

Climate Change and Soil Nitrogen Dynamics in Winter Wheat

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Introduction

- With climate change, Europe becomes warmer (0.1-0.4 °C per decade) and the greatest increases are predicted over northern Europe.
- Widespread changes in annual rainfall patterns; amount, distribution and intensity, are also predicted and Europe would get wetter (1-2 % increase per decade) with regional variations (IPCC, 2006).
- These above changes will have profound impact on agriculture productivity and the environment by affecting seasonal soil temperature and moisture, two major soil factors affecting soil nitrogen dynamics.



Wheat growth & leaf area coverage in heated plots (left) & non-heated plots (right) during 1st week of Apr. 2009

Material and Methods

A semi-field experiment on winter wheat is laid out in 32 lysimeters (1m x 1m x 1.5 m in size) with loamy sand soil using soil warming cables, automatic rain shelter and watering system.

Factor 1: Soil warming

* Normal soil Vs Heating (up by 5 °C) at 10 cm depth

Factor 2: Rainfall amount

* Normal (av. of 1961-1990) Vs Predicted amount (2071-2100)

Factor 3: Rainfall events (rainy days)

* Normal rainy days (av. of 1961-90) Vs 50 % fewer rainy days

Eight treatments with four replications in CRB Design

Treatments

1. Normal soil + Normal rainfall + Normal rainy days
2. Normal soil + Normal rainfall + 50 % fewer rainy days
3. Normal soil + Projected rainfall + Normal rainy days
4. Normal soil + Projected rainfall + 50 % fewer rainy days
5. Heated soil + Normal rainfall + Normal rainy days
6. Heated soil + Normal rainfall + 50 % fewer rainy days
7. Heated soil + Projected rainfall + Normal rainy days
8. Heated soil + Projected rainfall + 50 % fewer rainy days

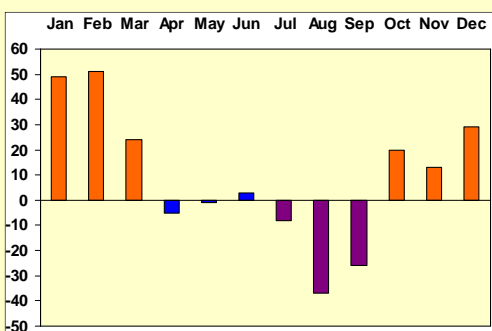


Fig. 1: Change in monthly rainfall (%) in northern Europe projected for 2071-2100 AD compared to the base year 1961-90

Objectives

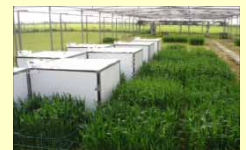
- Study the effect of increased soil temperature & future rainfall patterns on:
- Soil N mineralization rate and N losses through leaching and emissions
 - Growth & development of winter wheat, final grain yield and protein quality
 - Incidence of pests and diseases on winter wheat and
 - Crop water consumption, percolation losses, and soil water balance.



32 Lysimeters (1 x 1 x 1.5 m size)



Percolated water collection points



Gas emission measurement chambers



Soil warming cables at 10 cm depth



Automated watering system



Wet & frozen soil in heated & control plots

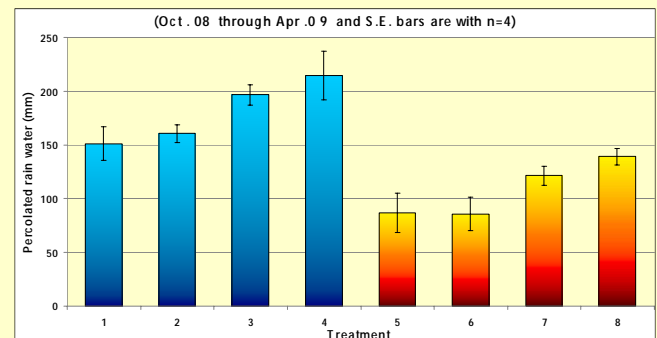


Fig. 2: Soil water percolated (mm) through soil profile

Results

- Soil warming affected the normal soil freezing and thawing cycles during winter, increased the evapo-transpiration rates thereby reducing the N losses through percolated water (Fig. 3 & 4).
- Soil warming hastened wheat crop growth, development, & above-ground biomass during winter when compared to non-heating control plots.
- Soil warming lead to increased mildew attack on wheat in heating plots.
- Future rainfall patterns increased the soil water percolation losses (Fig. 2), which in turn increased nitrogen leaching (Fig. 3 & 4), mostly during the winter period.

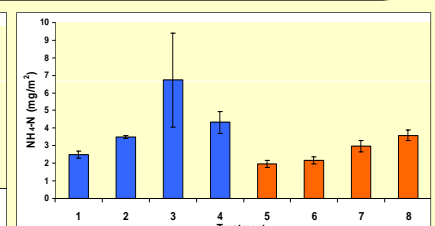
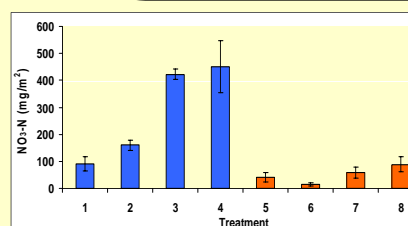


Fig. 3 & 4: Nitrogen losses (NO₃-N & NH₄-N) through percolated water as influenced by soil warming and future rainfall patterns (Oct. 08 through Jan. 09)