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Fertilizer management for maize-mungbean-T. aman based cropping pattern

M.Z. Ferdous, M.M. Anowar, M. A. Rahman[1], F. Yasmine[2] and Julker Nain[3]
On Farm Research Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, [1]Agriculture Engineering Division, [2]Plant Breeding Division, [3]Training communication and Publication Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh.

Abstract: The experiment was conducted at the MLT site, Gobindagonj, Rangpur during 2007-08 to 2008-09 under OFRD, Agricultural Research Station, Rangpur to investigate the possibility of increasing the yield of Maize, Mungbean and T. aman rice in the cropping pattern through sustaining soil fertility and to increase farmer's income. There were four fertilizer treatments evaluated in 2007-08 viz., T_1 = soil test based (STB) inorganic fertilizer for high yield goal (HYG), T_2 = Brown manuring with mungbean + inorganic fertilizer for high yield goal, T_3 = Recommended fertilizer following fertilizer recommended Guide-2005 (FRG, 2005) and T4= Farmers practice and three fertilizer treatments. viz., $T_{1=}$ soil test based (STB) inorganic fertilizer for high yield goal (HYG), T_2= Brown manuring with mungbean + inorganic fertilizer for high yield goal, d T_3= Farmers practices were evaluated in 2008-09. Fertilizer doses for different concerned treatments were estimated based on initial soil test data at 2007. The highest gross return and gross margin of the whole cropping (Maize-Mungbean- T.aman) obtained from T_2 in both the years. The lowest gross return and gross margin of the whole cropping obtained from farmers practice in both the years.
Key words: Fertilizer management, Maize-Mungbean- T.aman crroping pattern.

Introduction

Soil fertility and productively status of this area (AEZ-3) are not satisfactory due to low organic matter content in soil, imbalance use of inorganic fertilizer, less use of organic manure and use of high yielding modern crop varieties. A crop production system with high yield target cannot be sustainable unless balance nutrient input and supplied to soil against nutrient removal by crops (Bhuiyan *et al.,* 1991). Available data indicate that the soil fertility in Bangladesh is in decline trend (Karim *et al.,* 1994 and Ali *et al.,* 1997) which is responsible for declining crop yields (Anonymous . 1996 and Cassman *et al.,* 1995). The use of chemical fertilizers as a supplement source of nutrient has been increasing steadily in Bangladesh. However,most of the farmers usually do not apply fertilizers in balanced proportion (Anonymous. 1997). The development of appropriate nutrient management system for different cropping pattern felt an urgent need for soil fertility research. Maize is an important cereal crop grown in Bangladesh. Last few years wheat yield is drastically reduced due to environmental condition and is being replaced by maize due to its higher yield potential. But maize is an exhaustive as well as high nutrient- demanding crop. Imbalance chemical fertilizer management and no addition of organic matter is becoming a threat for soil health and sustainable yield. From the previous study, it was revealed that maize yield declined substantially over 3 to 4 consecutive years. The present system of fertilizer application is mostly based on the nutrient requirement of individual crops inorganic the carry-over effect of the manure or fertilizer applied to the preceding crop. Organic sources of nutrients applied to the proceeding crop can benefit the succeeding crop to a great extent (Singh *et al.,* 1996 and Hedge, 1998) and the system productivity may become sustainable through integrated use of organic and in organic sources of nutrients (Singh and Yadav, 1992). Integrated nutrient management for prevailing cropping system appears to be one of the effective ways to meet the economical nutrition requirement of crop (kulkarmi *et al.,* 1993). Inorganic fertilizers today hold the key to the success of the crop production system of Bangladesh agriculture being responsible for about 50 percent of the total production but usually they are not applied in balanced proportion by our farmers (BARC 1997). It is important to develop a cropping system based fertilizer dose for specific agro-ecological zone. Leguminous crop is important for soil fertility concern because of its nitrogen fixation ability and subsequent adding to the soil. In maize based cropping pattern Mungbean can be relayed in the later reproductive stage of maize with low ground coverage making by top working of maize canopy. After the first picking of pod of Mungbean, incorporation of brown biomass may lead to improve soil fertility and supply of available nutrients to the growing plants. Organic matter through adding Mungbean biomass may exert subsequent effect on succeeding T.aman rice. In addition to that soil test based (STB) fertilizer management is deemed great significance for improvement of soil health and sustainable yield. Therefore, the study was undertaken to increase yield of Maize and T.aman rice in the cropping pattern through sustaining soil fertility and to increase farmer's income.

Materials and Methods

The experiment was conducted at the Gobindagonj MLT site, under OFRD, Agricultural Research Station, Rangpur during 2007-08 to 2008-09. The study was initiated with the first crop maize of the Maize - Mungbean –T. aman rice cropping pattern in irrigated medium highland condition. The first cycle of the cropping pattern was completed in 2007-2008 and the second cycle was started in 2008-2009 at MLT sites, Gobindoganj, OFRD, Rangpur. Soil samples were collected from the selected land and sent to the laboratory for chemical analysis. After received of analytical report (Table 1), soil test based fertilizer doses were determined. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 6m x 7m. Four fertilizer treatments viz., T_1= soil test based (STB) inorganic fertilizer for high yield goal (HYG), T_2= Brown manuring with mungbean + inorganic fertilizer for HYG, T_3= Recommended fertilizer following fertilizer recommendation guide 2005 (FRG,2005) and T_4= Farmers practice were evaluated in 2007-2008 and three fertilizer treatments viz., T_1 =soil test based (STB) inorganic fertilizer for high yield goal HYG, T_2= Brown

manuring with mungbean + inorganic fertilizer for HYG and T_3 = Farmers practice were evaluated in 2008-09. The details of the treatments are shown in Table 2 & 3.

The cultivar NK-40 was used for test crop in maize for the both years. The seeds were sown on 20-22 November in 2007 and 20-24 November in 2008, maintaining 75cm x 25cm plant spacing. Fertilizers were applied as per treatment concerned. One third of urea and entire amount of other fertilizers were applied during final land preparation. The rest of N was applied in two equal installments as top dress at 25-30 DAS and at 40-45 DAS in both the years. One weeding was done at 20 and 25 DAS in 2007 and 2008 respectively. Irrigation was given at 15, 35, 70 and 85 DAS in 2007 and at 20, 35, 70 and 80 DAS in 2008. At the later stage of maturity of maize, mungbean seed was sown on 25 March in 2008 and 28 March in 2009 in between two maize lines. The maize was harvested on 10 April, 2008 and 13 April in 2009. Mungbean pod was harvested on 25-30 May in 2008 and 20-28 May in 2009. After picking of pod the brown biomass of mungbean was incorporated to the soil in treatment T_2 in both the years. In case of other treatment Mungbean crop was uprooted. Thirty days old seedlings of t.aman rice (BRRI dhan33) was transplanted on 6-8 August, 2008 and 7-8 August, 2009 maintaining 20cm x 15cm plant spacing. The crop was fertilized as per treatment concerned, the entire amount of P.K.S and Zn were applied during final land preparation. Nitrogen was applied in three equal installments at 15, 30 and 45 DAT one weeding was done on 25 DAT. Other intercultural operations were done as and when necessary. The crop was harvested on 1-5 November, 2008 and 6-8 November, 2009. Data on yield and yield contributing characters of all the crops were taken and analyzed using MSTAT-c software package.

Table 1. Initial status of soils of the experimental plots under Gobindoganj MLT sites of, OFRD, Rangpur at 2007

pH	OM	Total N	P	S	Zn	B	Mg
	(%)	(%)	(Micro gram/g soil)				(m.eq/100 g soil)
6.03	1.25	0.06	30.66	33.30	0.82	0.52	3.11
Slightly acidic	Low	Very low	Very high	High	Low	Optimum	Very high

Table 2. Details of different treatments of the tested cropping pattern on Gobindoganj MLT sites of, OFRD, Rangpur at (2007-08)

Treatments	N-P-K-S-Mg-Zn-B (kg/ha)		
	Maize	Mungbean	T.aman
T_1: Soil test based inorganic fertilizer (HYG)	209-44-37-22-3-3-2	15-10-10	97-7-11-4-0-1-0-0
T_2 : Brown manuring with mungbean + Inorganic fertilizer	209-44-37-22-3-3-2	15-10-10	97-7-11-4-0-1-0-0
T_3 : Rec. fertilizer (FRG'2005)	196-36-75-30-3-3-1	15-10-10	45-4-14-8-0-1-0-0
T_4 : Farmers practice	160-24-35-8-0-0-0	15-10-10	100-0-0-0-0-0

Table 3. Details of different treatments of the tested cropping pattern on Gobindoganj MLT sites of OFRD, Rangpur at (2008-09)

Treatments	N-P-K-S-Mg-Zn-B (kg/ha)		
	Maize	Mungbean	T.aman
T1: Soil test based inorganic fertilizer for HYG	209-44-37-22-3-3-2	15-10-10	97-7-11-4-0-1-0-0
T2:Brownmanuring with mungbean + Inorganic fertilizer for HYG	209-44-37-22-3-3-2	15-10-10	97-7-11-4-0-1-0-0
T3:Farmerspractice	160-24-35-8-0-0-0	15-10-10	100-0-0-0-0-0

Results and Discussion

The yield and yield contributing characters of maize are presented in Tables 4-9. The tallest plant (216.9 cm) was obtained from T_1 (Soil test based inorganic fertilizer for HYG) which was identical to T_2 (Brown manuring + inorganic fertilizer) and T_3 (recommended fertilizer following FRG, 05) in 2007-08. While the tallest plant (179 cm) was recorded from T_2 in 2008-09 which was identical to T_1. Similar trend of results was obtained in case of length of cob in both the years. The diameter of the cob obtained from T_1 and T_2 were identical in both the years but differed significantly from other treatment. The highest number of grains per cob was recorded from T_1 (434.6) which was identical to T_2 (434.5) and T_3 (433.9) in 2007-08 while the highest number of grains per cob was recorded from T_2 (434.6) which was identical to T_1 (433.2) in 2008-09 but differed significantly from T_3 (Farmer practice). The 100 grains weight obtained from T_1, T_2, T_3 was identical but differed significantly from farmer practice in 2007-08. In 2008-09, T_1 and T_2 also gave identical 100 grain weight. The highest grain yield (9.40 t/ha) was obtained from T_1 which was identical to T_2 (9.35 t/ha) and T_3 (9.18 t/ha) in 2007-08 but differed significantly from farmers practice. In 2008-09, the highest grain yield (9.46 t/ha) was obtained from T_2 which was identical to T_1 (9.07 t/ha) but differed significantly from farmers practice (6.25 t/ha). In case of mungbean, the plant height, number of pods per plant, number of grains per pod and 1000 grains weight obtained from T_1, T2 and T_3 were identical but differed significantly from farmers practice. The highest brown biomass yield (2.98 t/ha) was obtained from T_1 which was identical to T_2 (2.87 t/ha) and T_3 (2.97 t/ha). The biomass obtained from T_2 was incorporated to the soil and it was uprooted in other treatments. In case of t.aman, the plant height, number of effective tillers per hill, panicle length, number filled grains per panicle, 1000 grain weight and straw yield obtained from T_1,T_2 and T_3 were identical but differed

significantly from farmers practice. The highest grain yield (5.92 t/ha) of T. aman rice was obtained from T_2 which was identical to T_1 (5.65 t/ha) and T_3 (5.60 t/ha) but differed significantly from T_4 (farmers practice). The result revealed that significant impact of mungbean brown manuring was not observed in grain yield of succeeding T. aman rice.

Table 4. Effect of differjent nutrient management package on the yield of maize in Maize-Mungbean-T. Aman rice cropping pattern at Gobindoganj MLT sites OFRD, Rangpur during 2007-08

Treatments	Plant height (cm)	Length of cob (cm)	Diameter of cob (cm)	No. of grain/ cob	100 seed wt (g)	Grain yield (t/ha)
T_1: Soil test based inorganic fertilizer (HYG)	216.9a	18.75a	13.59a	434.6a	40.50a	9.40a
T_2 : Brown manuring with mungbean + Inorganic fertilizer	216.6a	18.51a	13.71a	434.5a	40.49a	9.35a
T_3 : Rec. fertilizer (FRG'2005)	213.9a	16.69a	12.56b	433.9a	40.30a	9.18a
T_4= Farmers practice	199.3b	15.79b	10.32c	378.08b	38.21b	6.34b
CV (%)	4.9	5.41	7.88	4.69	2.97	3.80

Table 5. Effect of different nutrient management package on the yield of mungbean in Maize- Mungbean- T. Aman rice cropping pattern at Gobindoganj MLT sites OFRD, Rangpur during 2007-08.

Treatments	Plant height (cm)	No. of Pods /plant	No. of grains /pod	1000 grain wt (g)	Grain Yield (t/ha)	Brown Biomass Yield (t/ha)
T_1= HYG	25.85a	12.62a	6.62a	35.99a	1.37a	2.98a
T_2= HYG	25.81a	11.93a	6.52a	35.57a	1.29a	2.875a
T_3= FRG'05	24.90a	11.93a	5.98a	35.77a	1.35a	2.972a
T_4= Farmers practice	20.00b	6.93b	4.12b	34.25b	0.831b	1.977b
CV (%)	7.17	10.47	9.65	3.30	8.77	7.95

Table 6. Effect of different nutrient management on yield of T.aman in Maize-Mungbean - T. Aman rice cropping pattern at the Gobindoganj MLT sites OFRD, Rangpur during 2007-08.

Treatments	Plant height (cm)	No. of effective tiller/hill	Panicle length (cm)	No. of filled grain /panicle	1000-rain wt. (g)	Yield (t/ha)	Straw Yield (t/ha)
T_1	90.50a	8.72a	22.25a	107.0a	22.62a	5.06a	5.65a
T_2	91.83a	9.28a	23.05a	110.7a	22.80a	5.20a	5.92a
T_3	90.33a	8.98a	21.52a	100.0a	22.20a	4.67a	5.60a
T_4	89.50b	7.42b	19.60b	87.76b	20.32b	3.91b	4.01b
CV (%)	4.25	10.86	5.83	9.67	5.81	8.78	9.20

Table 7. Effect of different nutrient management package on the yield of maize in Maize-Mungbean-T. Aman rice cropping pattern at Gobindoganj MLT sites OFRD, Rangpur during 2008-09

Treatments	Plant height (cm)	Length of cob (cm)	Diameter of cob (cm)	No. of grain/cob	100 seed wt (g)	Grain yield (t/ha)
T_1= HYG	209.9a	17.90a	14.82a	433.2a	44.47a	9.07a
T_2= HYG	202.9a	18.68a	15.63a	434.6a	44.83a	9.46a
T_3=Farmers practice	176.3b	14.40b	11.80b	377b	34.17b	6.25b
CV (%)	5.54	5.41	6.64	8.24	4.25	5.95

Table 8. Effect of different nutrient management package on the yield of mungbean in Maize- Mungbean- T. Aman rice cropping pattern at Gobindoganj MLT sites OFRD, Rangpur during 2008-09

Treatments	Plant height (cm)	No. of Pods/plant	No. of grains /pod	1000 grain wt (g)	Grain Yield (t/ha)	Brown Biomass Yield (t/ha)
T_1= HYG	52.91a	11.34a	8.7a	42.22a	1.10a	2.21a
T_2= HYG	54.12a	11.62a	8.9a	42.86a	1.14a	2..30a
T_3= FRG'05	43.45b	6.23a	7.4b	0.845b	1.05a	1.47b
CV (%)	5.32	6.35	6.23	3.12	5.23	5.12

Table 9. Effect of different nutrient management on yield of t.aman in Maize-Mungbean - T. Aman rice cropping pattern at the Gobindoganj MLT sites OFRD, Rangpur during 2008-09

Treatments	Plant height (cm)	No. of effective tiller/hill	Panicle length (cm)	No. of filled grain /panicle	1000-grain wt. (g)	Yield (t/ha)	Straw Yield (t/ha)
T_1	91.65a	8.82a	21.95a	108.0a	21.99a	5.01a	5.38a
T_2	92.11a	9.94a	22.86a	110.9a	23.01a	5.35a	5.59a
T_3	91.11a	8.67a	22.13a	103.0a	22.00a	4.19a	5.32a
CV (%)	6.29	9.86	6.72	10.35	5.81	7.54	8.21

Economic analysis: The cost and return analysis of Maize – Mungbean -T. aman rice cropping pattern are presented in Tables 10 &11. The mean gross return , gross margin and benefit cost ratio of the whole cropping pattern of two years was highest in Brown manuring + inorganic fertilizer treatment. The lower gross return, gross margin and benefit cost ratio was obtained from (Farmers practice). It was evident that Brown manuring + inorganic fertilizer based management in the cropping pattern found better compared to other fertilizer management. Cost and return analysis showed that the highest gross returns (Tk 262335/ha) and gross margin (Tk. 147028/ha) was obtained from Brown manuring + inorganic fertilizer (Table 10) in 2007-2008. In 2008-09 showed that the highest gross returns (Tk 238265/ha) and gross margin (Tk. 124893/ha) was obtained from Brown manuring + inorganic fertilizer treatment (Table 11).

Table 10. Cost and return analysis of the whole cropping pattern (Maize- Mungbean- T aman rice) as influenced by different fertilizer treatments at Gobindoganj MLT sites OFRD, Rangpur during 2007-08

Treatments	Grain yield (t/ha)			Stover yield (t/ha)			Gross Return (Tk/ha)	TVC (Tk/ha)	Gross margin (Tk/ha)	BCR
	Maize	Mungbean	Taman	Maize	Mungbean	Taman				
T_1	9.40	1.37	5.06	11.00	2.97	5.65	261455	115307	146148	2.27
T_2	9.35	1.36	5.2	11.25	2.88	5.92	262335	115307	147028	2.28
T_3	9.18	1.35	4.67	11.10	2.98	5.60	240430	95242	145188	2.52
T_4	6.34	0.83	3.91	7.94	1.98	4.01	176190	78349	97841	2.25

Price (Tk./kg): Urea=11.80 , TSP= 75, MP= 55, Gypsum= 8, Zinc sulphate= 150, Boric acid = 160, Maize =9 ,Mungbean =70 and Taman=13

Table 11. Cost and return analysis of the whole cropping pattern (Maize- Mungbean- T aman rice) as influenced by different fertilizer treatments at Gobindoganj MLT sites OFRD, Rangpur during 2008-09

Treatments	Grain yield (t/ha)			Stover yield (t/ha)			Gross Return (Tk/ha)	TVC (Tk/ha	Gross margin (Tk/ha)	BCR
	Maize	Mungbean	Taman	Maize	Mungbean	Taman				
T1	9.07a	1.10a	5.01a	10.9 5	2.21a	5.65	226955	113372	113583	2.00
T2	9.46a	1.14a	5.35a	11.45	2..30a	5.92	238265	113372	124893	2.10
T3	6.25b	1.05a	4.19b	10.10	1.47b	5.60	186600	110764	75836	1.68

Price (Tk./kg) for Maize and Mungbean: Urea=11.80 , TSP= 75, MP= 55, Gypsum= 8, Zinc sulphate= 150, Boric acid = 160, Maize =9 , and Mungbean =50. Price (Tk./kg)for Taman: Urea=12 , TSP= 22, MP= 25, Gypsum=7, Zinc sulphate= 120, Boric acid = 180, and Taman=15

Previously farmers were practicing Maize-fallow-T.aman rice cropping pattern .After intervention; mungbean crop was included in this cropping pattern. The result indicated that higher grain yield of all crops were obtained from Brown manuring + inorganic fertilizer treatment and it was identical to Soil test based inorganic fertilizer for HYG. The highest gross margin was also obtained from Brown manuring + inorganic fertilizer treatment. Though the yield was not differed significantly with Soil test based inorganic fertilizer for HYG treatment and recommended fertilizer treatment but in the long run soil fertility and soil health in Brown manuring + inorganic fertilizer treatment will be improved.

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