OnLine Journal of Biological Sciences 1 (9): 812-814, 2001

Fertilizer Management in Hybrid Maize with Soybean Intercropping System under Irrigated Condition

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Abstract: A field experiment was conducted to find out a suitable dose of fertilizer for hybrid maize (var. Pacific 11) intercropping with soybean (var. Sohag), two planting system and four fertilizer levels were used as treatment variables. Highest grain yield of maize was obtained from the highest dose of fertilizer. But soybean yield was the highest in lower doses of fertilizer at Jessore and Hathazari but at Joydebpur 250-120-120-40-5 N, P_2O_5, K_2O, S, Zn Kg ha^{-1}. Yield attributes increased with the increase of fertilizer in case of maize but reverse in soybean. From economic point of view, the highest benefit cost ratio was obtained from the fertilizer dose 250- 120- 120- 40- 5 of N, P_2O_5, K_2O, S, Zn Kg ha^{-1} in both normal and paired row systems at Joydebpur of Bangladesh. But at Jessore and Hathazari fertilizer dose 200-80-80- 20- 5 of N, P_2O_5, K_2O, S, Zn Kg ha^{-1} was found profitable.

Key words : Fertilizer management, planting system, maize + soybean intercropping

Introduction

Maize being an exhaustive crop requires high quantity of fertilizer, particularly nitrogenous, which is one of the problems for marginal farmers of Bangladesh. Nair *et al.* (1979) and Singh *et al.* (1986) reported from India the role of legumes in replacing nitrogen fertilizer and increasing the yield of associated crop. Intercropping system with maize was found suitable under different combinations but the nutrient requirement information about intercropping system is very scanty. The recommended doses of fertilizers for respective sole crop (Sarker *et al.*, 1998) were applied for intercropping. But its success depends on the proper nutrient management. Maize hybrid cultivation require high fertilizer dose but in intercropping situation with soybean, it is possible to reduce the amount of fertilizer requirement has yet to be ascertained. The research work was conducted to determine the optimum fertilizer dose for hybrid maize soybean intercrop system having minimum crop competition.

Materials and Methods

The experiment was conducted at Central Research Farm, Bangladesh Agricultural Research Institute, Joydebpur and Regional Agricultural Research Station, Jessore during the rabi season of 1997-98 and 1998-99 but at Regional Agricultural Research Station, Hathazari in 1998-99 in Bangladesh. Eight treatment combinations were evaluated such as:

T_1 = Maize normal row + 2 rows soybean with 300-150-150-60-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_2 = Maize normal row + 2 rows soybean with 250-120-120-40-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_3 = Maize normal row + 2 rows soybean with 200-80-80-20-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_4 = Maize normal row + 2 rows soybean with 150-60-60-10-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_5 = Maize paired row + 4 rows soybean with 300-150-150-60-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_6 = Maize paired row + 4 rows soybean with 250-120-120-40-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_7 = Maize paired row + 4 rows soybean with 200-80-80-20-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}
T_8 = Maize paired row + 4 rows soybean with 150-60-60-10-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1}

The hybrid maize (var. Pacific 11) and soybean (var. Sohag) were used in this experiment. The unit plot size was 4.5 x 5 m^2. Seeds were sown on 9th December, 1997 and 9th December, 1998 at BARI, Joydebpur, 1st December, 1997 and 8th December, 1998 at RARS, Jessore and 20th December, 1998 at RARS, Hathazari. Maize in normal row was planted at 75 x 25 cm^2 spacing and paired row system was 37.5 /150 / 37.5 cm and soybean was planted 2 or 4 rows between maize rows at 30 cm row spacing. The whole amount of P_2O_5 K_2O, S, Zn and 1/3 N were applied as basal in the form of triple super phosphate, muriate of potash, gypsum, zinc sulphate and urea, respectively. The rest of N was top-dressed in two equal splits at 35 and 65 DAE (days after emergence) as side dressed to maize rows. The irrigations were applied at 30, 50 and 70 DAE. Soybean was sprayed four times with Dimecron 100 WSC to control leaf roller (Anonymous, 1998). Soybean was harvested at 100 DAE and maize was harvested at 140 DAE. Data on yield and yield components were recorded. The recorded data were analyzed statistically by Randomized Complete Block Design (RCBD) and means were compared by Least Significant Difference (Gomez and Gomez, 1996). Total rainfall recorded during crop growing season were 126.4 mm in 1997-98 and 4.8 mm in 1998-99 at Joydebpur (Anonymous, 1999).

Results and Discussion

Yield attributes and yield of maize and soybean

Joydebpur site: Planting system and fertilizer application significantly affected the plant height, grains/cob, 1000 seed weight, grain yield of maize in both the years but straw yield was not significantly affected. There was a trend to increase plant height, grains/cob and 1000 grain weight with the increase of fertilizer doses in both planting systems. The treatment T_1, T_5, T_2 and T_6 showed higher grain yield but statistically identical. Grain yield was drastically reduced in treatment T_8, T_7, T_4 and T_8 where lower fertilizer dose was used (Table 1). Pods/plant and 1000 seed weight of Soybean showed higher with the increase of fertilizer except T_1. Seed yield of Soybean was increased with the increase of fertilizer dose in normal and paired row system except treatment T_1 and T_5 where slightly lower seed yield was recorded than treatment T_2 and T_6. Straw yields was not affected with the increase of fertilizer dose in both the planting systems.

Table 1: Yield and yield attributes of maize and soybean as affected by fertilizer level and planting system (Joydebpur, pooled 1997-98 and 1998-99)

Treatment	Plant height (cm)		Grain/cob[M] Pods/plant[S] (no.)		1000 grain / seed wt. (g)		Grain/seed yield (t ha^{-1})		Straw yield (t ha^{-1})	
	M	S	M	S	M	S	M	S	M	S
T_1	178.5a	52.7	411.2a	28.6a	293.0a	106.5a	6.6a	0.65a	7.7	1.1
T_2	167.0b	55.5	389.6a	29.1a	280.5ab	112.0a	6.3a	0.70a	7.4	1.2
T_3	163.8b	51.7	349.0b	26.3a	282.5ab	104.5ab	5.1bc	0.57b	6.6	1.0
T_4	155.9c	46.7	353.1b	20.8b	278.0ab	101.5abc	4.6c	0.50bc	6.4	0.9
T_5	178.9a	56.0	404.5a	28.4a	292.5ab	106.5a	6.6a	0.56bc	7.7	1.0
T_6	169.7b	53.0	405.1a	28.2a	291.0ab	102.0ab	6.2ab	0.62a	7.2	1.1
T_7	159.2bc	51.5	391.7a	25.8ab	267.0c	98.0bc	4.9c	0.58b	6.2	1.0
T_8	156.8c	51.2	361.7b	21.7b	256.5c	94.5c	4.6c	0.46c	5.9	0.8
LSD (0.05)	6.4	NS	30.3	5.7	15.0	7.0	1.0	0.10	NS	NS
Cv (%)	9.6	10.1	7.0	11.6	3.63	8.2	4.9	15.6	5.65	4.3

In a column, the figures having common letters did not differ significantly at 5% level by DMRT M = Maize S = Soybean
NS = Non significant

Table 2: Yield and yield attributes of maize and soybean as affected by fertilizer level and planting system (Jessore, pooled 1997-98 and 1998-99)

Treatment	Plant height (cm)		Grain/cob[M] Pods/plant[S] (no.)		1000 grain / seed wt. (g)		Grain/seed yield (t ha^{-1})		Straw yield (t ha^{-1})	
	M	S	M	S	M	S	M	S	M	S
T_1	222.0	92.5a	557.0a	30.9d	371.5a	102.0	6.61a	0.67c	8.6a	1.2ab
T_2	222.0	90.2ab	545.0abd	27.9c	356.0b	104.8	5.87b	0.66c	7.3b	1.1b
T_3	222.0	82.0cd	522.0bd	32.3b	351.0c	105.8	5.56b	0.73b	7.0bc	1.3ab
T_4	218.5	83.5c	532.0abd	31.7b	338.0d	103.0	5.19bc	0.78a	6.9bc	1.4a
T_5	220.5	88.0b	552.5ab	37.1a	370.0a	105.8	6.40a	0.68c	7.8ab	1.2ab
T_6	223.5	86.5b	535.0ab	36.7a	365.0ab	103.6	5.82b	0.69c	7.5b	1.2ab
T_7	236.5	83.0cd	514.5de	35.3a	351.5c	102.0	5.67b	0.79a	6.9bc	1.4a
T_8	233.0	80.0d	498.5e	36.8a	342.5cd	103.4	5.00c	0.81a	6.2c	1.4a
LSD (0.05)	NS	3.0	35.5	2.6	11.5	NS	0.44	0.04	0.9	0.2
CV (%)	8.17	5.6	6.4	12.5	2.2	5.2	7.48	5.02	6.3	8.6

In a column, the figures having common letters did not differ significantly at 5% level by DMRT M = Maize S = Soybean
NS = Non significant

Table 3: Yield and yield attributes of maize and soybean as affected by fertilizer level and planting system (Hathazari, during 1998-99)

Treatment	Plant height (cm)		Grain/cob[M] Pods/plant[S] (no.)		1000 grain / seed wt. (g)		Grain/seed yield (t ha^{-1})		Straw yield (t ha^{-1})	
	M	S	M	S	M	S	M	S	M	S
T_1	157.7b	48.6c	392.8a	35.6c	326.7a	77.7b	7.07a	0.85bc	8.7	1.5
T_2	161.4a	53.5b	367.5b	35.1c	327.6a	74.2d	6.40ab	0.83bcd	7.9	1.4
T_3	153.5d	56.0a	354.5b	42.7b	310.2a	81.1a	5.94bc	0.96a	7.3	1.7
T_4	153.0d	49.6c	346.4b	46.1a	290.4b	82.4a	5.02cd	1.11a	6.2	1.9
T_5	155.7c	50.1c	369.3b	32.9d	330.7a	76.7c	6.79ab	0.79cd	8.3	1.4
T_6	151.4e	55.6a	366.4b	36.5c	320.3a	74.4d	6.13b	0.73d	7.5	1.3
T_7	144.1f	54.9a	303.4c	37.6c	309.6a	80.2a	4.95d	0.86bc	6.1	1.5
T_8	144.9f	54.9ab	329.2d	45.4a	308.8a	81.8a	5.12cd	0.98ab	6.3	1.7
LSD (0.05)	1.6	2.2	20.1	2.0	18.3	0.9	0.75	0.15	NS	NS
CV(%)	0.4	1.5	2.1	1.9	2.1	3.7	4.6	6.4	6.1	4.5

In a column, the figures having common letters did not differ significantly at 5% level by DMRT M = Maize S = Soybean
NS = Non significant

Jessore site : Yield and yield attributes of maize were significantly affected by fertilizer application and planting system in both the years. Plant height was not significantly influenced but grains/cob showed higher in number with the increase of fertilizer dose except in treatment T_3. With the increase of fertilizer dose, 1000 seed weight, grain yield and straw yield were increased. But significantly highest grain yield was recorded from higher dose of fertilizer in both the planting systems (T_1 & T_5). Similar trend was followed in case of straw yield.

Plant height, yield attributes and yields of soybean were significantly influenced by the treatment except 1000 seed weight. Plant height was decreased with the decease of fertilizer dose except treatment T_3. Pods/plant did not show any definite trend in pods/plant in normal row but in paired row showed similar number of pods/plant with increase or decrease of fertilizer. Seed yield increased with the decrease of fertilizer dose in both the systems. Straw yields almost similar in all treatments except T_2.

Hathazari site : Plant height, grain/cob, 1000 seed weight and grain yield of maize were differed significantly by the

Table 4: Maize equivalent yield and economic analysis of maize + soybean intercropping systems (averaged over the years)

Treatment	Maize equivalent Yield (t ha^{-1})			Gross return ('000 Tk ha^{-1})			Net return ('000 Tk ha^{-1})			Benefit cost ratio		
	Joydebpur	Jessore	Hathazari	Joydebpur	Jessore	Hathazari	Joydebpur	Jessore	Hathazari	Joydebpur	Jessore	Hathazari
T_1	8.2	8.0	8.9	57.4	64.0	71.2	32.2	39.8	47.1	2.27	2.64	2.95
T_2	7.9	7.1	8.1	55.3	56.8	64.8	32.2	35.0	42.8	2.39	2.61	2.95
T_3	6.5	6.9	7.8	45.5	55.2	62.4	24.9	36.2	43.0	2.21	2.91	3.21
T_4	5.8	6.6	7.0	40.6	52.8	56.0	21.6	35.6	38.2	2.14	3.07	3.14
T_5	8.0	7.7	8.5	56.6	61.6	68.0	30.8	37.4	43.9	2.22	2.55	2.82
T_6	7.7	7.1	7.7	53.9	56.8	61.6	30.8	35.0	39.9	2.33	2.61	2.80
T_7	6.2	7.1	6.6	43.4	56.8	52.8	22.8	37.8	33.4	2.11	2.99	2.72
T_8	5.7	6.4	6.9	39.9	51.2	55.2	20.9	34.0	37.4	2.10	2.98	3.10

Price : Tk./Kg

Crop	Joydebpur	Jessore	Hathazari
Maize grain :	7.00	8.00	8.00
Soybean seed :	10.00	8.00	10.00
Stover/straw :	0.50	0.50	0.50

treatments but straw yield was statistically identical. No definite trend was followed in case of plant height. Grains/cob revealed higher in number with increased fertilizer dose but significantly the highest number of grain/cob was obtained from higher dose of fertilizer in normal row (T_1). There was a trend to decrease 1000 seed weight with the decrease of fertilizer dose except treatment T_1 where slightly lower seed weight than T_2 but statistically at par. Grain yield was the highest from the higher fertilizer dose in both the system and the lowest from the lower dose of fertilizer except in treatment T_8 (Table 3).

Plant height, pods/plant, 1000 seed weight, grain yields of soybean were significantly influenced both parameters but straw yield was statistically identical. Pods/plant and 1000 seed weight increased with the decrease of fertilizer dose. Higher seed yield was obtained from treatment T_4 which was statistically identical to treatment T_8 and T_3. But definite trend was followed in both systems I. e., lower doses of fertilizer showed higher seed yield of Soybean (Table 3).

Maize equivalent yield (MEY): There was a trend of increasing maize equivalent yield with increased fertilizer dose in both the planting systems. MEY decreased considerably beyond fertilizer dose 250-120-120-40-5 of N-P_2O_5-K_2O-S-Zn Kg ha^{-1} in both the planting systems. Similar trend was noted in Jessore (Table 3) but at Hathazari showed higher equivalent yield with the increase of fertilizer except T_7 which was lower than treatment T_8 (Table 4).

Economic analysis : At Joydebpur the highest gross return (Tk. 57400/ha) was recorded from treatment T_1 which was closely followed by treatment T_5 (Tk. 56600/ha). These two treatments also involved higher cost of cultivation due to higher dose of fertilizer used. The highest net return (Tk. 32200/ha) was recorded from the treatments T_1 and T_2 which was followed by treatments T_5 and T_6. Similar trend was found in case of benefit cost ratio where the highest benefit cost ratio (2.39) was recorded from the fertilizer dose 250-120-120-40-5 of N-P_2O_5-K_2O-S-Zn^{-1} in normal row system closely followed by the same fertilizer dose of paired row system. At Jessore, the highest gross return was recorded from treatment T_1 which was closely followed by treatment T_5. Treatment T_1 also showed the highest net return followed by T_5 treatment but benefit cost ratio revealed higher from treatment T_4. In intercropping situation fertilizer can be saved considerably in intercropping system (Quayyum *et al*., 1998). Similar trend was followed in hybrid maize with soybean system. At Hathazari, the highest gross return and net return were recorded from higher dose of fertilizer in normal planting. This system involved the highest cost of cultivation. So, benefit cost ratio analysis showed higher economic benefit from treatment T_3.

The above result showed that hybrid maize (var. Pacific 11) could be grown with 2 rows of soybean in normal or paired row system with 4 rows of Soybean with fertilizer dose T_2, T_4 and T_3 at Joydebpur, Jessore and Hathazari, respectively of Bangladesh.

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