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Research Article

EFFECT OF FERTILIZER ON THE NUTRIENT CONCENTRATION AND UPTAKE OF LOCAL FINE RICE VARIETIES IN *HAOR* AREAS OF BANGLADESH

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Abstract

The experiment was conducted at the farmers' fields of Bahadurpur and Noagaon village at Sadarupazilla and Dakshin Sunamganj, respectively under the Dekharhaor (wetland) of Sunamganj district, Bangladesh during November, 2015 to May 2016 to observe the nutrients concentration and uptake by the local fine rice varieties under different rates of fertilizers application. The experiment comprised four varieties viz. Tapiboro (V_1), Begun bichi (V_2), Rata boro (V_3), Atobshail (V_4), and three fertilizers package treatments- F_1= Farmers' practice, FP (NPK @ 41.4-4.2-10.5 kg ha^{-1}), F_2= Recommended Fertilizer Dose, RFD (NPKSZn@69-22.4-31.7-6.7-0.65 kg ha^{-1}) and F_3= Soil test based fertilizers, STB (NPKSZn@61-17.5-33.5-3.1-0.7 $kgha^{-1}$). The experiment was laid out in two factors Completely Randomized Block Design (RCBD) with three farmers' replications. Data were collected on yield, nutrients concentration and uptake of rice. Tapiboro produced the highest grain yield of 3.10 $tha^{-1}$and straw yield of 5.49 tha^{-1}. The grain and straw yield varied significantly due to application of different fertilizer doses. Application of STB fertilizer were produced the highest grain yield of 2.95 tha^{-1} and straw yield of 4.85 tha^{-1}. The highest amount of NPKSZn concentration was found in Tapiboro and application of STB fertilizers. Tapiboro uptakes the highest amount of NPKSZn. The NPSZn apparent balance was found positive and negative K balance was found in all treatments. Tapiboro with STB based fertilizers application was the best option in the haor area for the farmers'.

Introduction

Water remains either stagnant or in flash flooding condition in the haors (basin like structure) during the months of late May to October. Mainly Boro rice is grown in the Rabi season. Geographically, most of the haors are located in seven districts of the North- East Bangladesh (Master Plan of Haor Areas, 2012). Early flood, hailstorm and drought are the main constraints to grow modern boro rice. The available statistics indicate that the total cultivated area in those haor districts is about 1.99 million hectares of which 0.85 million ha is a great possibility of growing fine rice and other rice with better management to get higher yields. The data from agricultural research organization before 1965 hardly showed any significant response to added P and K, even with N, the responses were not significant (Jackson, 1962). After the introduction of high yielding varieties and launching intensive cropping for maximum crop production per unit area and per unit time, rapid depletion of soil fertility has been observed almost all over the country. In Bangladesh, nutrient deficiency in soils is intensifying (Shahane et al., 2018) one of the reasons for this being unbalanced fertilizers use. A number of surveys revealed that the farmers of haor areas apply unbalanced fertilizers in boro rice cultivation (Ali, 2016; Aziz, 2020; Saha, 2020). The most widely deficient nutrients in the soils are nitrogen, phosphorus, potassium and sulphur. Research information on fine rice cultivation in Sylhet haor areas is not sufficient. The present research work was aimed to identify fine rice cultivars /varieties with different fertilizer management packages to improve the nutrient uptake for raising productivity.

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Materials and Methods

The experiment was carried out at the Bahadurpur and Noagaon village of farmers' fields at Sadarupazila and DaskinSunamganj, respectively under Dekarhaor of Sunamganj district, Bangladesh during the period from November, 2015 to May 2016. For varieties viz. Tapiboro (V_1), Begun bichi (V_2), Rata boro (V_3), Atobshail (V_4) and three fertilizers packages treatments- F_1= Farmers' practice, FP (NPK @ 41.4-4.2-10.5 kg ha^{-1}; F_2= Recommended fertilizer Dose, RFD (NPKSZn @69-22.4-31.7-67-0.65 kg ha^{-1}); F_3= Soil test based fertilizers, STB (NPKSZn@61-17.5-33.5-3.1-0.7 kgha^{-1}) were included in the experiment. The initial soil properties of the experimental sites were pH 5.27, total-N 0.089%, organic carbon 0.90% organic matter 1.55%, exchangeable K 0.14 meq 100 g^{-1} soil, available p 6.5 ug g^{-1} soil,available S 17.67 ug g^{-1} soil and available Zn 0.137 mg kg^{-1} soil. Soil texture, pH, organic matter, available PS, Zn and exchangeable K, were determined following standard methods (Black, 1965, Jackson, 1962, Page et al., 1982, Walkey and Black, 1934). Seeds were sown in seedbed on 24 November 2015. Seedlings were transplanted on 30 December 2015 at 25 cm × 15 cm spacing. TSP, MoP, Gypsum and Zinc sulphate were applied during final land preparation as per treatment. Urea was applied as top dressing in three equal splits at 20, 35 and 50 days after transplanting. Two hand weeding were done during crop growth. Harvesting was done on 15 April 2016. The grain and straw yields were recorded from whole plot and converted into per hectare basis. Chemical analyses of grain and straw were done following standard methods. Nutrient uptake was calculated from nutrient concentrations and yield. The data were analyzed following randomized complete block design and mean separation was done by DMRT (Gomez and Gomez, 1984).

Results and Discussion

The grain and straw yield showed significant response due to application of different variety. The highest grain yield of 3.10 t ha^{-1} and straw yield of 5.49 t ha^{-1} was obtained in Tapiboro rice (Table 1). The grain and straw yield had significant response due to application of different fertilizer packages. The highest grain yield of 2.95 t ha^{-1} and straw yield of 4.85t ha^{-1} was recorded due to application of STB fertilizers. The highest straw yield of 5.16 t ha^{-1} was produced due to the interaction of Tapiboro and application of soil test based fertilizers packages application.

Nitrogen concentration in rice grain responded significantly due to variety, fertilizer and their interaction (Table 1).The highest N concentration observed in rice grain of 1.055%, 1.100% and 1.125% was found in Tapiboro rice, STB fertilizers and their interaction. The highest N uptake was found in Tapiboro (32.70 kg ha^{-1}). Nitrogen uptake in rice grain was significantly influenced due to application of different fertilizer doses. The highest N uptake (32.45 kg ha^{-1}) was recorded where STB fertilizers dose applied. Significantly highest N uptake (31.92 kg ha^{-1}) was observed in the interaction of Tapiboro and the application of STB fertilizers. The highest N concentration in rice grain of 0.459% was found in Tapiboro and 0.470% of STB fertilizers. The highest N concentration in rice straw of 0.537% was recorded due to the interaction effect of Tapiboro and application of STB fertilizers.

The highest N uptake in rice straw of 24.71, 22.79 and 25.73 kg ha^{-1} was found in tapiboro application of STB fertilizers and their interaction. The highest total N uptake of 57.41,55.24 and 57.65 kg ha^{-1} was recorded in Tapiboro, application of STB fertilizers and their interaction. Results showed in the table 2 indicated that phosphorus concentration in rice grain significantly varied due to fertilizer application. The highest P concentration in rice grain of 0.374% was recorded in soil test-based fertilizers and the lowest in FP. The highest P concentration in rice straw of 0.128% was recorded in Tapiboro and the lowest of 0.108% was found in Rata boro. The highest P concentration in rice of 0.136% was observed due to application of STB. The highest P concentration in straw of 0.169% was also found due to interaction effect of Tapiboro and application of STB fertilizers. Significantly the highest P uptake in rice straw of 3.90 kg ha^{-1} was found in Tapiboro and the lowest of 2.51 kg ha^{-1} was recorded in Atobshail.

Table 1. Nitrogen concentration (%) and uptake of local fine boro ricein the *haor* area

Treatment	Yield (t ha^{-1})		Nitrogen concentration (%)		Nitrogen uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Total
Variety							
Tapiboro	3.10a	5.49a	1.05a	0.45a	32.7a	24.7a	57.4a
Begun bichi	2.60c	4.90b	1.04c	0.42c	27.2c	21.0c	48.2c
Rata boro	2.53d	4.50c	1.01d	0.38d	25.6d	17.3d	43.0d
Atobshail	2.84b	4.82b	1.05b	0.45b	29.8b	22.1b	51.9b
Sx	0.183	0.112	0.018	0.033	0.631	0.653	0.752
LS	**	*	**	**	**	**	**
Fertilizer							
F_1	2.45c	4.10c	0.93c	0.36c	22.9c	14.9c	37.9c
F_2	2.64b	4.45b	1.09b	0.45b	28.7b	20.4b	49.1b
F_3	2.95a	4.85a	1.10a	0.47a	32.4a	22.7a	55.2a
Sx	0.123	0.097	0.091	0.057	0.865	0.721	0.471
LS	*	*	**	**	*	*	*
Variety × Fertilizer							
V_1F_1	2.90	4.61e	0.99g	0.33h	28.9d	15.4h	44.3i
V_1F_2	2.72	4.80d	1.05f	0.52b	28.8d	24.9b	53.7b
V_1F_3	2.91	5.16a	1.12a	0.53a	31.9a	25.7a	57.6a
V_2F_1	2.43	5.05abc	0.99g	0.42e	24.0g	21.5e	45.6h
V_2F_2	2.79	4.50ef	1.07e	0.43d	29.9c	19.4f	49.4f
V_2F_3	2.90	4.93bcd	1.07e	0.42e	31.2b	22.0d	53.2c
V_3F_1	2.68	4.27gh	0.82i	0.31i	22.1h	13.5j	35.7l
V_3F_2	2.48	4.15h	1.11b	0.34g	27.7e	14.3i	42.0j
V_3F_3	2.43	5.10ab	1.10c	0.49c	26.8f	25.1b	51.9d
V_4F_1	2.39	4.90cd	0.93h	0.37f	22.3h	18.5g	40.8k
V_4F_2	2.50	4.35fg	1.10c	0.52b	27.7e	23.3c	51.0e
V_4F_3	2.55	4.23gh	1.09d	0.43d	28.6d	18.4g	47.1g
Sx	-	0.056	0.029	0.043	0.722	0.852	0.548
CV(%)	6.28	6.54	0.62	1.23	2.34	2.42	2.38
LS	NS	*	**	**	**	**	**

In a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1% level of probability; * = Significant at 5% level of probability, NS=Notsignificant, LS= Level of significance, V_1= Tapiboro, V_2= Begun bichi, V_3= Rata boro, V_4= Atobshail, F_1= Farmers' practice(FP) NPK@ 41.5-4.2-10.5, F_2= Fertilizer recommendation guide '12 based fertilizers (RFD) @69-11.2-31.7-6.7- 0.65 , F_3= Soil test based fertilizers (STB) NPKSZn @ 61-17.5-33.5-3.1-0.7 kg ha^{-1}.

In case of interaction, the highest P uptake of 4.02 kg ha^{-1} was recorded due to the interaction of Tapiboro and application of STB fertilizers. The highest total P uptake of 7.04 and 9.10 kg ha^{-1} was found in Tapiboro and due to the interaction of Tapiboro and application of STB.

Result in the Table 3 indicated that K concentration in rice grain differed significantly due to different variety and fertilizer packages during 2015-16. The highest K concentration in rice grain of 0.281% was found in Tapiboro and the lowest of 0.252% was recorded in Alobshail. The highest K concentration in rice grain of 0.278% was also observed due to application of STB and the lowest of 1.548% was found in FP. Significantly the highest K uptake in rice of 7.81,8.02 and 8.49 kg ha^{-1} was recorded in Tapiboro, application of STB and their interaction. The highest K concentration in rice straw of 2.182% was recorded in Tapiboro and the lowest of 1.490% was observed in Rata boro. The highest K concentration in rice straw of 2.213% and 2.684% was observed due to application of STB and the interaction of Tapiboro and application of STB. The highest K uptake in rice straw 115.39,104.81 kg ha^{-1} was found in Tapiboro, application of STB and their interaction. The highest total K uptake of 123.20,112.83 and 135.17 kg ha-1 was found in Tapiboro, application of STB fertilizers and their interaction. Significantly highest S concentration in rice grain 0.110% and was found due to application of STB fertilizers (Table 4). The highest S uptake in rice grain of 1.92 kg ha-1 was recorded due to application of STB

fertilizers. The highest S concentration in rice straw of 0.2615,0.256% and 0.300% was found in Tapiboro, application of STB fertilizers and their interaction.Sulpur uptake in rice straw responded significantly due to different fertilizer packages. The highest S uptake in rice straw of 4.41 kg ha^{-1} was found due to application of STB and the lowest of 1.80 kg ha^{-1} was recorded due to application of FP. Total S uptake by rice grain + straw was significant among the different variety and fertilizer packages. The highest total S uptake of 6.40 kg ha^{-1} was found in Tapiboro. The highest total S uptake (6.33kg ha^{-1}) was also recorded due to application of STB and the lowest of 3.00 kg ha^{-1} was found due to application of FP.

Table 2. Phosphorus concentration (%) and uptake of local fine boro ricein the *haor* area

Treatment	Phosphorus concentration (%)		Phosphorus uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
Variety					
Tapiboro	0.348	0.128a	3.18	3.90a	7.08a
Begun bichi	0.361	0.120b	3.20	3.09b	6.29c
Rata boro	0.354	0.108d	3.19	2.97c	6.16d
Atobshail	0.349	0.118c	4.09	2.51d	6.60b
Sx	-	0.010	-	0.442	0.211
LS	NS	*	NS	**	**
Fertilizer					
F_1	0.329 c	0.092c	2.20	1.80	4.00
F_2	0.355 b	0.129b	3.19	2.89	6.09
F_3	0.374 a	0.136a	4.19	3.78	7.97
Sx	0.019	0.0241	-	-	-
LS	**	**	NS	NS	NS
Variety × Fertilizer					
V_1F_1	0.317	0.093f	2.10	1.87f	3.97f
V_1F_2	0.380	0.114e	4.90	2.98d	7.87b
V_1F_3	0.348	0.169a	4.31	4.02a	9.10a
V_2F_1	0.336	0.094f	2.30	1.56g	3.86g
V_2F_2	0.373	0.155b	3.71	3.02d	6.73d
V_2F_3	0.375	0.121d	5.08	3.55b	7.86b
V_3F_1	0.325	0.089h	2.35	1.43g	3.78h
V_3F_2	0.374	0.122d	4.32	2.86e	7.18c
V_3F_3	0.361	0.114e	3.91	3.93a	7.84b
V_4F_1	0.339	0.091g	2.32	1.70f	4.02e
V_4F_2	0.369	0.139c	4.23	2.96d	7.18c
V_4F_3	0.337	0.125d	3.49	3.34c	6.84d
Sx	-	0.025	-	0.325	0.142
CV(%)	2.10	2.35	3.12	3.18	3.15
LS	NS	**	NS	*	**

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Table 3. Potassium concentration (%) and uptake of local fine boro ricein the *haor* area

Treatment	Potassium concentration (%)		Potassium uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
Variety					
Tapiboro	0.281a	2.18a	7.81a	115.3a	123.2a
Begun bichi	0.258b	2.12b	7.30b	104.0b	111.3b
Rata boro	0.256b	1.49d	6.47c	98.1c	104.6c
Atobshail	0.252c	2.10c	7.32b	71.8d	79.1d
Sx	0.014	0.324	0.211	1.524	1.446
LS	**	**	*	**	**
Fertilizer					
F_1	0.235c	1.54c	5.75c	63.4c	69.2c
F_2	0.272b	2.16b	7.33b	98.4b	105.8b
F_3	0.278a	2.21a	8.02a	104.8a	112.8a
Sx	0.022	0.370	0.651	1.220	1.228
LS	**	**	*	*	*
Variety × Fertilizer					
V_1F_1	0.219	1.21l	6.35e	55.9l	62.2k
V_1F_2	0.286	1.38k	7.78c	66.3k	74.1j
V_1F_3	0.268	2.68a	8.49a	128.5a	135.1a
V_2F_1	0.254	1.41j	6.17e	71.4j	77.6i
V_2F_2	0.296	1.87g	8.25b	120.7b	129.0b
V_2F_3	0.293	2.27e	7.79c	117.1c	125.6c
V_3F_1	0.233	1.73i	6.24e	73.9i	80.1h
V_3F_2	0.263	2.29d	6.52d	95.2e	101.7e
V_3F_3	0.272	2.52b	6.60d	92.4f	100.2f
V_4F_1	0.235	1.83h	5.62f	89.7g	95.3g
V_4F_2	0.266	2.49c	6.65d	108.4d	115.1d
V_4F_3	0.255	1.98f	6.50d	83.7h	90.2g
Sx	-	0.074	0.256	1.401	1.302
CV(%)	1.23	2.15	3.12	4.15	3.75
LS	NS	**	*	**	**

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Results showed in the Table 5 indicated that zinc concentration in rice grain significantly varied by the different variety and fertilizer packages. The highest Zn concentration in rice grain of 18.48 ppm was observed in Tapiboro the lowest of 16.28 ppm was recorded in atobshail. The highest Zn concentration in rice grain of 18.90 ppm was recorded due to application of STB fertilizers. The highest Zn uptake in rice grain of 0.080 kg ha-1 was found in Tapiboro. The highest Zn uptake in rice grain of 0.086 kg ha^{-1} was recorded due to the interaction of Tapiboro and application of STB fertilizers. The highest Zn concentration in rice straw of 21.97 ppm was recoded in Tapiboro. The highest Zn concentration in rice straw of 21.32 ppm was observed due to the interaction of tapiboro and application of STB. Significantly the highest Zn uptake in rice straw of 0.172 kg ha^{-1} was recorded in Tapiboro. Total Zn uptake in rice grain + straw showed significant variations due to the effect of interaction variety and fertilizer packages and the highest total Zn uptake of 0.260 kg ha-1 was recorded due to the interaction of Tapiboro and application of STB and the lowest Zn uptake of 0.153 kg ha-1 due to the interaction of Tapiboro and application of STB Tapiboro and FP.

The study of apparent nutrient balance in soil due to fertilizer application presented in Table 6.N was added 41.47 to 69. 10 kg ha^{-1} in soil. Total N uptake was 35.70 to 57.65 kg ha^{-1}. The N apparent balance was found positive in all treatments in 2015-16. The value was 0.635 to 19.91 kg ha-1. Removal of N by the crops was lower than addition of N. Phosphorus was added to soil 4.20 to 17.50 kg ha^{-1}. Total P balance varied from soil 3.78 to 9.10 kg ha^{-1}. The balance for P was positive in all the treatment. The P balance varied from 0.18 to 10.66 kg ha^{-1}. Potassium was added to soil 21.0 to 33.50 kg ha^{-1}. Total K uptake from soil 62.26 to 135.10 kg ha^{-1}. The K balance was negative in all the treatments. The K balance in soil from-97.28 to -42.36 kg ha^{-1}. Sulphur was applied to 3.14 to 6.74 kg ha^{-1}. Total S uptake from soil 2.87 to 6.66 kg ha^{-1}. For S , the apparent balance was positive in all treatment except where S was applied. The value varied from 0.08 to 0.82 kg ha^{-1}. Zinc was added to soil 0.65 to 0.72 kg ha^{-1}. Total Zn uptake from soil 0.161 to 0.248 kg ha^{-1}. The balance for Zn was positive in all treatments except where Zn was not applied. The value varied from 0.42 to 0.53 kg ha^{-1}.

Table 4. Sulphur concentration (%) and uptake of local fine boro ricein the *haor* area

Treatment	Sulphur concentration (%)		Sulphur uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
Variety					
Tapiboro	0.097	0.261a	1.75	4.29	6.40a
Begun bichi	0.105	0.203d	1.81	4.58	6.04c
Rata boro	0.094	0.220b	1.70	4.20	5.90c
Atobshail	0.098	0.203c	1.83	4.42	6.25b
Sx	-	0.027	-	-	0.156
LS	NS	**	NS	NS	*
Fertilizer					
F_1	0.087c	0.176c	1.20c	1.80c	3.00c
F_2	0.099b	0.233b	1.53b	4.07b	5.60b
F_3	0.110a	0.256a	1.92a	4.41a	6.33a
Sx	0.0129	0.0408	0.125	0.215	0.236
LS	**	**	**	**	**
Variety × Fertilizer					
V_1F_1	0.094	0.149j	1.68	3.78	5.46
V_1F_2	0.112	0.191g	1.76	4.56	6.33
V_1F_3	0.085	0.300a	1.20	1.74	2.94
V_2F_1	0.085	0.209f	1.46	4.39	5.85
V_2F_2	0.117	0.275b	2.01	4.41	6.42
V_2F_3	0.115	0.269c	1.00	1.87	2.87
V_3F_1	0.083	0.167i	1.47	3.75	5.23
V_3F_2	0.101	0.248d	1.86	4.06	5.92
V_3F_3	0.098	0.246d	1.00	1.89	2.89
V_4F_1	0.087	0.180h	1.53	4.36	5.89
V_4F_2	0.110	0.218e	2.05	4.61	6.66
V_4F_3	0.098	0.211e	1.05	2.00	3.05
Sx	-	0.021	-	-	-
CV(%)	2.78	1.85	2.16	2.19	2.18
LS	NS	*	NS	NS	NS

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Table 5. Zinc concentration (%) and uptake of local fine boro ricein the *haor* area

Treatment	Zinc concentration (%)		Zinc uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
Variety					
Tapiboro	18.4a	21.9a	0.080a	0.172a	0.252
Begun bichi	17.6b	19.6c	0.072b	0.154b	0.226
Rata boro	16.8c	19.4d	0.060d	0.132d	0.192
Atobshail	16.2d	20.1b	0.065c	0.137c	0.202
Sx	2.064	0.125	0.002	0.021	-
LS	**	**	*	*	NS
Fertilizer					
F_1	16.1c	20.8c	0.053	0.108	0.161
F_2	17.3b	22.8b	0.076	0.154	0.230
F_3	18.9a	23.5a	0.073	0.148	0.221
Sx	0.213	0.421	-	-	-
LS	**	**	NS	NS	NS
Variety × Fertilizer					
V_1F_1	17.8	17.4k	0.049e	0.104	0.153g
V_1F_2	18.0	18.0h	0.056d	0.112	0.168f
V_1F_3	18.1	21.3a	0.086a	0.174	0.260a
V_2F_1	16.8	18.0f	0.058d	0.123	0.181e
V_2F_2	17.6	19.5d	0.069c	0.142	0.211c
V_2F_3	18.9	19.3e	0.081b	0.167	0.248b
V_3F_1	16.1	17.6j	0.062d	0.126	0.188d
V_3F_2	17.0	19.8c	0.064d	0.126	0.190d
V_3F_3	18.2	20.6b	0.061d	0.127	0.188d
V_4F_1	16.7	17.2l	0.055e	0.112	0.167f
V_4F_2	17.8	19.2g	0.071c	0.143	0.214c
V_4F_3	18.1	17.7i	0.063d	0.126	0.189d
Sx	-	0.124	0.021	-	0.042
CV(%)	1.52	2.23	2.45	2.65	2.54
LS	NS	*	*	NS	**

In a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1% level of probability; * = Significant at 5% level of probability, NS=Notsignificant, LS= Level of significance, V_1= Tapiboro, V_2= Begun bichi, V_3= Rata boro, V_4= Atobshail, F_1= Farmers' practice(FP) NPK@ 41.5-4.2-10.5, F_2= Fertilizer recommendation guide '12 based fertilizers (RFD) @69-11.2-31.7-6.7- 0.65 , F_3= Soil test based fertilizers (STB) NPKSZn @ 61-17.5-33.5-3.1-0.7 kg ha^{-1}.

Table 6: Apparent nutrient balance of soil as affected by different fertilizer dose of local fine boro rice in the *haor* area

Treatment	Total nutrient added (kg ha^{-1})					Total nutrient uptake (kg ha^{-1})					Nutrient balance (kg ha^{-1})				
	N	P	K	S	Zn	N	P	K	S	Zn	N	P	K	S	Zn
Fertilizer															
FP	41.47	4.2	21.0	0	0	37.91	4.00	69.21	5.60	0.161	3.565	0.20	-65.01	-5.60	-0.161
FRG	69.1	11.2	31.75	6.74	0.65	49.19	6.09	105.8	6.33	0.230	19.91	5.11	-74.05	0.41	0.42
STB	61.05	17.5	33.5	3.14	0.72	55.24	7.97	112.8	3.00	0.221	5.81	9.53	-79.33	0.14	0.499
LS	NA	NA	NA	NA	NA	*	NS	*	*	NS	NA	NA	NA	NA	NA
Variety × Fertilizer															
V_1F_1	41.47	4.2	21.0	0	0	40.35	3.97	62.26	5.46	0.153	1.12	0.23	-58.06	-5.46	-0.153
V_1F_2	69.1	11.2	31.75	6.74	0.65	53.76	7.87	74.11	6.33	0.168	15.34	3.33	-42.36	0.41	0.482
V_1F_3	61.05	17.5	33.5	3.14	0.72	57.65	7.86	100.2	2.94	0.26	3.4	9.64	-66.72	0.20	0.46
V_2F_1	41.47	4.2	21.0	0	0	39.61	3.86	77.62	5.85	0.181	1.86	0.34	-73.42	-5.85	-0.181
V_2F_2	69.1	11.2	31.75	6.74	0.65	49.47	6.73	129.0	6.42	0.211	19.63	4.47	-97.28	0.32	0.439
V_2F_3	61.05	17.5	33.5	3.14	0.72	53.26	9.10	125.6	2.87	0.248	7.79	8.40	-92.12	0.27	0.472
V_3F_1	41.47	4.2	21.0	0	0	35.7	3.78	80.15	5.23	0.188	5.775	0.42	-75.95	-5.23	-0.188
V_3F_2	69.1	11.2	31.75	6.74	0.65	42.07	7.18	101.7	5.92	0.19	27.03	4.02	-69.97	0.82	0.46
V_3F_3	61.05	17.5	33.5	3.14	0.72	51.99	7.84	135.1	2.89	0.188	9.06	9.66	-101.67	0.25	0.532
V_4F_1	41.47	4.2	21.0	0	0	40.84	4.02	95.38	5.89	0.167	0.635	0.18	-91.18	-5.89	-0.167
V_4F_2	69.1	11.2	31.75	6.74	0.65	51.05	7.18	115.1	6.66	0.214	18.05	4.02	-83.38	0.08	0.436
V_4F_3	61.05	17.5	33.5	3.14	0.72	47.16	6.84	90.25	3.05	0.189	13.89	10.66	-56.75	0.09	0.531
LS	NA	NA	NA	NA	NA	**	**	**	NS	**	NA	NA	NA	NA	NA

n a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1% level of probability; * = Significant at 5% level of probability, NS=Notsignificant, LS= Level of significance, NA= Not statistically analyzed, V_1= Tapiboro, V_2= Begun bichi, V_3= Rata boro, V_4= Atobshail, F_1= Farmers' practice(FP) NPK@ 41.5-4.2-10.5, F_2= Fertilizer recommendation guide '12 based fertilizers (RFD) @69-11.2-31.7-6.7- 0.65 , F_3= Soil test based fertilizers (STB) NPKSZn @ 61-17.5-33.5-3.1- 0.7 kg ha^{-1}.

Conclusion

The result of the experiment revealed that the highest grain yield of 3.10 ha^{-1} was produced by Tapiboro. STB fertilizer also produced the highest grain of yield. It may be concluded that Tapiboro with application of STB fertilizers is suggested for the farmers in the haor area. The nutrient balance was possitive for all studied elements for except potassium incase of STV treatment.

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