Impacts of fertilizer and water management on greenhouse gas emissions and nitrogen use efficiency from lowland rice cultivation


Session: Mitigation
Independent University, Bangladesh
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Introduction

- Staple food
- Rice and greenhouse gases (GHG)
- Global warming
Likely impact in agriculture
Objectives

- To determine the effects of PU vs UDP on floodwater $\text{NH}_4^+\text{-N}$, $\text{NH}_3$ volatilization, greenhouse gas emission, grain yield and NUE
- To compare the effects of water management on GWP in dry season.
- To find out an efficient N and water management option for increased crop productivity with reduced negative environmental impacts.
Materials and Methods

- **Seasons**
- **Treatments:** 3
- **Design:** RCB
- **Replication:** 3

**N₂O and NO gas measurement**

- **Gas chambers** were installed in respective plots over aluminum base. $\text{N}_2\text{O}$ and NO gas were measured with an automated closed chamber technique.
CH$_4$ gas measurement

- Closed gas chamber (manual sampling)
- Gas sampling was done once a week at 15 min interval (0, 15 and 30 min).
- Gas conc. was measured using GC Analyzer.
### Results and Discussion

Table. The interaction effects of water regime × N application methods on grain yield (GY) and recovery efficiency of N at BRRI farm, Gazipur.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>GY (t ha(^{-1}))</th>
<th>RE(_N) (kg N uptake N kg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AWD</td>
<td>CSW</td>
</tr>
<tr>
<td>Control</td>
<td>1.91c</td>
<td>1.79c</td>
</tr>
<tr>
<td>Urea briquette</td>
<td>4.95a</td>
<td>4.99a</td>
</tr>
<tr>
<td>Prilled urea</td>
<td>3.85b</td>
<td>4.20b</td>
</tr>
<tr>
<td>Mean</td>
<td>3.57A</td>
<td>3.66A</td>
</tr>
</tbody>
</table>

**ANOVA (p Values)**

- Treat (T): 0.000
- Water (W): 0.328
- T × W: 0.127
Fig. Changes in floodwater NH$_4^+$-N and NH$_3$ volatilization in control, UDP and PU treat under AWD in dry season. Vertical bars indicate standard error of mean (n=3).
Fig. Impacts of N fert. and water management on cumulative N$_2$O-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.
Fig. Impacts of N fert. and water management on yield-scaled N$_2$O-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.
Cumulative nitric oxide (NO) emission

Cumulative nitric oxide (NO) emission (g ha⁻¹ season⁻¹)

Fig. Effects of N fert. and water management on cumulative NO-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.
Fig. Effects of water management on cumulative CH$_4$ emission during dry season.
Table. Impacts of fertilizer and water management on CH$_4$ and N$_2$O emission and GWP in dry seasons

<table>
<thead>
<tr>
<th>Treat.</th>
<th>Total CH$_4$ flux (kg ha$^{-1}$ sea$^{-1}$)</th>
<th>Total N$_2$O flux (g ha$^{-1}$ seas$^{-1}$)</th>
<th>GWP (kg CO$_2$ eq. ha$^{-1}$ season$^{-1}$)$^a$</th>
<th>% GWP reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AWD</td>
<td>CSW</td>
<td>AWD</td>
<td>CSW</td>
</tr>
<tr>
<td>Control</td>
<td>131</td>
<td>246</td>
<td>90</td>
<td>19</td>
</tr>
<tr>
<td>UDP</td>
<td>251</td>
<td>372</td>
<td>470</td>
<td>48</td>
</tr>
<tr>
<td>PU</td>
<td>191</td>
<td>328</td>
<td>332</td>
<td>133</td>
</tr>
<tr>
<td>Average</td>
<td>191</td>
<td>315</td>
<td>297</td>
<td>67</td>
</tr>
</tbody>
</table>

$^a$GWP (global warming potential) of CH$_4$ and N$_2$O were calculated by multiplying 28 and 265 on seasonal CH$_4$ and N$_2$O fluxes, respectively.
Deep placement of urea briquette significantly increased rice yield compared to PU, additionally it could save N by 20-30% without any yield penalty (Islam et al., 2018).

UDP significantly reduced floodwater \( \text{NH}_4^+ \) and \( \text{NH}_3 \) volatilization compared to PU (Islam et al., 2016, 2018).

UDP and PU showed similar \( \text{N}_2\text{O} \) fluxes in AWD condition, while UDP significantly reduced \( \text{N}_2\text{O} \) fluxes over PU in CSW practice (Gaihre et al., 2015, 2018, Islam et al., 2018).
Across the water regimes, UDP reduced GWP by 10% compared to broadcast PU.

Across the N management, AWD irrigation reduced GWP by 39% compared to CSW condition in dry season.


THANK YOU
Fig. Nitrous and nitric oxides emission rates, floodwater depth, air temperature and rainfall under AWD condition during Boro 2015 and Boro 2016 seasons at BRRI, Gazipur. T, TD-1, TD-2, TD-3 and H correspond to transplanting, first, second and third topdressing and harvesting, respectively. Shaded area indicates the drying period.