International Journal of Plant & Soil Science

23(6): 1-10, 2018; Article no.IJPSS.42071
ISSN: 2320-7035

Effect of Fertilizers on Yield and Yield Contributing Characters of Local Aromatic Aman Rice Varieties in Sylhet Region

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Authors' contributions

This work was carried out in collaboration between all authors. Author KNM designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Authors MNHM and MAK managed the analyses of the study. Author IM managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/42071
Editor(s):
(1) Fatemeh Nejatzadeh, Department of Horticulture, Faculty of Agriculture, Khoy Branch, Islamic Azad University, Iran.
Reviewers:
(1) M. M. Buri, CSIR-Soil Research Institute, Ghana.
(2) Mónica Guadalupe Lozano Contreras, National Institute of Forest Research Agricultural and Livestock (INIFAP), Mexico.
Complete Peer review History: http://www.sciencedomain.org/review-history/25890

Original Research Article

Received 12th May 2018
Accepted 3rd August 2018
Published 16th August 2018

ABSTRACT

A pot experiment was conducted at the experimental net house of the Department of Soil Science, Sylhet Agricultural University, Sylhet, Bangladesh to observe the effect of variety and fertilizer on yield and yield contributing character of local aromatic rice varieties during the Aman season of 2015. Five aromatic rice varieties (Kalizira: V_1, Muktasail: V_2, Nagrasail: V_3, Maloti: V_4 and Chinigura: V_5) and four levels of fertilizer (Recommended dose: F_1 i.e. 45-10-20-10-0.5 kg ha^{-1} of N-P-K-S-Zn, 2/3rd of recommended dose: F_2, 1/3rd of recommended dose: F_3, and Control: F_4) were

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used with three replication following RCBD. Recorded yield and yield contributing characters were panicle length, a number of effective and non-effective tillers hill^{-1}, grains panicle^{-1}, sterile spikelets panicle^{-1}, total spikelets panicle^{-1}, 1000-grain weight, grain yield, straw yield, harvest index, panicle emergence days, and total maturity days. With few exceptions, yield and yield contributing characters of the aromatic rice varieties were significantly affected due to the application of different fertilizer levels. The highest grain yield was recorded in Nagrasail variety (65.33 g pot^{-1}) followed by Kalizira (65.26 g pot^{-1}) with the recommended dose of fertilizers while the lowest yield (24.31 g pot^{-1}) was obtained in Maloti with control. Straw yield was the highest (174.07 g pot^{-1}) in Maloti with the recommended dose of fertilizers but the lowest yield (61.70 g pot^{-1}) was recorded in Kalizira variety with control. The overall results indicated that recommended dose of all chemical fertilizers optimized the yield of aromatic rice.

Keywords: Aromatic rice; fertilizer dose; transplant aman rice; yield.

1. INTRODUCTION

Agriculture in Bangladesh is dominated by intensive rice (*Oryza sativa L.*) cultivation. It accounts for 89.56% annual food grain production [1]. At present aman rice is the second largest crop in the country in respect of volume of production [1]. With a few exceptions, all aromatic rice varieties are cultivated in the rainy aman season. Aromatic rice is generally low yielding [2] but they are considered the best in quality and highly valued in respect of price and acceptance. It has great specialty and importance among all the rice varieties due to their nice aroma. Public preference and demand for this rice are increasing day by day. Besides, due to its aroma quality, the buyers of the global market are very much attracted to aromatic rice. In Bangladesh, the average yield of rice in aman season is 2.385 t ha^{-1}, and local transplanted aman rice is 1.652 t ha^{-1} [1]. Farmers invest 38% less money for production of aromatic rice than coarse grain rice per acre but yield is much lower than coarse rice [3]. For this reason, our farmers do not show their interest to cultivate aromatic rice though it is a very highly valued crop. But the high price of aromatic rice can help them in getting 30% of higher gross margin as compared to coarse rice [3]. The average yield of local transplant aman rice in Sylhet region is 1.605 t.ha^{-1} [1]. Locally cultivated aromaic rice in Sylhet region during aman season are Chinigura, Kalizira, Chinirsail, Gandi, Muktasail, Mikrisail, Nagrasail, Bantos, Maloti etc. The yield of aromatic rice is affected by various management practices as well as fertilization. Regarding fertilizer usage in course, rice field farmer applies about 2.06 and 1.62 times more urea and TSP respectively than aromatic rice. But unexpectedly aromatic rice growers use 15 kg ha^{-1} more MoP than coarse rice farmers [3]. To find out a balanced fertilization, suitable fertilizer recommendation for aromatic rice needed to be developed. If we can improve the yield of these varieties, there will be a huge opportunity to earn foreign currency by exporting these and also the local demand. With this view, the experiment was conducted to evaluate fertilizers response of five aromatic rice varieties on yield and yield contributing characters under pot culture condition.

2. METHODOLOGY

The pot experiment was conducted at the experimental yard of Sylhet Agricultural University, Sylhet, Bangladesh during aman season of 2015. The location of the site was 24.91° N latitude and 91.90° E longitude and elevation of 30 m from the sea level (Google Earth, 2014). The soil belongs to the "Pritim Pasha" soil series of Northern and Eastern Piedmont Plains (Agro Ecological Zone 22). Different chemical properties of initial soil i.e. soil pH (4.97), organic carbon (0.90%), organic matter (1.56%), total N (0.089%), available P (6.5 mg kg^{-1}), exchangeable K (0.14 meq 100g^{-1} soil), available S (17.67 mg kg^{-1}) and available Zn (0.137 mg kg^{-1}) were recorded.

During the experimental period, the maximum temperature was recorded at 33.0°C, minimum 14.7°C and the mean monthly relative humidity was 73.33%. Heavy rainfall occurs during the first three months. The experiment comprised of five local aromatic rice varieties viz. V_1: Kalizira, V_2: Muktasail, V_3: Nagrasail, V_4: Maloti and V_5: Chinigura, and four levels of fertilizer viz. F_1: recommended dose, F_2: 2/3rd of recommended dose, F_3: 1/3rd of recommended dose: and F_4: Control (no fertilizer). Total number of treatment combinations was 20. The experiment was laid out in a Randomized Complete Block Design with three replications. Total 60 pots were used

having the size of 45.72 cm × 45.72 cm (18´´×18´´). Three rows of pots were arranged and row to row distance was 1 m. Each pot was filled up with 45 kg field soil. According to the treatments, all fertilizers except urea were applied to the soil surface during final pot preparation and then mixed by flood irrigation. Urea was applied in two equal splits (one half as basal and another half at 40 DAT). There were four hills in each pot. The spacing of transplanting was 18 cm × 18 cm and five seedlings were transplanted in each hill. Cultural operations such as weeding, irrigation and pest control were done as and when needed. The 30 days old seedling of aromatic rice varieties were transplanted on 07 August 2015 and harvested from 01 to 04 December 2015. Grain and straw yields were recorded potwise. After harvesting, ten plants were randomly selected from each pot to collect yield contributing characters. Recorded yield parameters were panicle length, number of effective and non-effective tillers $hill^{-1}$, grains $panicle^{-1}$, sterile spikelets $panicle^{-1}$, total spikelets $panicle^{-1}$, 1000-grain weight, grain yield, straw yield, harvest index, panicle emergence and period of field duration up to maturity. Grain and straw yields were recorded potwise and adjusted at 14% moisture basis. Yield data were statistically analyzed by using MSTAT-C program and mean comparison was made by Duncan's Multiple Range Test (DMRT). The dose of fertilizer for the aromatic local transplant rice was taken according to Fertilizer Recommendation Guide [4]. The doses, sources and amount of fertilizers for pot experiment were mentioned in Table 1 for upper 10 kg soil in each pot.

Table 1. Procedures used to determine soil parameters

Soil parameters	Determination procedure
pH	Determined in 1:2.5 soil:water suspension using a glass electrode pH meter [5].
Organic matter	Organic carbon was determined volumetrically by wet oxidation method [6] and the organic matter content was calculated by multiplying the present organic carbon with the Van Bemmelen factor of 1.73.
Total N	Estimated by following Micro Kjeldahl method [7]. The samples were digested with 30% H_2O_2, concentrated H_2SO_4 and catalyst mixture (K_2SO_4:$CuSO_4.5H_2O$: Se in the ratio of 10:1:0.1. The samples were distilled with 40% NaOH followed by titration with 0.01 N H_2SO_4.
Available P	The sample was extracted with 0.5 M $NaHCO_3$ solution [8] and developed blue colour by $SnCl_2$ and measured the colour colorimetrically.
Exchangeable K	The sample was extracted with 1.0 N NH_4OAc (pH 7) and K was determined from the extract by Flame Photometer [9] and calibrated with a standard K curve.
Available S	Determined by extracting the soil samples with 0.15% $CaCl_2$ solution [7]. The S content in the extract was estimated turbidimetrically with a spectrophotometer at 420 nm.
Available zinc	The sample was extracted by 0.05M DTPA solution (pH 7.3) maintaining 1:2 soil-extractant ratio and directly measured by Atomic Absorption Spectrophotometer [10].

Table 2. Nutrient element, their sources and doses

Nutrient elements	Doses for pot expt. ($kg\ ha^{-1}$)	Sources of fertilizers	Doses ($g\ pot^{-1}$)			
			Recommended dose (F_1)	2/3rd of F_1 (F_2)	1/3rd of F_1 (F_3)	Control (F_4)
Nitrogen	45	Urea	4.90	3.26	1.63	-
Phosphorus	10	TSP	3.00	2.00	1.00	-
Potassium	20	MoP	2 .10	1.40	0.70	-
Sulphur	10	Gypsum	3.30	2.20	1.10	-
Zinc	0.5	$ZnSO_4$	0.075	0.05	0.025	-

3. RESULTS AND DISCUSSION

3.1 Varietal Effect

Aromatic rice varieties had a significant effect on different yield and yield contributing characters except for a number of non-effective tillers hill^{-1}. The longest panicle (20.28 cm) was found in Chinigura and the shortest (18.05 cm) was noted in Nagrasail variety (Fig. 1a). Kalizira produced the highest number of effective tillers hill^{-1} (14.33) but Chinigura (8.92) had the lowest. The highest number of non-effective tillers hill^{-1} (1.67) was found in Nagrasail and the lowest (1.08) was recorded in Chinigura (Fig. 1b). Chinigura produced the highest number of grains panicle^{-1} (117.50) while the lowest number (72.92) was produced by Nagrasail variety (Fig. 1c). A number of sterile spikelets panicle^{-1} was also noticed as the highest (13.42) in Chinigura whereas Nagrasail (6.08) had the lowest. Chinigura produced the highest number of total spikelets panicle^{-1} (127.58) but the lowest number (91.17) was recorded in Maloti variety (Fig. 1c). 1000-grain weight was maximum in Muktasail (17.06 g) while Chinigura (9.99 g) had the lowest weight (Fig. 1d). Grain yield ranged from 41.24-51.57 g pot^{-1}. Muktasail produced the highest grain yield (51.57 g pot^{-1}) and the lowest (41.24 g pot^{-1}) was found in Maloti (Fig. 1e).

In case of straw yield, Nagrasail produced the highest (124.75 g pot^{-1}) whereas Muktasail (102.39 g pot^{-1}) the lowest (Fig. 1e). Nagrasail also had the highest harvest index (50.90%) but Chinigura (41.60%) had the lowest (Fig. 1f). Panicle emergence day varied among varieties. Kalizira (83.67 days) required the highest period for panicle emergence and Muktasail (67.33 days) required the least (Fig. 1g). Among five aromatic rice varieties, the maximum period of field duration up to maturity (115.00 days) was noticed in three varieties viz. Kalizira, Nagrasail and Maloti while the shortest period (111.50 days) was found in Chinigura (Fig. 1g). It was observed from the above results that different yield and yield contributing characters differed greatly from variety to variety. It might be due to having variation in attributes and potentialities of five different aromatic rice varieties. An experiment showed that modification in the management practices can positively influence the rice crop outputs [11]. Rice KJTKH-1 was found to produce a significantly higher yield than conventional cultivars Jaya and Swarna by applying different N rate and there was a significant increasing grain yield with successive increase in fertilizer rate [12]. Besides, the yield of 'Proagro 6207' hybrid rice variety increased significantly with an application of sulfur-containing nitrogen fertilizer [13].

3.2 Fertilizers' Effect

All the fertilizer levels i.e. treatments F_1 to F_4 showed significant effects on all the yield and yield contributing characters of the aromatic rice varieties. The longest panicle length was recorded as 20.45 cm due to F_1 treatment application and the shortest length was 17.56 cm in control treatment (Fig. 2a). Recommended dose produced the highest and control treatment produced the lowest number of effective tillers hill^{-1} and these were 14.27 and 7.47, respectively (Fig. 2b). The highest number of non-effective tillers hill^{-1} was 2.07 found in F_4 treatment and the lowest was 1.00 in F_1 (Fig. 2b). The highest number of grains panicle^{-1} was 110.07 recorded in the recommended dose of fertilizer and the lowest was 81.67 in control treatment (Fig. 2c). The pots having treatment F_4 yielded the highest number of sterile spikelets panicle^{-1} (13.27) and F_1 produced the lowest (7.93). The highest and the lowest numbers of total spikelets panicle^{-1} were 119.13 and 88.73, respectively in F_1 and F_4 treatment (Fig. 2c). 1000-grain weight was found as the highest (14.59 g) for applying the recommended dose of fertilizer and control treatment showed the lowest (12.86 g) value (Fig. 2d). Grain yield varied from 31.00 to 59.16 g pot^{-1} due to different fertilizer levels (Fig. 2e).

Application of recommended dose produced the highest grain yield and control treatment indicated the lowest. Straw yields ranged from 67.78 to 144.65 g pot^{-1}. The highest straw yield was recorded in F_1 dose and lowest in F_4 dose (Fig. 2e). The highest and the lowest harvest indices were 48.87% and 40.31%, respectively (Fig. 2f). The longest period of panicle emergence was recorded as 78.53 days in F_1 treatment and the shortest period was 68.07 days in F_4 treatment (Fig. 2g). Pots receiving recommended dose of fertilizer showed the longest (113.27 days) period of field duration up to maturity and the shortest period (112.07 days) in control treatment in soil (Fig. 2g). It was seen that different levels of nitrogen influenced grain yield, straw and biological yields with the application of 100% recommended dose (RD) of N which was statistically followed by other treatments in descending order, and the highest grain yield was found with 100% RD of N and the

lowest from no application of nitrogen [14]. Application of higher doses of N and K_2O significantly influence the yield attributes of hybrid rice and produced higher grain and straw

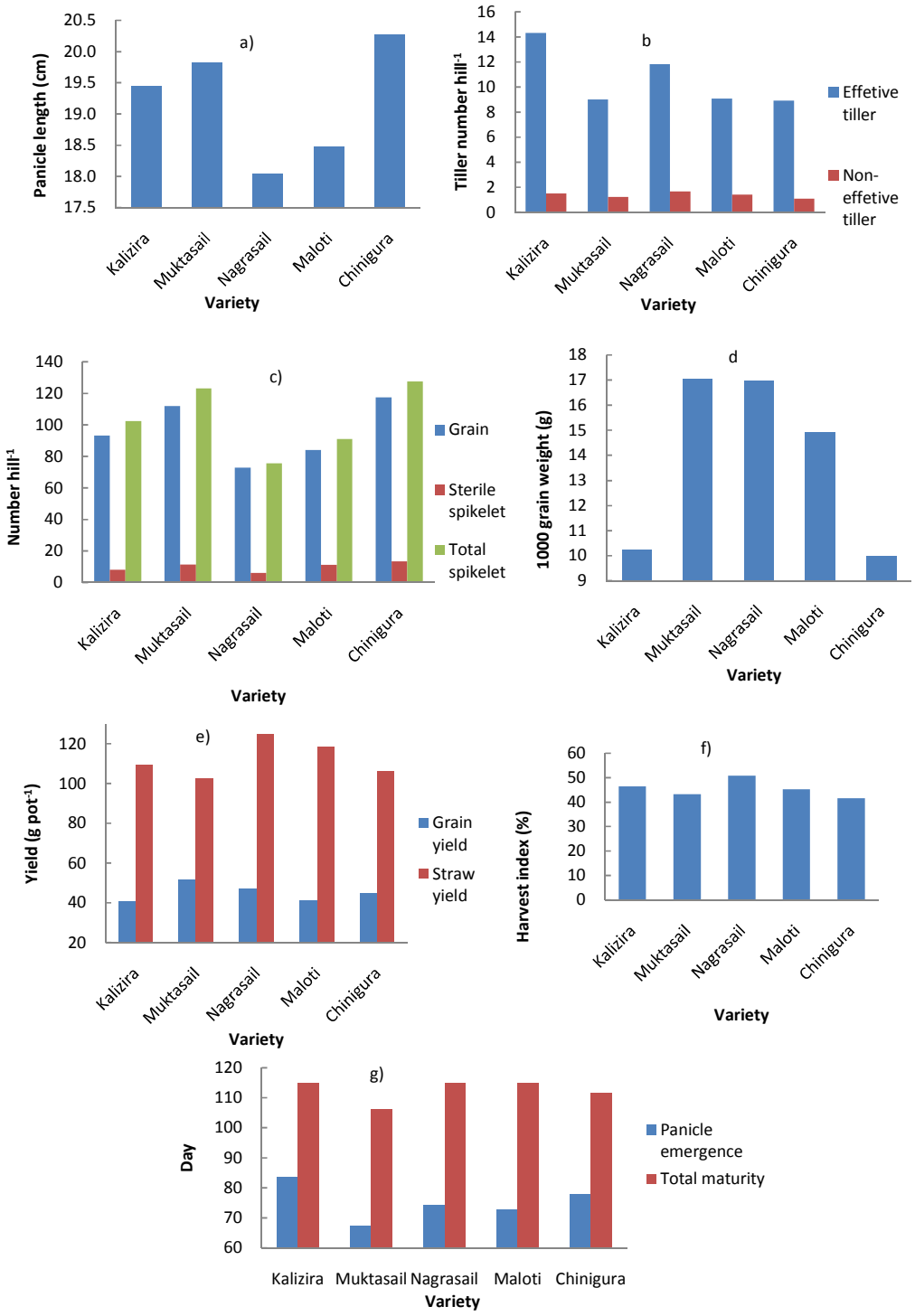

Fig. 1. Varietal effect on (a) Panicle length (b) Number of effective and non-effective tiller (c) Number of grain, sterile and total spikelet (d) 1000-grain weight (e) Grain yield and straw yield (f) Harvest index, and (g) Panicle emergence and total maturity days of aromatic rice

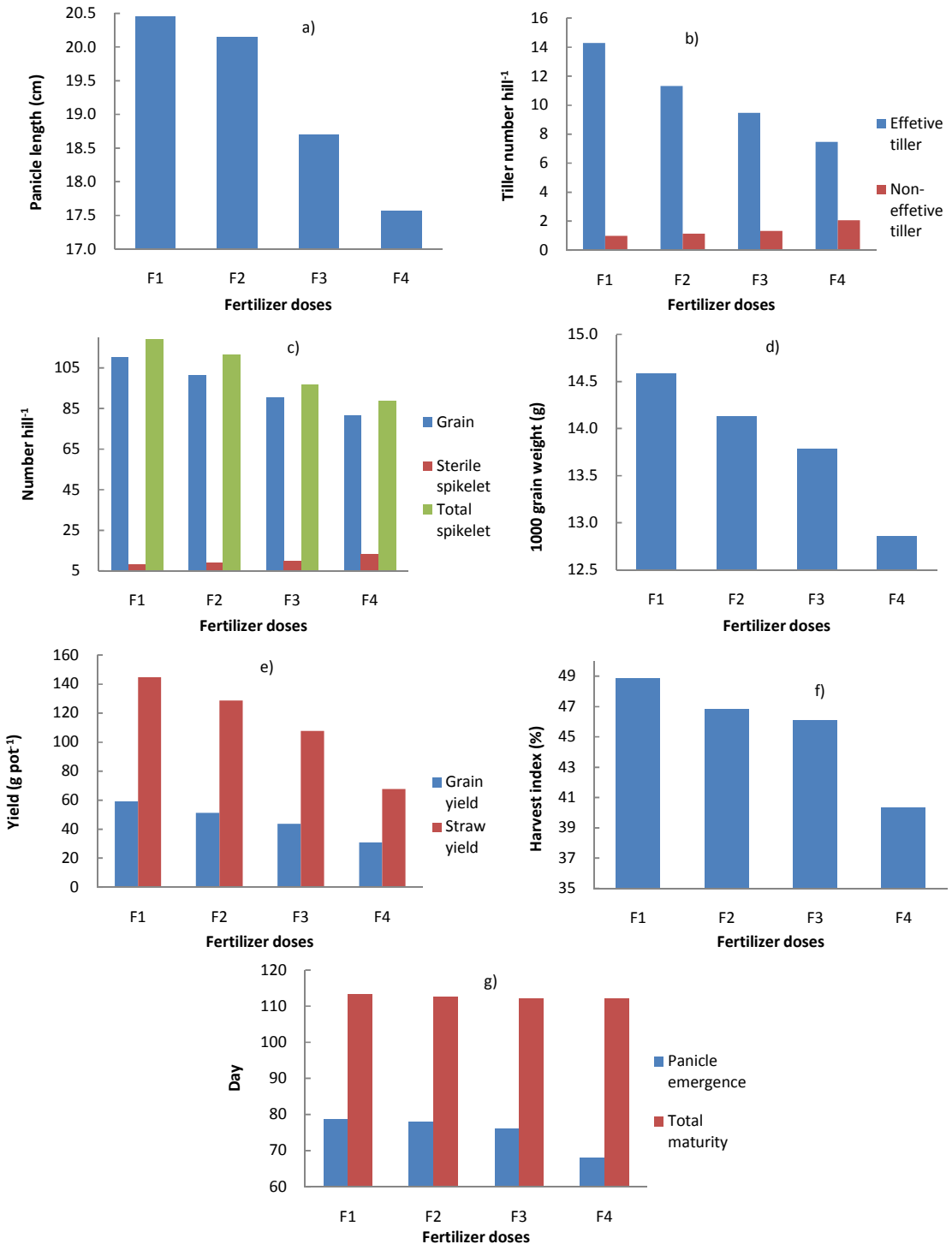

Fig. 2. Fertilizers' effect on (a) Panicle length (b) Number of effective and non-effective tiller (c) Number of grain, sterile and total spikelet (d) 1000-grain weight (e) Grain yield and straw yield (f) Harvest index, and (g) Panicle emergence and total maturity days of aromatic rice

yield [15]. Basmati rice produced significant grain yield and yield attributes while combined application of N and Zn was made at its maximum rate [16].

3.3 Interaction Effect of Variety and Fertilizer

There was significant interaction effect among different fertilizer levels and varieties on all of the yield and yield contributing characters except panicle length, number of effective tillers hill^{-1} and harvest index (Table 3). Muktasail had the longest panicle length (21.60 cm) with 2/3rd of the recommended dose of fertilizer (F_2) and the shortest (15.30 cm) was recorded in Nagrasail with control treatment. Kalizira produced the highest number of effective tillers hill^{-1} (22.00) with F_1 dose of fertilizer while Chinigura (3.00) with F_4 showed the lowest number. The highest number of non-effective tillers hill^{-1} (2.67) was noted in Nagrasail variety with control and the lowest number of non-effective tillers hill^{-1} (0.33) was found in Chinigura with F_1 dose of fertilizer. Chinigura yielded the highest number of grains panicle^{-1} (131.67) with the recommended dose of fertilizer but the lowest number of grains panicle^{-1} (48.00) was produced by Nagrasail with control treatment. Among five aromatic rice varieties, Muktasail had the highest number (15.67) of sterile spikelets panicle^{-1} with control treatment and Kalizira had the lowest number (5.33) with recommended dose of fertilizer. In case of a total number of spikelets panicle^{-1}, the highest value (135.67) was recorded in Chinigura variety with 2/3rd of the recommended dose and Nagrasail with control showed the lowest (53.67) value. Nagrasail variety with 2/3rd of the recommended dose of fertilizer produced the highest 1000-grain weight (17.59 g) while Chinigura had the lowest weight (8.81 g) without any fertilizer.

Application of F_1 dose of fertilizer had the highest grain yield in Nagrasail (65.33 g pot^{-1}) variety followed by Kalizira (65.26 g pot^{-1}) with F_1 dose but the lowest grain yield (24.31 g pot^{-1}) was recorded in Maloti with control treatment. Straw yield ranged from 61.70 to 174.07 g pot^{-1}. Maloti had the highest straw yield

Table 3. Interaction effect of variety and fertilizer effect on yield and yield contributing characters of aromatic rice

Variety and Fertilizer	Panicle length (cm)	Effective tillers hill^{-1} (nos.)	Non-effective tillers hill^{-1} (nos.)	Grain panicle^{-1} (nos.)	Sterile spikelets panicle^{-1} (nos.)	Total spikelets panicle^{-1} (nos.)
V_1F_1	21.07	22.00	1.33 b-e	110.67 d	5.33 f	121.33 bc
V_1F_2	20.55	17.33	0.67 de	106.67 d	6.00 f	108.33 de
V_1F_3	18.63	7.33	1.67 b-d	81.67 fg	6.33 f	100.00 ef
V_1F_4	17.53	10.67	2.33 ab	73.67 gh	14.67 ab	80.00 hi
V_2F_1	20.27	9.67	1.33 b-e	124.00 ab	8.00 d-f	135.33 a
V_2F_2	21.60	9.67	1.33 b-e	114.33 cd	10.33 c-e	130.00 a
V_2F_3	19.42	9.00	0.67 de	105.00 d	11.67 bc	113.00 cd
V_2F_4	17.99	7.67	1.67 a-d	104.67 d	15.67 a	114.66 cd
V_3F_1	20.28	13.67	0.67 b	92.00 e	5.67 f	96.00 fg
V_3F_2	18.47	14.67	1.67 a-d	81.00 fg	6.00 f	88.00 gh
V_3F_3	18.16	10.67	1.67 a-d	70.67 h	5.67 f	65.33 j
V_3F_4	15.30	8.33	2.67 a	48.00 i	7.00 f	53.67 k
V_4F_1	19.50	13.33	1.33 b-e	92.00 e	7.67 ef	108.33 de
V_4F_2	19.30	4.67	0.67 de	84.67 ef	11.00 cd	94.67 fg
V_4F_3	17.71	10.67	1.67 a-d	84.00 ef	12.33 a-c	79.33 i
V_4F_4	17.42	7.67	2.00 a-c	75.67 f-h	13.67a-c	82.33 hi
V_5F_1	21.13	12.67	0.33 e	131.67 a	13.00 a-c	134.67 a
V_5F_2	20.84	10.33	1.33 b-e	120.67 bc	12.67 a-c	135.67 a
V_5F_3	19.57	9.67	1.00 c-e	111.33 d	12.67 a-c	127.00 ab
V_5F_4	19.56	3.00	1.67 a-d	106.33 d	15.33 a	113.00 cd
SE±	-	-	0.3215	2.320	0.7941	2.085
LS	NS	NS	*	**	**	**

In a column, the figure(s) having similar letter(s) do not differ significantly

*V_1 = Kalizira, V_2 = Muktasail, V_3 = Nagrasail, V_4 = Maloti, V_5 = Chinigura, F_1 = RD= Recommended Dose (45-10-20-10-0.5 kg ha^{-1} of N-P-K-S-Zn), F_2 = 2/3rd of RD, F_3 = 1/3rd of RD, F_4 = Control, SE± = Standard error, LS = Level of significance, NS= Not Significant, * = Significant at 5% level, ** = Highly significant at 1% level*

Table 3. Interaction effect of variety and fertilizer effect on yield and yield contributing characters of aromatic rice (Continued)

Variety and fertilizer	1000-grain wt. (g)	Grain yield (g pot^{-1})	Straw yield (g pot^{-1})	Harvest index (%)	Panicle emergence (days)	Total maturity days
V_1F_1	10.54 de	65.26 a	148.27 b	49.36 a-c	85.33 a	115.00 a
V_1F_2	10.51 de	45.25 cd	116.77 c	47.42 a-c	85.67 a	115.00 a
V_1F_3	10.02 ef	41.00 de	110.33 c	48.15 a-c	83.00 ab	115.00 a
V_1F_4	9.84 ef	35.76 ef	61.70 e	40.81 a-e	80.67 a-c	115.00 a
V_2F_1	17.40 a	64.76 a	124.23 c	46.91 a-d	69.00 d	109.00 d
V_2F_2	17.35 a	63.11 a	109.27c	44.91 a-d	68.67 d	106.33 e
V_2F_3	16.94 ab	41.71 de	106.13 c	44.41 a-e	65.33 d	104.67 f
V_2F_4	16.54 ab	36.71 ef	69.93 de	37.14 de	68.33 d	104.33 f
V_3F_1	17.45 a	65.33 a	153.83 b	51.65 a	79.00 bc	115.00 a
V_3F_2	17.59 a	47.69 b-d	151.93 b	52.35 a	80.00 a-c	115.00 a
V_3F_3	16.79 ab	42.75 de	122.83 c	50.28 ab	80.00 a-c	115.00 a
V_3F_4	16.12 ab	32.39 fg	70.40 de	49.31a-c	58.00 e	115.00 a
V_4F_1	15.67 b	47.28 b-d	174.07 a	52.07 a	80.67 a-c	115.00 a
V_4F_2	15.38 b	47.39 b-d	147.63 b	46.01 a-d	77.33 bc	115.00 a
V_4F_3	15.67 b	46.00 b-d	85.40 d	43.73 a-e	75.33 c	115.00 a
V_4F_4	13.00 c	24.31 h	67.27 de	39.59 c-e	58.00 e	115.00 a
V_5F_1	11.89 cd	53.19 b	122.83 c	44.33 a-e	68.67 bc	112.33 b
V_5F_2	9.74 ef	52.37 bc	117.53 c	43.43 a-e	78.33 bc	111.67 bc
V_5F_3	9.51 ef	46.80 b-d	114.07 c	43.96 a-e	77.00 ce	111.00 c
V_5F_4	8.81 f	25.83 gh	69.60 de	34.68 e	77.33 bc	111.00 c
SE±	0.3629	1.792	4.507	2.992	1.347	0.307
LS	**	**	**	*	**	**

In a column, the figure(s) having a similar letter(s) do not differ significantly
*V_1 = Kalizira, V_2 = Muktasail, V_3 = Nagrasail, V_4 = Maloti, V_5 = Chinigura, F_1 = RD= Recommended Dose (45-10-20-10-0.5 kg ha^{-1} of N-P-K-S-Zn), F_2 = 2/3rd of RD, F_3 = 1/3rd of RD, F_4 = Control, SE± = Standard error, LS = Level of significance, ** = Highly significant at 1% level*

(174.07 g pot^{-1}) with F_1 dose of fertilizers while the lowest one (61.70 g pot^{-1})was produced by Kalizira with control treatment. It was observed that the highest harvest index (52.35%) was found in Nagrasail variety with 2/3rd of recommended dose of fertilizer (F_2) and the lowest harvest index (34.68%) was found in Chinigura with F_4 dose. In case of panicle emergence day, Kalizira required the highest days (85.67) with 2/3rd of recommended dose of fertilizer (F_2), whereas both Nagrasail and Maloti varieties had the lowest (58.00) with control treatment. Among five aromatic rice varieties, the highest period of field duration up to maturity (115.00 days) was noted in three varieties viz. Kalizira, Nagrasail and Maloti with recommended dose of fertilizer and the lowest (104.33 days) were found only in Muktasail with control treatment.

In most of the cases, it was noticed that recommended dose of all fertilizer had the highest result and control treatment resulted the lowest. In the present study Nagrasail possessed the highest grain yield. It might be due to having the highest 1000-grain weight, long panicle length, fewer sterile spikelets panicle^{-1} etc. in Nagrasail variety. This grain yield was statistically similar to the grain yield found in Kalizira. That might be due to having longest panicle length and the highest effective tillers hill^{-1}, fewer sterile spikelets panicle^{-1} and more total spikelets panicle^{-1} etc. in Kalizira variety. It was said that the application of the highest ratio of NPK fertilizer ha^{-1} resulted in the highest number of panicles per hill, 1000-grain weight, grain yield and straw yield [17]. It was also found that [18] the yield of rice increased with increasing zinc levels. Besides, an experiment [19] showed that application of zinc significantly increased the number of filled grains panicle^{-1} and 1000-grain weight. The average grain and straw yields increased with increasing rates of S and P [20]. A similar result also found in another experiment [15].

4. CONCLUSION

In conclusion, it could be said that the results of the study of five aromatic rice varieties had significantly higher yield when they received recommended dose of fertilizers. In case of varietal performance, Nagrasail and Kalizira produced the highest yield among the varieties. In order to obtain a higher yield of aromatic rice, recommended a dose of fertilizer (45-10-20-10-0.5 kg ha-1 of N-P-K-S-Zn) may be applied under the similar agro-climatic and soil condition.

ACKNOWLEDGEMENTS

It is pleased to acknowledge Bangladesh Agricultural Research Council (BARC) for granting fund the project entitled “Yield gap minimization of Boro rice in the haor areas through agronomic management with special reference to fertilization” under which the research work was conducted. Ministry of Science and Technology (MOST) of Bangladesh is also highly acknowledged for providing fellowship to complete the research work successfully.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. BBS (Bangladesh Bureau of Statistics). The yearbook of agricultural statistics of Bangladesh. Statistics division, Ministry of planning, Govt. people's republic of Bangladesh, Dhaka. 2015;39-63.
2. Gangaiah B, Prasad R. Response of scented rice (*Oryza sativa*) to fertilizers. Indian J. Agron. 1999;44(2):294.
3. Adhikary RC, Hasan SMK. Problem and prospects of aromatic and fine rice cultivation and marketing in north-west Bangladesh. RDA, Bogra; 2006. (ISBN 984-556-241-8).
4. BARC (Bangladesh Agricultural Research Council). Fertilizer recommendation Guide. Farmgate, Khamarbari road, Dhaka-1215. 2012;85.
5. Jackson ML. Soil Chemical analysis. Constable and Co. Ltd. London. 1962; 46.
6. Walkey A, Black IA. An examination of degtiareff method for determining soils organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 1934;37:29-38.
7. Page AL, Miller RH, Keeney DR. Methods of Soil Analysis Part II. 2nd ed. Amer. Soc. of Argon. Inc. Pub. Madison, Wisconsin, USA. 1982;539-622.
8. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, U.S. Dept. Agric. Cric. 1954;939.
9. Black CA. Methods of Soil Analysis. Part I and II. American Soc. of Agron. Inc. Pub. Madison, Wisconsin, USA. 1965;545-567.
10. Lindsay WI, Norvell WA. Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Science Society America. 1978;42: 421-428.
11. Lin XQ, Zhu HZ, Chen SH, Cheng S, Uphoff N. Effect of plant density and nitrogen fertilizer rates on grain yield and nitrogen uptake of hybrid rice (*Oryza sativa*). J. Agri. Biotech. and Sustain. Devel. 2009;1(2):44-53.
12. Dongarwar UR, Patankar MN, Pawar WS. Response of rice to different fertility levels. J. Soils and Crops. Nagger, India. 2003;13(1): 120-122.
13. Chaturvedi I, Lahori P. Effect of nitrogen fertilizers on growth, yield and quality of hybrid rice (*Oryza sativa*). J. Agri. Sci. 2007;6(4):45-52.
14. Mazumder MR, Bhuiya MSU, Hossain SMA. Effect of N level and split application of Sesbania rostrata as green manure on the performance of transplanted aman rice cv. BRRI dhan 31. Bangladesh J. Agri. Sci. 2005;31(2):183-188.
15. Kumar R, Kumar R, Shivani, Kumar S. Effect of nitrogen and potassium levels on growth and yield of hybrid rice. J. Applied Biol. 2005;15(1):31-34.
16. Ali H, Hasnaini Z, Ahmad N, Sarwar N, Qureshi MK, Khaliq S, Qayyum MF. Nitrogen and Zinc Interaction Improves Yield and Quality of Submerged Basmati Rice (*Oryza sativa* L.). Not. Bot. Horti. Agrobo. 2014;42(2): 372-379.
17. Arivazhagan K, Ravichandran M. Interaction effect of nitrogen and potassium on yield and yield attributes in rice cv. IR 20. Advances Plant Sci. 2005;18(1):425-427.
18. Malik NJ, Chamon AS, Mondol MN, Elahi SF, Faiz SMA. Effect of different levels of

Zn on growth and yield of red amaranth (*Amaranthus sp.)* and rice (*Oryza sativa*, variety-BR49). J. of Bd. Asso. of Yo. Resr. (JBAYR. 2011;1(1):79-91.

19. Sudha S, Stalin P. Effect of zinc on yield, quality and grain zinc content of rice genotypes. Inter. J. of Farm Sci. 2015;5(3): 17-27.
20. Ali MM, Mian MS, Islam A, Begum JA, Ferdous AKM. Interaction effects of sulphur and phosphorus on wetland rice. Asian J. Plant Sci. 2004;3(5):597-601.

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