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Rice genotypic variation in methane emission patterns under irrigated culture

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ABSTRACT

Anthropogenic emission of methane under anaerobic condition of irrigated rice field is a global concern contributing to global warming more than any other greenhouse gases. A field experiment was conducted with eight rice genotypes to identify the genotype(s) with low methane emission coupled with high yielding potential. Emissions of methane were measured from all treatments using manual operated closed chamber technique following standard guidelines and CH_4 concentrations in the collected air samples were measured by gas chromatography. Methane emissions during different growth stages of rice ranged between 43.6 and 579.2 mg CH_4 m^{-2} d^{-1} and showed a higher emission at maximum tillering to flowering stages, while peaks in CH_4 fluxes were observed in 67 DAT for short duration and 84 DAT in long duration rice genotypes. Root biomass and growth duration showed significant positive correlation with methane emission (p<0.01), but above ground biomass had no significant effect on methane emission. The highest cumulative CH_4 emission (257.6 kg CH_4 ha^{-1}) was noted in BRRI dhan29 having grain yield of 6.55 t ha^{-1}, while the lowest (158.9 kg CH_4 ha^{-1}) was found in local variety, Kheyaliboro having grain yield of 3.04 t ha^{-1}. Kheyaliboro showed lower methane emission but the lower grain yield contributed to the higher yield scaled methane emission. While quantifying yield scaled methane emission, considering the national food security, eight rice genotypes followed the order: Kheyaliboro>BR16>Binadhan-6>BRRI dhan29>Binadhan-10>BRRI dhan28>BRRI dhan55>Binadhan-17. Yield scaled methane emission decreased by 14-45% in response to different rice genotypes. Employing yield scaled methane emission can address both climate change and national food demand.

Keywords: Growth duration, biomass yield, grain yield, yield scaled methane emission

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1 Introduction

Wetland rice fields emit significant amount of methane which is a great concern in terms of global warming potential. Agriculture is the top contributor, with 39% greenhouse gas (GHG) emissions among various sectors, while rice cultivation contributing

32% of Bangladesh's agricultural GHG emissions (FAOSTAT, 2015). Rice production is increasing (51.64 million tons) occupying almost 11.4 million ha of land in Bangladesh (BBS, 2015). Increased population demands higher rice production, which should be expected to increase 56% by 2050 than in 2001 (Kabir et al., 2016). Increased rice production can increase the methane emission as well as contribute more to the global warming, where a country like Bangladesh is more vulnerable.

Irrigated rice cultivation is a major anthropogenic source of CH_4 emission. Methane gas emissions involve production, oxidation and transportation systems (Mer and Roger, 2001; Mingxing and Jing, 2002) in irrigated rice field, following three pathways *viz.*, molecular diffusion, ebullition and plant-mediated transport (Wassmann et al., 1996; Khosa et al., 2010). Plant-mediated methane emissions from rice field accounts about 60-90% of the total methane emissions (Schutz et al., 1989; Wassmann and Aulakh, 2000). Methane budget is regulated by rice plants from functioning of three factors (Zheng et al., 2014): source of methanogenic substrate (Wang et al., 1999; Kerdchoechuen, 2005), effective methane gas exchange through aerenchyma (well developed intercellular air spaces) between atmosphere and anaerobic soil (Fu et al., 2007) and active CH_4-oxidizing site in the rice rhizosphere by supporting O_2 counter transport through the aerenchyma system (Win et al., 2011; Gutierrez et al., 2014). Until now no report has been published on methane emission from rice genotypes in Bangladesh.

There is a greatest opportunity and also most influential to mitigate methane emission from rice field through selection of high yielding rice genotypes with low methane emission Baruah et al. (2010); Su et al. (2015). Indian rice variety Saket had the highest methane emission followed by Pant 4, Sarju 52 and Sundari in decreasing order (Singh et al., 2003). Methane emissions measured from Indica and Japonica rice varieties in Taiwan (Liou et al., 2003) reported that the first one emitted more methane than latter. Furthermost, methane emissions results from different rice cultivars are related to rice growth performance, i.e. number of plant tillers, plant above and belowground biomass (Wang et al., 1997; Xu et al., 1999). Seasonal CH_4 emission from flooded soil was affected by rice plant growth duration (Setyanto et al., 2000).

The objective of the current study was to determine the disparity in methane emission rates from different rice genotypes, including traditional and high-yielding, widely grown in Bangladesh under irrigated rice culture. The objective also covers the carbon credit estimation with the potential biological yield of rice plants to identify genotype(s) with low methane emission potential.

2 Materials and Methods

2.1 Experimental site and weather

The experiment was conducted in typical rice growing silt loam soil at the Soil Science Field Laboratory, Bangladesh Agricultural University, Mymensingh located at 24°43′4.8″N, 90°25′30.1″E during January-May, 2017. Land was medium high having non-calcareous dark grey floodplain soil under Sonatala series. The soil was acidic in nature having pH 5.38, organic carbon 1.75%, total nitrogen 0.16%, available phosphorus 2.95 mg kg^{-1}, available sulphur 12.06 mg kg^{-1} and exchangeable potassium 0.08 meq 100 g^{-1} soil. Daily rainfall and air temperature during growing season are shown in Fig. 1.

2.2 Experimental design and agronomy

Eight rice genotypes *viz.* BR16, BRRI dhan28, BRRI dhan29, BRRI dhan55, Binadhan-6, Binadhan-10, Binadhan-17 and Kheyaliboro were used in this experiment as the test crop. The experiment was laid out in a randomized complete block design (RCBD) with four replications, each plot measuring 5.6 m × 3.6 m. The plots were surrounded by 30 cm wide and 10 cm high earthen bunds. Hundred centimeter wide irrigation channel was made in-between two blocks for experiment. Recommended doses of nutrients *viz.* N (140 kg ha^{-1}), P (25 kg ha^{-1}), K (85 kg ha^{-1}), S (20 kg ha^{-1}) and Zn (3 kg ha^{-1}) were applied as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum ($CaSO_4.2H_2O$) and zinc oxide (ZnO) respectively for all plots. Triple super phosphate, muriate of potash, gypsum and zinc oxide were applied during final land preparation. Prilled urea was also applied in three equal splits at 09, 29 and 57 DAT. Thirty-five-days old rice seedlings were transplanted. Seedlings were transplanted in rows where both plant to plant and row to row distances were 20 cm.

2.3 Measurement of CH_4 emission

Emissions of methane were measured using manual operated closed chamber technique following standard guidelines (Minamikawa et al., 2012). A closed chamber consisted of chamber top and chamber base. Acrylic glass was used to prepare a chamber top (0.60 m × 0.40 m × 1.3 m, length, width and height, respectively), while a separate chamber base (0.6 m × 0.4 m × 0.3 m, length, width and height, respectively) was prepared using same glass and installed in respective plots 24 h before gas sampling. To get the daily mean CH_4 flux during the flooded growing period measurements were conducted during mid-morning at 10:00-11:00 (Sander and Wassmann, 2014; Yun et al., 2013; Minamikawa et al., 2015). Gas sample was collected from rice fields at different growth

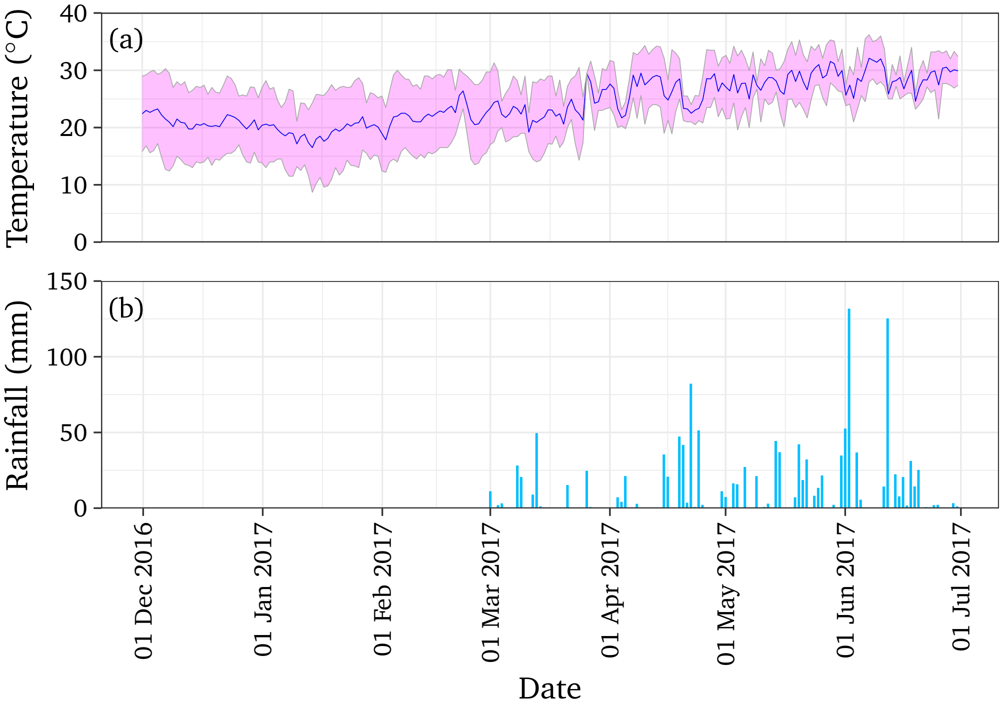

Figure 1. Variation in (a) air temperature and (b) average rainfall during rice growing period at Bangladesh Agricultural University (BAU). The ribbon indicates the range of maximum and minimum air temperatures, and blue line indicates mean air temperature.

stages (Table 1) of rice plants to get the cumulative CH_4 emissions during the cropping season. The air gas samples were collected from chambers using 50 mL air-tight syringes at 0, 15 and 30 min intervals after chamber placement.

2.4 Harvesting

The crop was harvested at maturity. The area of 6.08 m^2 was harvested from each plot. Yield components and yield parameters *i.e.* plant height, number of tiller $hill^{-1}$, filled grains $panicle^{-1}$, unfilled grains $hill^{-1}$, root biomass, 1000-grain weight, grain and straw yields were recorded. The grain yield was obtained on 14% moisture basis while the straw yield was recorded on sundry basis.

2.5 Calculation of hourly gas fluxes and cumulative emissions

2.5.1 Hourly gas flux

Linear regression method was followed for calculating the hourly CH_4 flux (Minamikawa et al., 2015). This method is based on the principle that the concentration gradient of CH_4 between flooded soil and the atmosphere is quite large so that CH_4 can be considered to be emitted at a constant rate.

The hourly fluxes of CH_4 (mg CH_4 m^{-2} h^{-1}) was calculated as follows:

$$\text{Flux}_{CH_4} = \frac{\Delta C}{\Delta t} \times \frac{V}{A} \times \rho \times \frac{273}{273 + T} \tag{1}$$

where $\Delta C/\Delta t$ is the concentration change over time (ppm CH_4 h^{-1}); V is chamber volume (m^3); A is chamber area (footprint; m^2); ρ is gas density (0.717 kg m^{-3} for CH_4 at 0 °C); and T is the mean air temperature inside the chamber (°C).

2.5.2 Cumulative emission

For calculating cumulative methane emissions, trapezoidal integration method (linear interpolation and numerical integration between sampling times) was used (Minamikawa et al., 2015). Calculation involved three steps, firstly, calculation of the daily gas flux by multiplying the daily mean hourly gas flux by 24. Secondly, calculation of the emission between every two consecutive measurements using the trapezoidal rule and thirdly, sum up the areas of all the trapezoids. The cumulative CH_4 emission was calculated as follows:

$$CME = \sum A_n \tag{2}$$

where CME is the cumulative methane emission, and A_n (A_1, A_2,....,A_n) is the emission between every two consecutive measurements.

Table 1. Growth stages of different rice genotypes at BAU farm

Rice genotypes	Growth Stages† (DAT)						
	27	53	67	84	99	106	119
Kheyaliboro	AT – LT	PI	H – F	M	M		
Binadhan-10	AT	PI	H	F – GF	M	M	
Binadhan-17	AT	PI	H	F – GF	M	M	
BRRI dhan28	AT	PI	H	F – GF	M	M	
BRRI dhan55	AT	PI	H	F – GF	M	M	
Binadhan-6	AT	SE	H	F	GF	M	M
BR16	AT	SE	H	F	GF	M	M
BRRI dhan29	AT	SE	H	F	GF	M	M

† AT = active tillering, LT = lag tillering, PI = panicle initiation, SE = stem elongation, H = heading, F = flowering, GF = grain filling, M = maturation

2.6 Yield scale methane emission

Yield scale methane emission ($YSME$) was calculated using the cumulative methane emission (kg CH_4 ha^{-1}) and rice grain yield (t ha^{-1}). The $YSME$ was calculated as follows:

$$YSME = \frac{CME}{\text{Grain yield}} \tag{3}$$

2.7 CO_2-eq emission and carbon credit

The CO_2-eq of CH_4 over 100 years is 28 times that of CO_2 (Ghosh et al., 2015; Finn et al., 2014). CO_2-eq of CH_4 emission from production of 1 ha rice was estimated using the following equation (Taghavi et al., 2017):

$$CO_2\text{-eq} = \frac{W_{CH_4} \times GWP}{1000} \tag{4}$$

where, CO_2-eq (t) = methane emission from 1 ha of rice field; W (CH_4) (kg) = total weight of CH_4 emitted from rice growing season; GWP = global warming potential, CH_4 = 28 and 1,000 = coefficient of kg to t.

Carbon credit (t CO_2 reduction ha^{-1}) was calculated by comparing seasonal CO_2-eq methane emissions of the eight rice genotypes (used as a treatment). For reference genotype, the genotype produced highest yield and emission was considered.

2.8 Statistical analysis

Plant parameters (growth, yield and yield components) data was subjected to statistical analysis through computer based statistical program Statistical Tool for Agricultural Research (STAR 2.0.1, International Rice Research Institute, Philippines), following the basic principles, as outlined by Gomez and Gomez (1984). Significant effects of the treatments were determined by analysis of variance (ANOVA) and the treatment means was compared at 5% level of significance by Duncan's Multiple Range Test (DMRT).

3 Results

3.1 Yield components of rice genotypes

The plant height of tested eight rice genotypes varied significantly. The plant height ranged from 81.7 to 92.8 cm and the tallest plant of 92.8 cm was found in Kheyaliboro. The shortest (81.7 cm) was observed in BR16. The tillers number $hill^{-1}$ differed significantly and ranged from 10.8 to 13.3. The average tiller number $hill^{-1}$ of BR16, BRRI dhan28, BRRI dhan29, BRRI dhan55, Binadhan-6, Binadhan-10, Binadhan-17 and Kheyaliboro was 12.0, 12.3, 11.8, 13.3, 10.8, 12.3 12.2 and 13.2 cm, respectively (Table 2). The maximum tiller number $hill^{-1}$ of 13.3 was found in BRRI dhan55 and the minimum value of 10.8 was observed in Binadhan-6.

The number of filled grains $panicle^{-1}$ of rice genotypes were significant and ranged from 55.2 to 109.4. Results presented in the Table 2 showed that the number of filled grains $panicle^{-1}$ was the highest (109.4) with Binadhan-17, which was identical with the genotype BRRI dhan29 and the lowest value was recorded in Kheyaliboro (55.2). Among the undesirable traits, number of unfilled grains $panicle^{-1}$ was important one and played a vital role in yield reduction. Effect of genotypes on the number of unfilled grains $panicle^{-1}$ was highly significant. BRRI dhan29 produced the lowest number of unfilled grains $panicle^{-1}$ (13.9) which contributed to highest grain yield (6.55 t ha^{-1}).

Grain yield of rice mainly depends on the number of effective tillers per unit area, filled grains $panicle^{-1}$ and 1000-grain weight. Results indicated that the grain yield was identical between BRRI dhan29 and Binadhan-17. The next similar yielding trend i.e. 5.61, 5.81 and 5.67 t ha^{-1} was observed in genotypes BRRI dhan28, BRRI dhan55 and Binadhan-6, respectively.

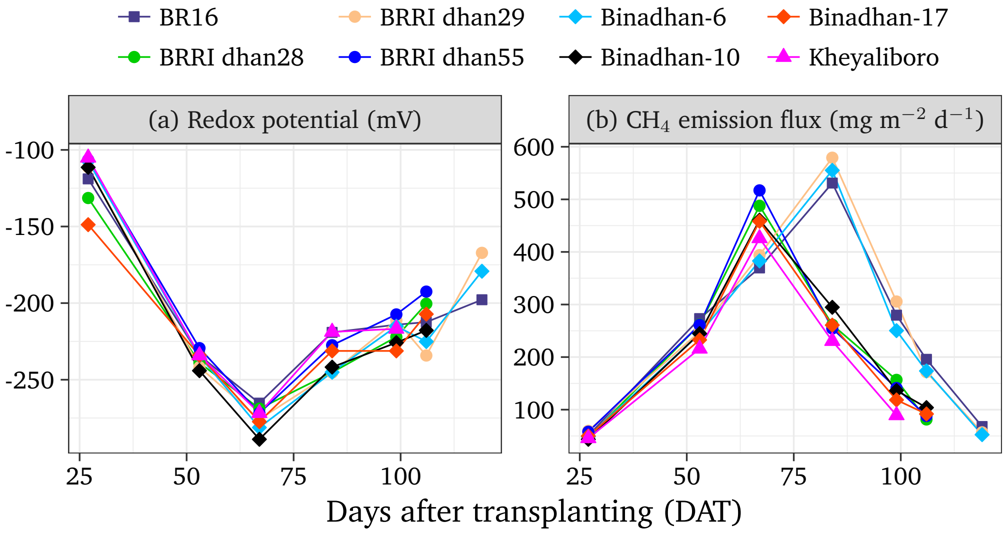

Figure 2. Changes of (a) redox potential (Eh) (b) CH$_4$ emission flux in flooded rice soil at BAU farm for different rice genotypes

The highest straw yield of 6.21 t ha^{-1} was obtained from Binadhan-17 and the lowest (3.68 t ha^{-1}) was recorded from Kheyaliboro.

3.2 Dynamics of soil redox potential (Eh)

The seasonal soil Eh for different rice genotypes showed more or less similar pattern. The redox potential significantly decreased by the advancement of the growth stages of different rice genotypes (Fig. 2). Initially, a low soil redox value (−105.10 mV to −148.80 mV) was observed in the rice field. While following the flooding, redox value then gradually decreased, reaching an Eh level less than −250 mV. Low redox was sustained throughout the growing season in all plots. The Eh ranged from −105.1 to −148.8 mV at 27 DAT, −229.4 to −244.1 mV at 53 DAT, −265.3 to −288.9 mV, at 67 DAT, −218.8 to −245.3 mV at 84 DAT, −207.4 to −231.10 mV at 90 DAT, −192.5 to −234.2 mV at 106 DAT and −167.2 to −197.8 mV at 119 DAT.

3.3 Rice genotypes and CH$_4$ emission

The trends of methane emission fluxes were similar among the rice genotypes. Figure 2b showed the temporal variations in CH$_4$ fluxes during different growth stages of rice genotypes. However, emissions were higher at maximum tillering (67 DAT) to flowering stages (84 DAT) than that during vegetative (27 DAT) and ripening stages (99 DAT). In case of early maturing rice genotypes (life cycle <145 d), peaks in CH$_4$ fluxes were observed in 67 DAT, corresponding to methane flux values between 569.1 and 369.6 mg m^{-2} d^{-1}. While for late maturing rice genotypes (life cycle >145 d), at 84 DAT methane fluxes peaked in, with the values ranges between 579.2 and 531.0 mg m^{-2} h^{-1}.

3.4 Rice growth and CH$_4$ emission

A strong relationship was noticed among methane emission and growth duration and rice growth parameters was found (Table 3). Root biomass, growth duration and methane emission showed significant positive correlation with each other (p<0.01). However, above ground biomass of rice plant had no significant effect on methane emission. This recommends an approach of selecting early maturing rice genotypes with higher yield but lower methane emission capacity. Moreover, CH$_4$ was also significantly and positively correlated with rice root biomass which indicates that more root biomass has the more root exudates and substrate for the methane production.

3.5 Cumulative and yield scaled CH$_4$ emission

Methane emission rates and total methane fluxes differed significantly among eight rice genotypes (DMRT, p<0.05). Cumulative seasonal emissions of CH$_4$ and YSME are presented in Fig. 3. Results showed that the cumulative CH$_4$ emissions of BRRI dhan29, BR16, Binadhan-6, BRRI dhan55, BRRI dhan28, Binadhan-10, Binadhan-17 and Kheyaliboro were 257.6, 249.1, 243.8, 199.3, 196.0, 192.1, 182.2 and 158.9 kg CH$_4$ ha^{-1}, respectively. Cumulative methane emission was higher in late maturing genotypes comparing to early maturing genotypes (Fig. 3a).

Late maturing genotypes, BRRI dhan29, showed the highest CH$_4$ emission. The lowest CH$_4$

Table 2. Effect of genotypes on yield components, grain and straw yield at maturity stage

Genotypes	Growth dur. (d)	Height (cm)	Tiller hill^{-1}	Fil. grains panilce^{-1}	Unfil. grains panilce^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
BR16	154	81.7g	12.0bc	66.7d	21.1bc	26.2c	5.54c	5.36b
BRRI dhan28	142	88.8c	12.3abc	84.5c	15.6d	21.9d	5.61c	5.42b
BRRI dhan29	154	89.5b	11.8cd	105.4ab	13.9d	22.1d	6.55a	6.19a
BRRI dhan55	142	87.9d	13.3a	84.0c	28.7a	26.8c	5.81bc	5.49b
Binadhan-6	154	83.3f	10.8d	91.1c	26.5a	29.1a	5.67c	5.57b
Binadhan-10	142	88.5cd	12.3abc	99.8b	24.4ab	27.0c	5.48c	5.33b
Binadhan-17	142	85.4e	12.2abc	109.4a	28.1a	28.0b	6.32ab	6.21a
Kheyaliboro	134	92.8a	13.2ab	55.2e	18.0cd	19.9e	3.04d	3.68c
Sig. value		0.0000	0.0029	0.0000	0.0000	0.0000	0.0000	0.0000
SE (±)		0.1896	0.3743	2.7661	1.5149	0.2759	0.1762	0.1783

† Figures in a column having common letters do not differ significantly at p<0.05; SE = Standard error of means

emission (158.9 kg ha^{-1}) was recorded in local early maturing genotypes, Kheyaliboro. While quantifying YSME, eight rice genotypes followed the order: Kheyaliboro>BR16>Binadhan-6>BRRI dhan29>Binadhan-10>BRRI dhan28>BRRI dhan55>Binadhan-17 (Fig. 3b). Among eight genotypes, YSME of Binadhan-17 was found lowest (28.8 kg CH_4 t^{-1} grain yield), followed by BRRI dhan55 (34.3 kg CH_4 t^{-1} grain yield), BRRI dhan28 and Binadhan-10 (35.0 kg CH_4 t^{-1} grain yield). The highest YSME was observed Kheyaliboro (52.3 kg CH_4 t^{-1} grain yield). Therefore, Binadhan-17 had the lowest potential methane emission with highest grain yield.

3.6 Carbon credit of rice genotypes

Carbon credit and biomass yield of eight rice genotypes indicated in Fig. 4. The highest biomass yield was found in BRRI dhan29 (12.7 t ha^{-1}) followed by Binadhan-17 (12.5 t ha^{-1}). The lowest was observed with the genotype Kheyaliboro (6.72 t ha^{-1}). Emission reduction credit was calculated as considering BRRI dhan29 as the highest methane emitter rice genotype. Carbon credit of Kheyaliboro was the highest with a value of 2.76 t CO_2 reduction ha^{-1}. Following to that Binadhan-17, Binadhan-10, BRRI dhan28 and BRRI dhan55 had the reduced carbon credit. This carbon credit has the chance to finance the GHG emission.

4 Discussion

4.1 CH_4 emission

In Bangladesh, where rice area covers more than 80% of the agricultural land, irrigated rice field is the major anthropogenic source of methane. More than 90% of methane emission is transported through rice plant in anaerobic rice field (Hussain et al., 2014; Setyanto et al., 2016; Jia and Cai, 2003; IPCC, 1996). No study has yet been investigated in Bangladesh to find the rice genotypes with high yield but less emission.

Our experiment was conducted with a view to identify the rice genotype(s) with low methane emission coupled with high yield. Soil oxidation-reduction (redox) potential is a critical indicator of anoxic condition of a soil which instigates methane production. Initial low Eh value (<−150 mV) followed by irrigation, decreased sharply to <−250 mV and subsequently increased after 84 DAT. Such low Eh value is triggered by continuous flooding condition in rice field (Oo et al., 2015; Ali et al., 2014; Babu et al., 2005). Results showed that the Eh decreased with time and the decrease was the highest at 67 DAT, leading to highest methane emission (Ali et al., 2014; Oo et al., 2015; Gaihre et al., 2011). Besides soil parameters, plant growth parameters also correlated with methane emission and in our study a significant positive relation showed among root biomass and growth duration and methane emission (Jia et al., 2006) though many previous studies showed strong relation between rice growth parameters and methane emission (Setyanto et al., 2016) whereas in the current study aboveground biomass had no significant relationship with methane emission. Growth duration of different rice genotypes had also strong positive relation with root biomass. Higher root biomass constitutes higher root exudates and substrates which ultimately colonize more methanogens in rhizosphere. The colonization and abundance of methanogen on rice roots are closely related to cumulative CH_4 emission (Liu et al., 2012).

There were significant and considerable amount of variation in methane emission among the rice genotypes which was also indicated in a number of field studies (Kumar and Viyol, 2009; Aulakh et al., 2000). With the growth of rice plant the emission increased, where higher emission was recorded from tillering to flowering stage. In early maturing rice genotypes the peak was observed at 67 DAT while in late ma-

Table 3. Correlation matrix of relationships among rice growth parameters and methane emission[†]

Parameters	Filled grains	Grain yield	Straw yield	Biomass yield	Root biomass	Growth duration	Methane emission
Filled grains							
Grain yield	0.8169	1					
Straw yield	0.8542	0.9903	1				
Biomass yield	0.8325	0.9985	0.9963	1			
Root biomass	0.3789	0.6994	0.6644	0.6854	1		
Growth duration	0.2835	0.6168	0.5965	0.6089	0.9615	1	
Methane emission	0.2261	0.5831	0.5474	0.5688	0.9774**	0.9845**	1

[†] ** means significant at $p<0.01$ level of significance

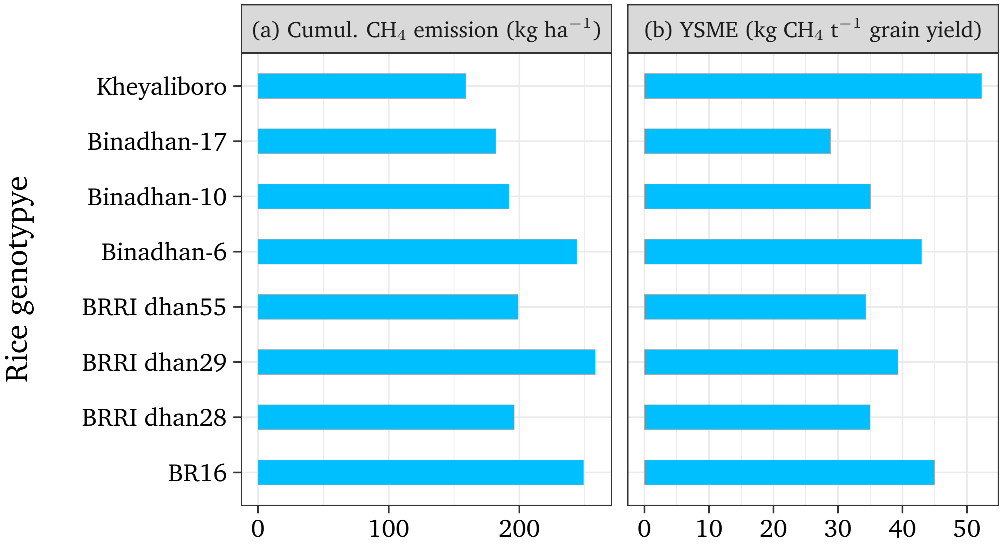

Figure 3. (a) Cumulative methane emission and (b) yield scaled methane emission from different rice genotypes at BAU farm. YSME designates yield scaled CH_4 emission.

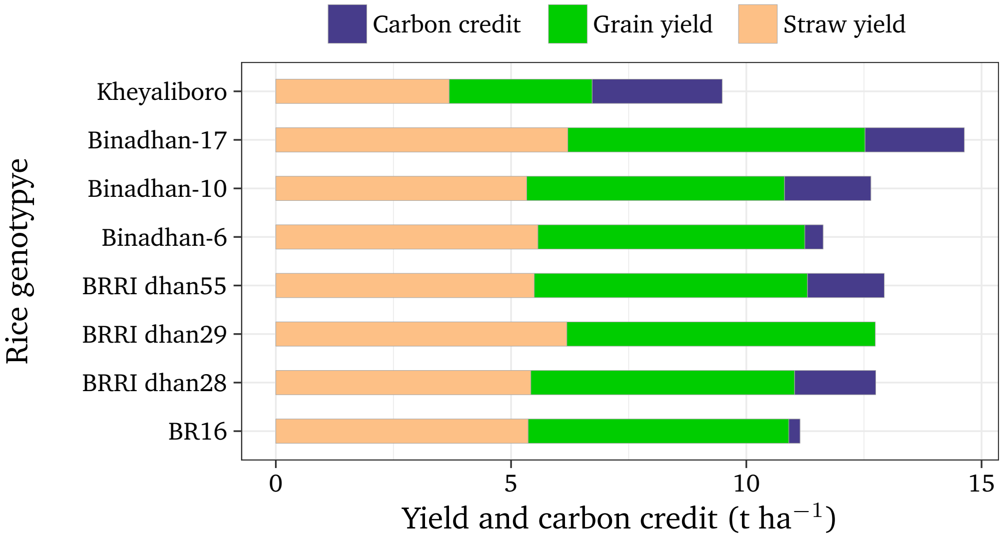

Figure 4. Seasonal total carbon credit from different rice genotypes at BAU farm

turity genotypes this was observed at 84 DAT (Bhattacharyya et al., 2014; Alberto et al., 2014; Suryavanshi et al., 2012; Inubushi et al., 2003; Miyata et al., 2000).

This is due to higher methanogensis, microbial decomposition of rhizosphere deposition, root exudates and other carbon inputs (Meijide et al., 2011; Tokida et al., 2010). It is an indication that rice genotypes have effects on methane emission which should be taken into account while increasing the rice grain yield.

4.2 Rice yield, YSME and carbon credit

Consisting with the findings of Setyanto et al. (2000), early maturing rice genotypes emitted less methane compared to that of late maturing genotypes. Commonly cultivated BRRI dhan29, a high yielding genotype with high biomass yield, emitted more cumulative methane emission compared to that of low yielding local genotype, Kheyaliboro. Due to variance of plant structure, size, number of tillers, metabolism, CH_4 gas transport potential and root exudates etc. methane emission varies in different genotypes (Setyanto et al., 2016; Jia et al., 2002). There are some potential genotypes having higher grain yield with less emission. Still this is area based cumulative methane emission calculation.

To meet up the increased demand of country's population, new approaches are to be found to attain the twin targets of achieving food security and reduced greenhouse gas emissions (Burney et al., 2010; Tilman et al., 2011). Combating food security with the increase of rice grain yield is inevitable. The attention must be given to rice genotypes with higher yield having less methane emission. Quantifying greenhouse gas emission per unit grain yield would provide an agronomic efficiency that possibly will ensure climate change and national food demand (Grassini and Cassman, 2012).

In context of Bangladesh this is first time methane emission from irrigated rice fields has been calculated based on grain yield rather than area. In our investigation, we are aiming to find the rice genotype(s) with high yielding potential but lower methane emission. Though Kheyaliboro, an early maturing genotype, produced lower methane emission, the lower grain yield contributed to the higher YSME. Results indicated that Binadhan-17, BRRI dhan55, BRRI dhan28 and Binadhan-10 had the higher yield potential but lower methane emission, later contributing to lower YSME. Yield scaled methane emission decreased by 14-45% in response to different rice genotypes. In relation to climate smart agriculture and sustainable rice production, carbon credit of rice genotypes will lower the greenhouse gas emission. Our results showed that cultivating Binadhan-17 could save the carbon which is sustainable for environment and means of sourcing GHG.

5 Conclusions

It could be concluded that Binadhan-17 would be promising rice genotype to reduce methane emission without negotiating the rice grain yield. More validation is needed to certify the carbon credit. Still this is triple win situation and that can be employed to our country's environment strategy and policy. Further field experiment in different agro-ecological Zone (AEZ) having wide range of soils needs to be carried out for rice genotypes based on low methane emission cultivated in Bangladesh.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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