23612
100 × 25	120	1.27	3.70	5.31	29185	2345	26840
150 × 25	0	0.97	0.98	2.04	11215	720	10495
150 × 25	40	1.16	1.31	2.59	14240	1242	12998
150 × 25	80	1.25	2.10	3.54	19475	1763	17712
150 × 25	120	1.30	2.81	4.37	24010	2245	21725
Sole rice	-	1.62	-	1.62	8910	1386	7523
Sole maize	-	-	4.53	4.94	27180	1805	25375

RAVC= Return above variable cost, Total variable cost includes the cost of nitrogen and seeds

Price: Rice = Tk 5.50/kg, Seed: Rice = Tk 6.00/kg, Maize =Tk 6.00/kg
Maize =Tk 8.00/kg, Nitrogen = Tk 13.04/kg

REFERENCES

Anjeneyula, V.R., S.P. Singh and M. Ali. 1982. Effect of competition free period and technique and pattern of pearl millet planting in growth and yield of mungbean and total productivity in solid pearl millet and pearl millet/mungbean intercropping systems. Indian J. Agron. 27(3): 219-226

BBS (Bangladesh Burea of Statistics). 2004. Yearbook of Agricultural Statistics of Bangladesh. Ministry of Planning. Dhaka. pp.26-29

Chowdhury, M. K, and E. L. Rosario, 1992. Nitrogen utilization efficiency of applied nitrogen as affected by component populations in maize-mungbean intercropping. Trop. Agric. (Trinidad).70(3):199-204.

Chui, J.N. and H. M. Madar. 1984. Effect of spatial arrangement on the yield and other agronomic characters of maize and legume intercrops. East African Agric. and Forestry J. 44:137-148.

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. 2nd ed. An International Rice Research Institute Book, John willey & Sons. Singapore.

Hasem, A. and A.F.M. Moniruzaman. 1986. Effect of intercropping maize with cowpea at varing plant population levels. Bangladesh Agron. J. 1(1): 25-39.

Kassam, A.H. and K.R. Stockinger. 1973. Growth and nitrogen uptake of sorgum and millet in mixed cropping. Samaru Agric. Newslett. 15: 28-33

Perrin, R.K., D.L. Winkelwann, E.R. Moscardi and J.R. Anderson. 1976. From Agronomic data to farmer recommendations. An economics training manual, CIMMYT, Mexico.

Satter , M.A. 1991. Effect of intercropping maize at different row spacing with B. aus rice under rainfed condition. *In* Research Report 1990-91. On-Farm Research Division, BARI, Jessore, pp. 55-63(Mimeo).

Shams, N.I. and M.A. Quddus. 1990. Effect of intercropping maize at different row spacing with B.aus rice under rainfed condition. *In* Research Report 1989-90. On-Farm Research Division, BARI, Joydebpur. pp. 11-18(Mimeo).

Shaner, W.W., P.F. Philipp and W.B. Schmehl. 1982. The equivalent ratio. Farming System Research Research and Development. Pp. 323-324. Westview Press. U.S.A.