Sustainable nitrogen management in rice cultivation under stress prone areas in Asia

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Abstract

Multi-location experiments were conducted under drought, submergence and saline conditions in Bangladesh, Nepal and Myanmar to determine the effects urea deep placement (UDP) vs broadcast prilled urea (PU) on rice yields, nitrogen use efficiency (NUE) and economic returns. UDP increased grain yields, reduced N losses including nitrous oxide emissions and increased NUE significantly compared to broadcast PU. Under drought condition, UDP increased grain yields by 12% (Bangladesh) to 21% (Nepal) compared to broadcast PU. Similarly, under saline condition, yield increment ranged from 10% (Bangladesh) to 40% (Myanmar) while saving urea fertilizer by up to 50%. Similar yield benefits and fertilizer savings were observed under submerged condition in Bangladesh and Myanmar.

Keywords: Nitrogen use efficiency, stress environment, rice, urea deep placement

1. Introduction

More than 50% of applied nitrogen is not utilized by crops, posing huge economical costs and environmental concerns. Fertilizer management is more challenging for rice cultivation in stress-prone environments subject to drought, submergence, and salinity. Farmers in these areas have poor control over water and fertilizer application. For conventional broadcast application of nitrogen, farmers are often unable or unwilling to apply the follow-on splits. Urea deep placement (UDP) could be a better alternative since it could be done before or at planting, ensures higher use efficiency due to reduction of losses (runoff and ammonia volatilization). UDP eliminates the need for additional split applications of urea and ensures higher yields. While UDP has proven its multiple benefits under favourable irrigated rice cultivation, but its effects under stress prone environments are still lacking. Multi-location experiments were conducted under drought, submergence and saline conditions in Bangladesh, Nepal and Myanmar to determine the effects UDP vs broadcast prilled urea (PU) on rice yields, nitrogen use efficiency and economic returns.

2. Materials and Methods

Nitrogen losses including floodwater ammonium, ammonia volatilization and nitrous oxide (N_2O) emissions were measured in on-station trials in Bangladesh, while grain yields and economic returns were recorded from on-farm trials.

3. Results

Across the countries and stress environments, UDP increased grain yields and NUE significantly compared to broadcast PU. Under drought condition, FDP increased grain yields by 12% (Bangladesh) to 21% (Nepal) compared to broadcast PU. Similarly, under saline condition, yield increment ranged from 10% (Bangladesh) to 40% (Myanmar) while saving urea fertilizer by up to 50%. Similar yield benefits and fertilizer savings were observed under submerged condition in Bangladesh and Myanmar. FDP significantly reduced

nitrogen losses compared to broadcast PU. Broadcast PU resulted in higher amounts of ammonium in floodwater and ammonia volatilization, both of which were negligible in FDP treatments. Moreover, UDP reduced N_2O emissions by 70% as compared to broadcast PU. These results confirm that UDP is equally effective if not more under stress environments than under favorable environment. UDP, in addition to saving N fertilizer and increasing crop productivity, reduces N losses as ammonia volatilization and greenhouse gas N2O emissions, could be considered a climate smart fertilizer management practice.

Acknowledgements

The United States Agency for International Development (USAID) provided support for this research through the project, “Feed the Future Soil Fertility Technology Adoption, Policy Reform and Knowledge Management (Cooperative Agreement number AID-BFS-IO-15-00001).”