Impact of different nitrogen rates on ammonia volatilization and nitrogen use efficiency of wheat (*Triticum aestivum* L.)

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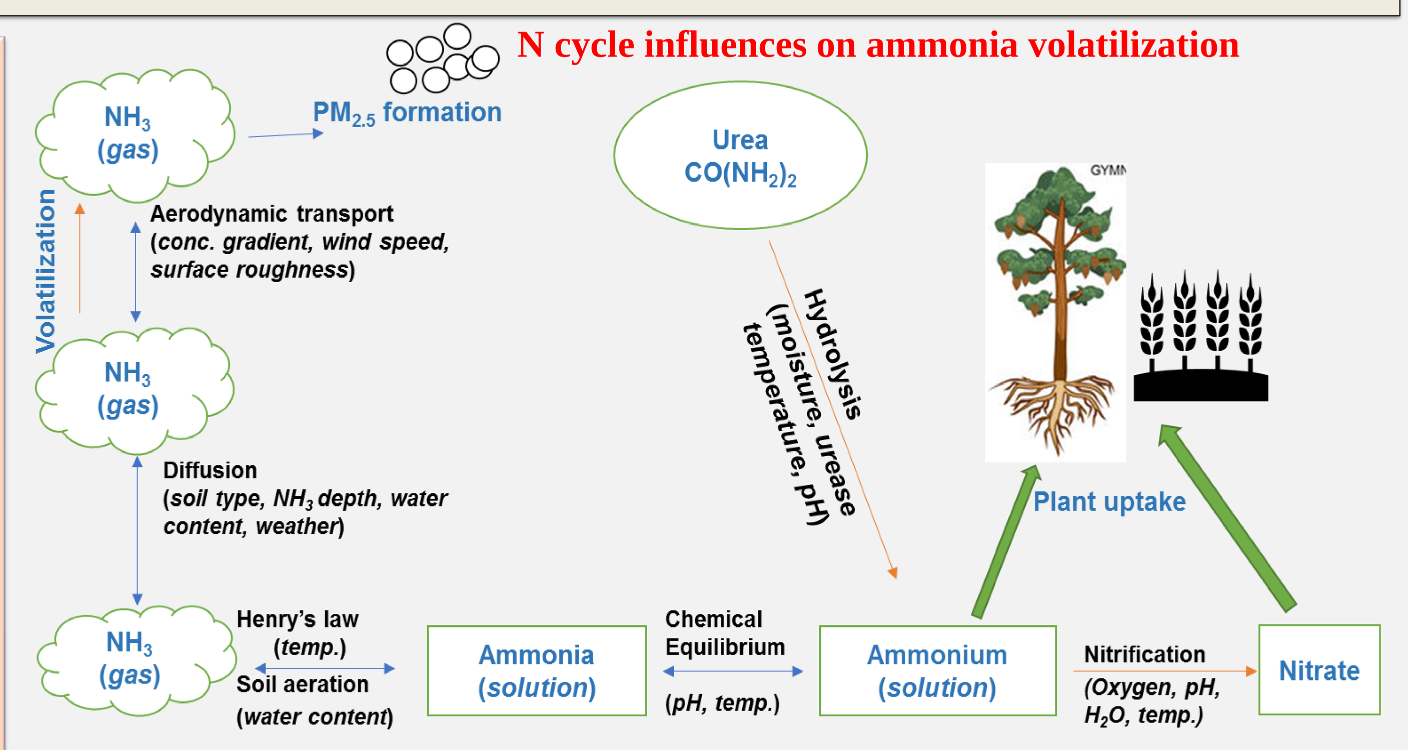
Introduction

Nitrogen (N) deficient soils impact on plant development and growth since N is a key plant nutrient. Low crop productivity is caused by the excessive and careless application of N fertilizers, which results in N losses and decreases N use efficiency (NUE). About half of the applied N is not taken up by crops, causing economic and environmental costs. It is released in many forms to the atmosphere but is mostly released in NH_3 volatilization and N_2O emissions form. There is ample evidence that N rate and N reduction can reduce NH_3 volatilization. Split-N applications were also recommended to reduce N stress.



Objective

This experiment was designed to determine the volatilization of NH_3 and NUE of wheat crops using different N (urea) rates.

Treatments

- T_1 — Control (No Nitrogen)
- T_2 — 100% recommended dose of N (134 kg N ha^{-1})
- T_3 — 25% less than recommended dose of N (100 kg N ha^{-1})
- T_4 — 25% more than recommended dose of N (168 kg N ha^{-1})

Materials and Methodology

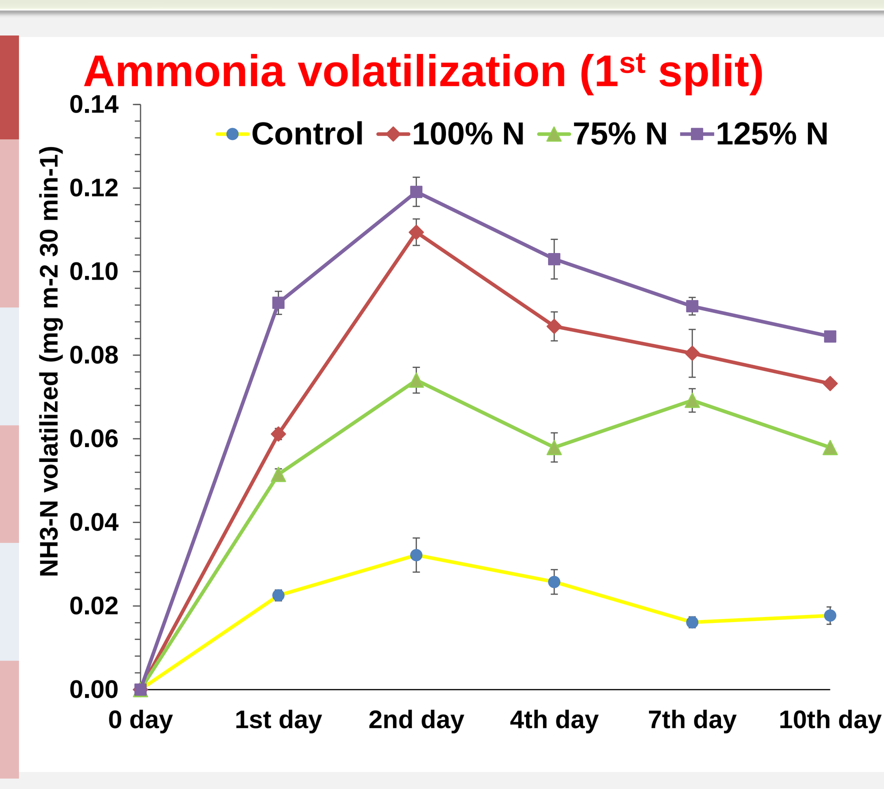
The field experiment was done at the research area of Institute of Soil and Environmental science, University of Agriculture Faisalabad.

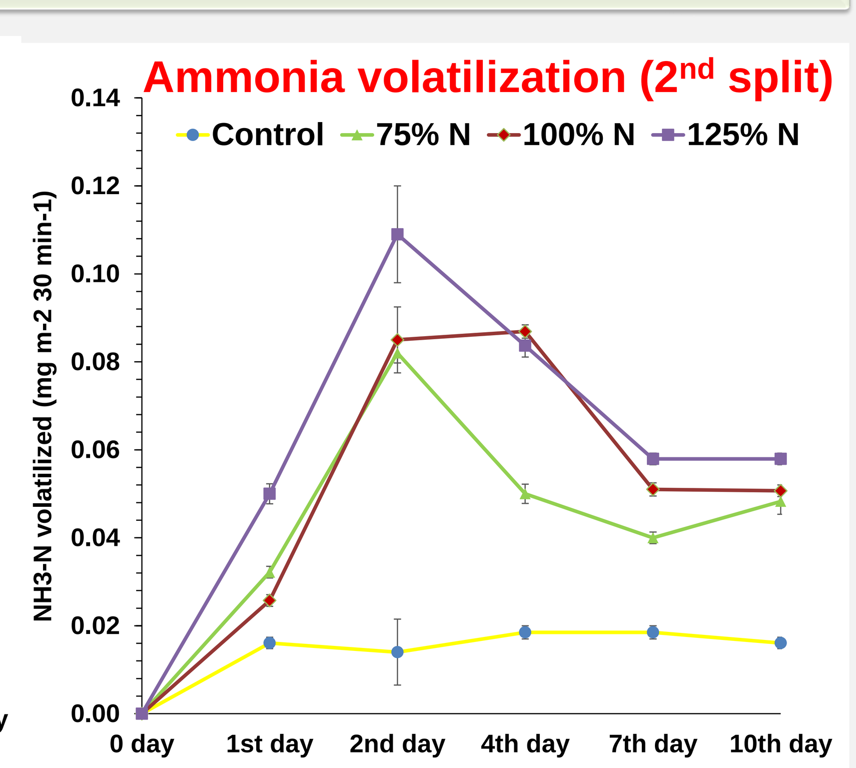
- A field experiment was conducted using a randomized complete block design having four treatments with four replicates. The N fertilizer (urea) was applied in three split.
- In each split, NH_3 volatilization was determined on the 1st, 2nd, 4th, 7th and10th day.
- Acrylic chamber was used to capture the volatilized NH_3 from the soil surface. An air suction sampling pump is used to collect the air and pass it through the solution (0.1% boric acid), which have mixed indicator (Methyl red & Bromocresol green).
- The volatilized ammoniacal N was determined by the titration of boric acid solution with sulphuric acid, until the color changes from green (solution color after absorbing volatilized NH_3) to wine red.
- Agronomic and yield parameter was taken at the harvest time.

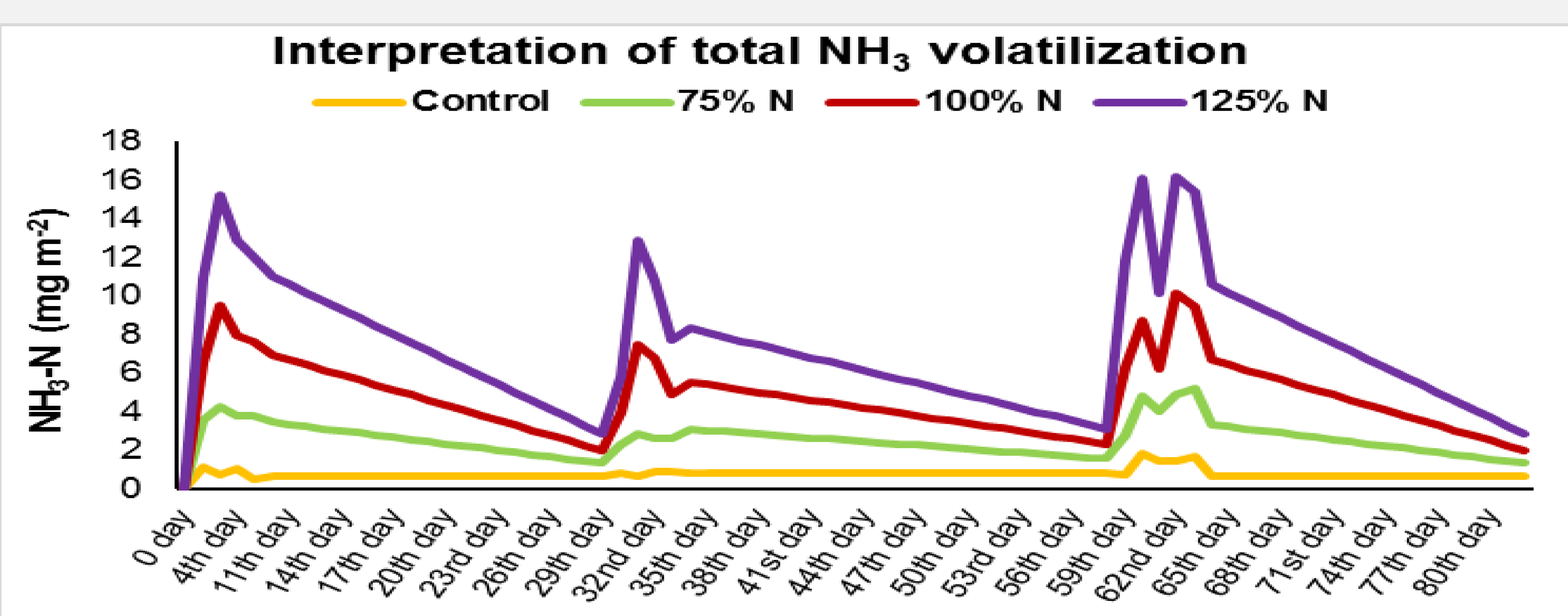
Results

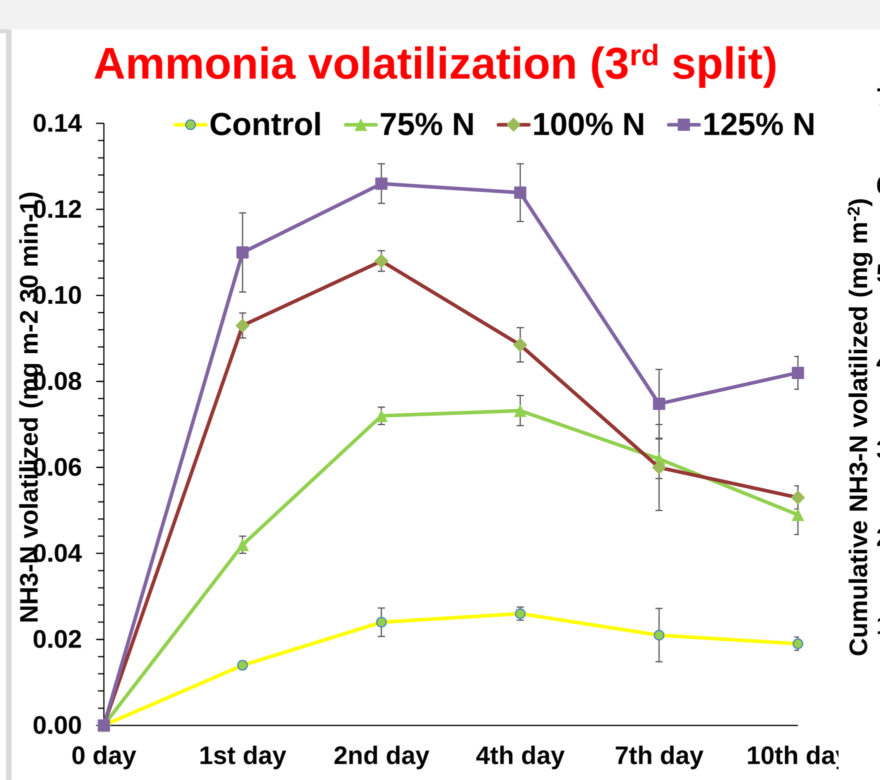
The results indicated that NH_3 volatilization loss increased linearly with the rate of N. In each split, NH_3 volatilization was increased in 125% N treatment plot. The peak time interval of NH_3 volatilization was between 2 to 4 days after each fertilization event and after that, it started to decline with the passing days. The ratio of NH_3 volatilization losses to the applied N ranged from 18.02% to 50% among N application rates. Cumulative NH_3-losses were in control<75% N<100% N< 125% N treatment plots. The maximum grain yield (3.56 t ha^{-1}) was observed in the 125% N treatment plot and plant biomass is non-significant between 100% N and 125% N treatment plots. Agronomic NUE was 9.05%, 11.79% and 11.66% respectively, in 75% N, 100% N and 125% N treatments. Hence, maximum NUE was determined in 100% N treatment.

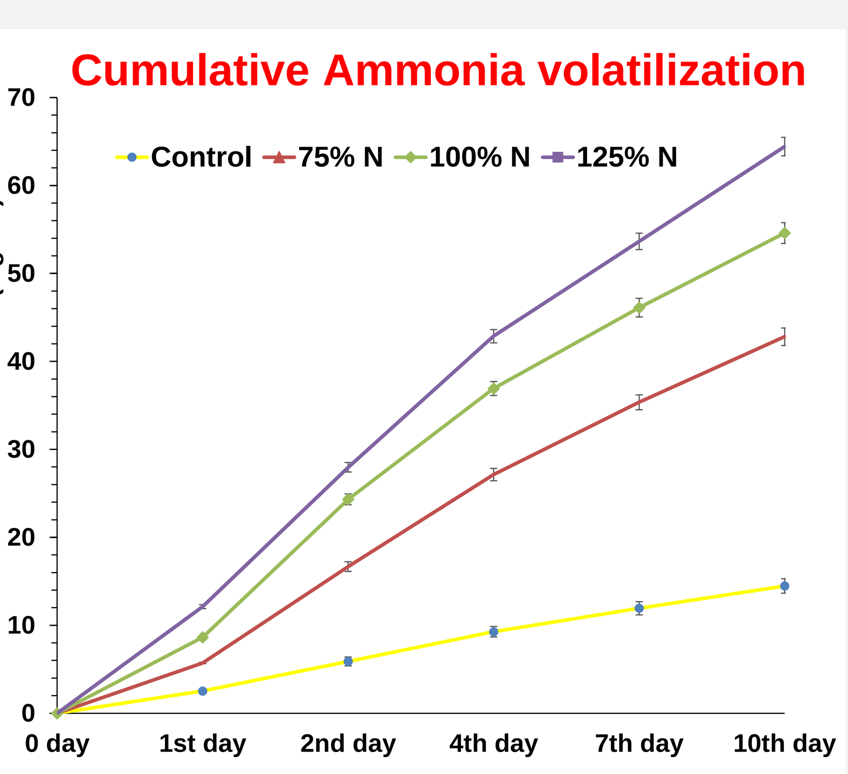
	Agronomic Parameters			Yield Parameters		Physiological
Treatments	Plant Height (cm)	Spike Length (cm)	No. of Spikelets Spike^{-1}	Total Biomass (t ha^{-1})	Total Grain (t ha^{-1})	Chlorophyll (SPAD)
Control	72.4 ± 1.2 ^{C}	8.9 ± 0.12 ^{C}	14 ± 0.75 ^{B}	1.6 ± 0.015 ^{D}	5.65±0.017 ^{D}	27.6 ± 3.53 ^{C}
100% N	92.5 ± 1.8 ^{A}	10.9±0.13 ^{A}	18 ± 0.75 ^{A}	3.2 ± 0.032 ^{A}	9.95±0.037 ^{B}	59.85 ± 8.9 ^{A}
75% N	83 ± 1.4 ^{B}	9.6 ± 0.13 ^{B}	17 ± 0.41 ^{A}	2.5 ± 0.024 ^{C}	7.75 ± 0.014 ^{C}	43.3 ± 4.66 ^{B}
125% N	93.2 ± 1.8 ^{A}	11 ± 0.14 ^{A}	19 ± 0.63 ^{A}	3.6 ± 0.045 ^{A}	10.7 ± 0.033 ^{A}	67.2 ± 6.02 ^{A}











Conclusion

It's concluded from the result that 125% N treatment showed more NH_3 volatilization with a little bit difference in yield. Therefore, higher N doses may be avoided. Overall, 100% N ha^{-1} rate practices are the optimal rate that farmers should opt for. Ammonia volatilization losses should be managed by appropriate N application level for sustainable wheat production and N management.

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