Reuse of municipal sewage sludge in agriculture: the case of maize crop

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Introduction

- Sewage sludge (SS) is a by-product of the municipal wastewater treatments.
- It contains **nutrients** essential for plant growth and is also a **source of OM** for soils. This is of particular importance in Mediterranean soils, in which high temperatures during the summer promote high annual mineralization of OM.

Introduction

- SS application to agricultural land

  reduces bulk density

  increases porosity

  improves structural soil stability

  can serve as a mean of waste disposal.

- SS may contain contaminants (e.g. trace elements).

- Trace element mobility can be reduced within a time-scale of a few years, provided soils have a relatively sufficient retention capacity (i.e. high CEC, clay content, and non-acidic pH) and the applied sludge has low heavy metal content.

Nitrogen translocation in grain crops

- Seed N in several field crops primarily originates as a result of assimilates translocation from the vegetative parts during the grain filling period.
- Nitrogen translocation is influenced by several abiotic (e.g. water deficit, heat) and/or biotic stresses (e.g. plant diseases).

Purpose of the study

- To investigate the response of maize to SS application, in terms of growth, productivity and nutrient accumulation and translocation under Mediterranean conditions, in comparison to the recommended inorganic fertilization for maize production in the area.
- In addition, the effect of SS application on trace element concentrations in soil and maize plants was examined.

Materials & Methods

Two field experiments were conducted in Orestiada, Greece during 2012 and 2013 growing seasons.

Materials & Methods

- Crop: The commercial maize hybrid ‘Dekalb 6040’ (Monsanto)
- Treatments

  SS1 = 20 Mg dry weight ha^{-1} yr^{-1} ≈150 kg N ha^{-1} yr^{-1}

  SS2 = 40 Mg dry weight ha^{-1} yr^{-1} ≈300 kg N ha^{-1} yr^{-1}

  SS3 = 60 Mg dry weight ha^{-1} yr^{-1} ≈450 kg N ha^{-1} yr^{-1}

  Iorganic Fertilizer (IF) = 300 kg N ha^{-1} yr^{-1} + 80 kg P_2O_5 ha^{-1} yr^{-1}

  C = unamended control.

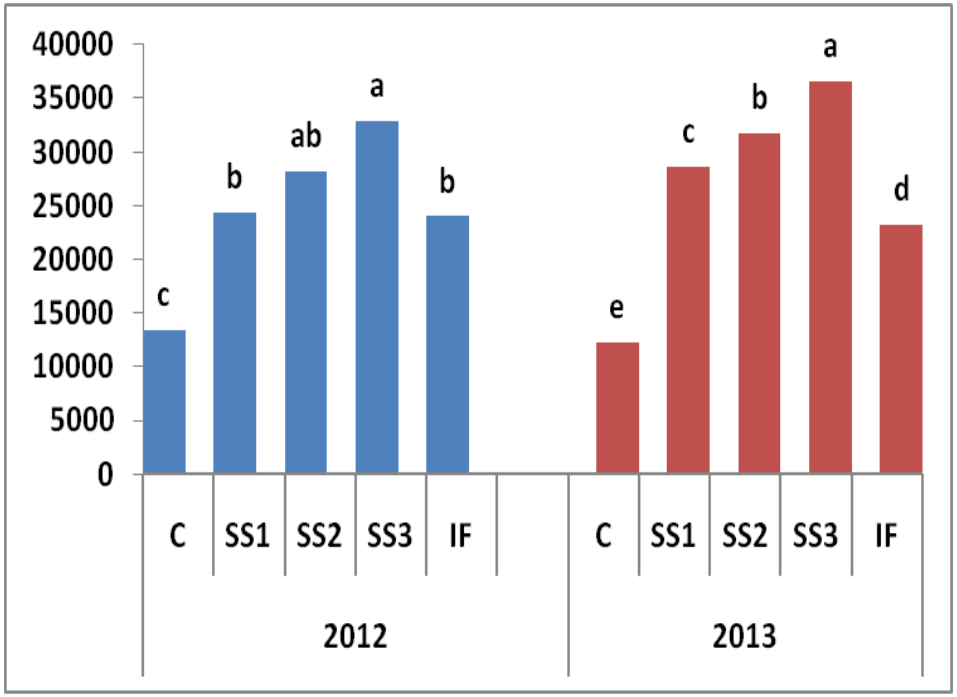
Materials & Methods

- Experiment design: RCB with four replications.
- Plots were 100 m^2 (10 x 10 m) and consisted of 13 rows spaced 0.75 m apart.
- Plant samples, composed of a row 1 m long, were taken at anthesis and maturity from each plot.

Results

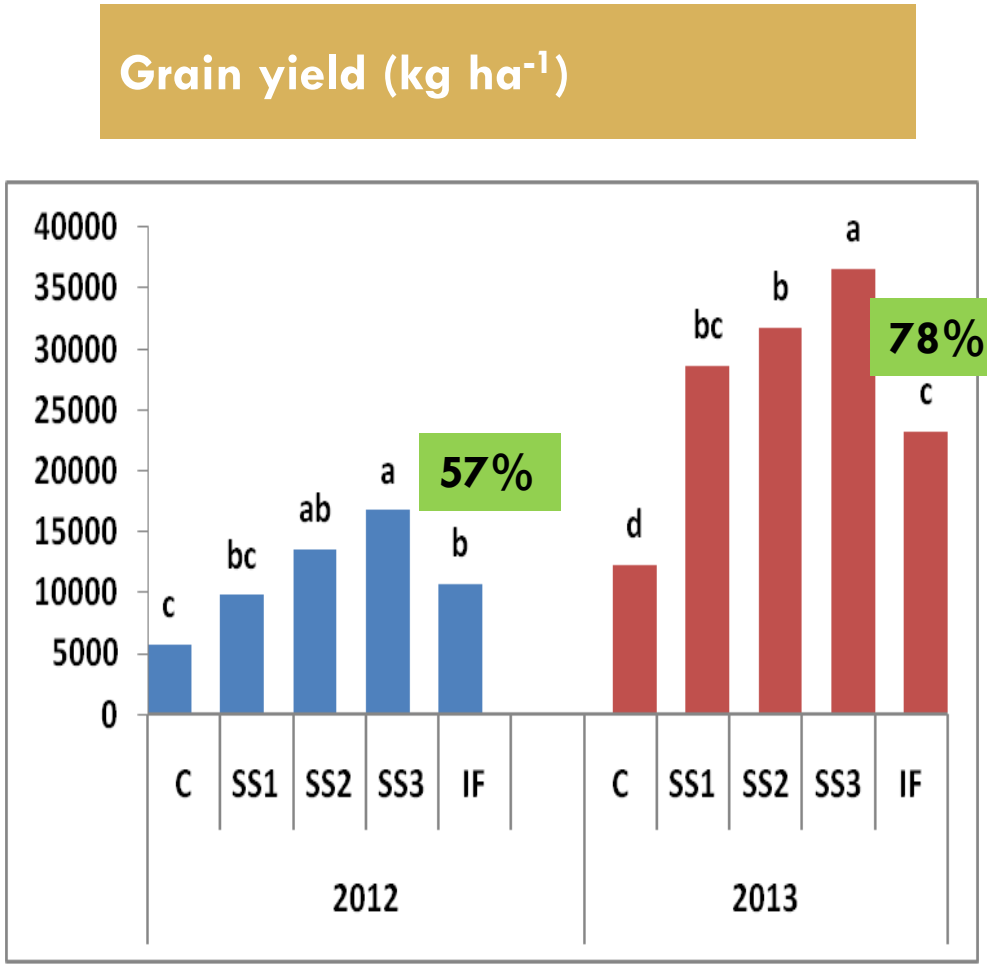
- The application of SS showed a beneficial effect on maize growth and productivity as indicated by the greater dry matter accumulation compared with the unamended control

Dry matter at maturity (kg ha^{-1})



Results

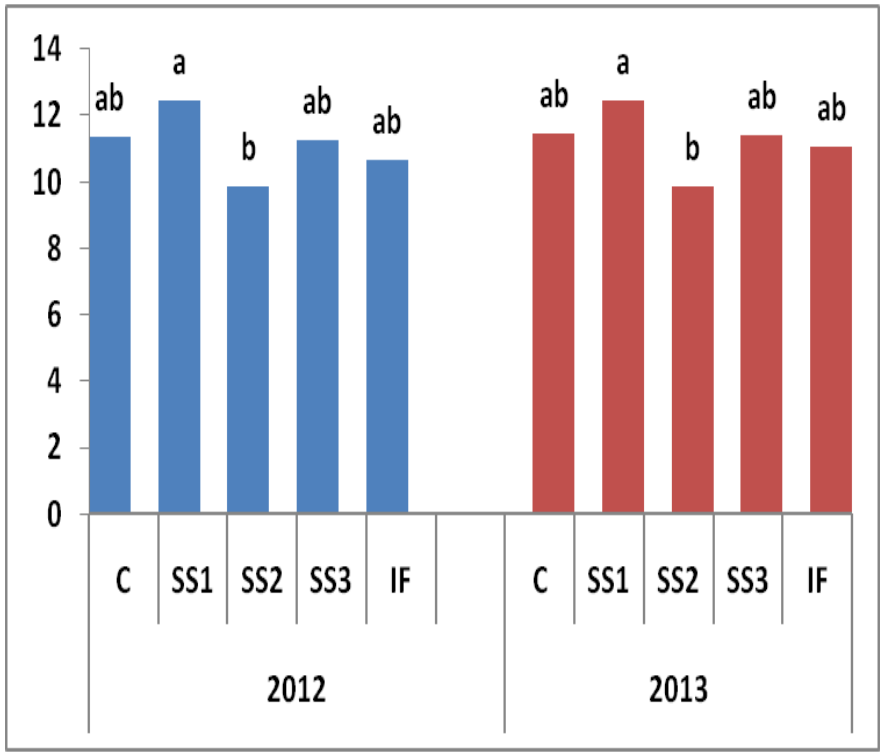
- The beneficial effect of SS application was also evident in terms of grain yield.
- Grain yields obtained with SS application were similar (SS1 and SS2) or greater (SS3) than those of IF.



Results

- The application of SS resulted in marginal differences among treatments in grain N concentration
- However, total N uptake at maturity (i.e. the product of dry matter accumulation and N concentration) showed a significant response to SS application

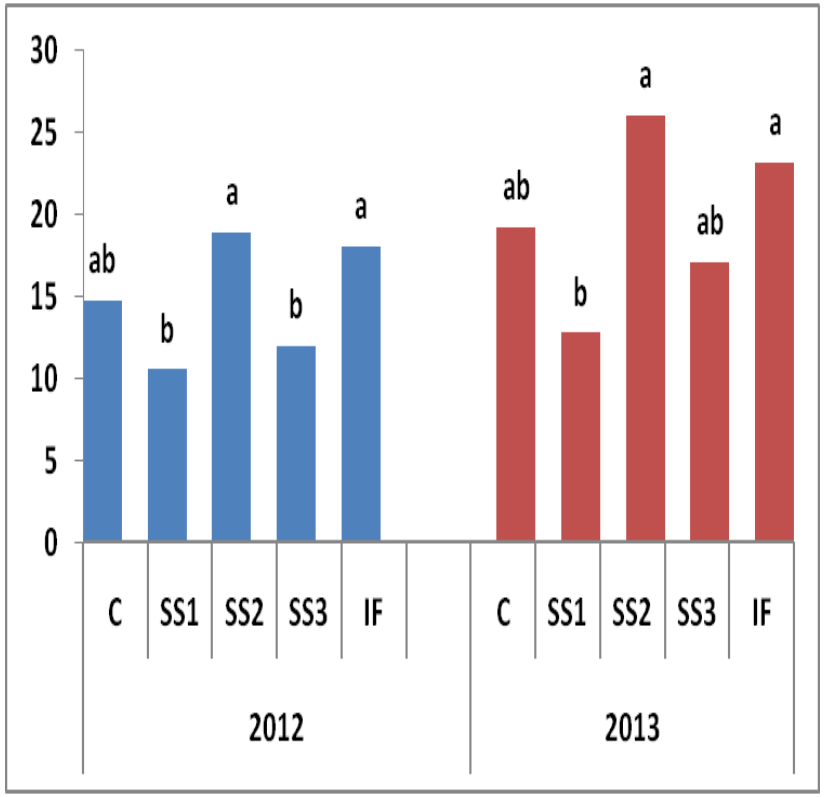
Grain N concentration (mg kg^{-1})



Results

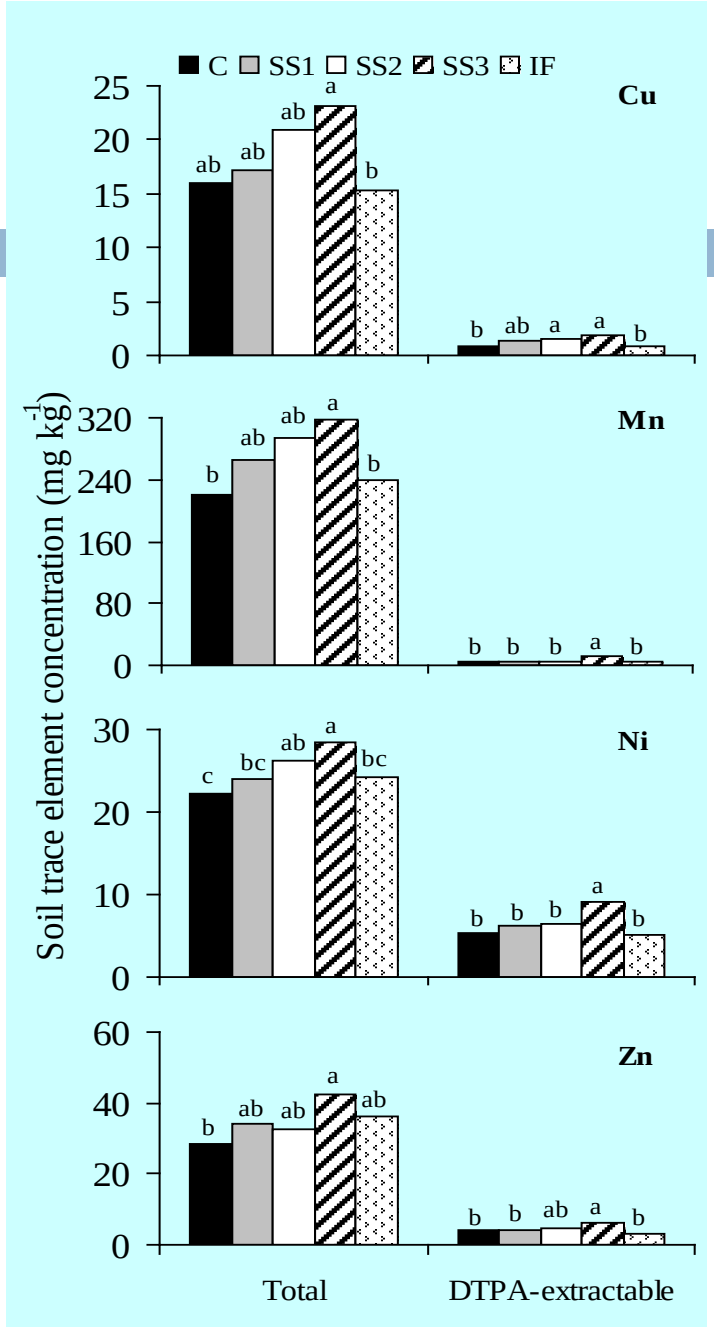
- Concentrations of Fe and Mn in maize plants were similar across treatments, or in the case of Zn did not exceed those obtained with IF

Grain Zn concentration (mg kg^{-1})



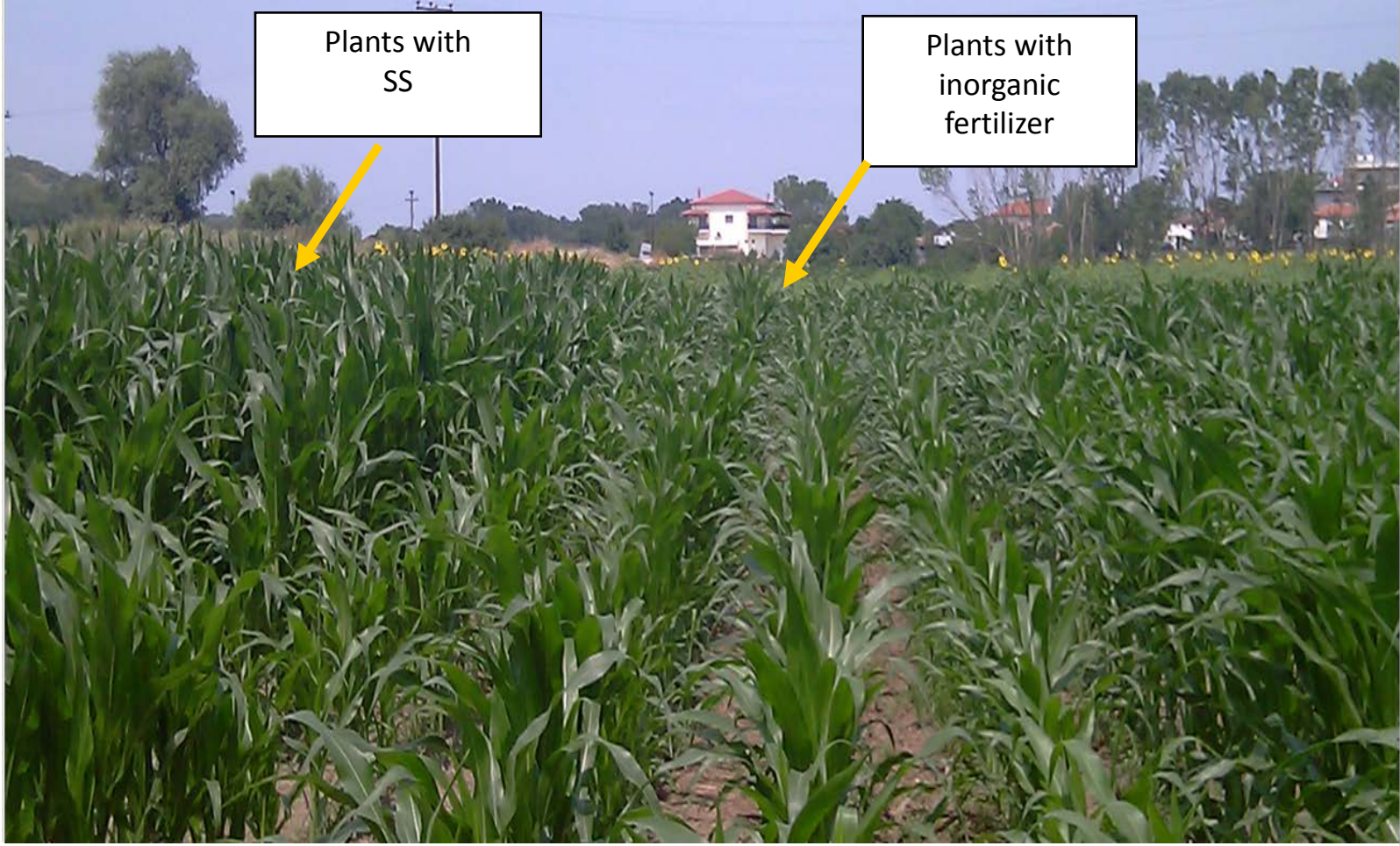
Results

- Although the concentrations of total and DTPA-extractable trace element in the soil at the end of the first year of experimentation tended to increase with SS application, particularly at the high rates, they were much lower than the regulation limits in all cases.

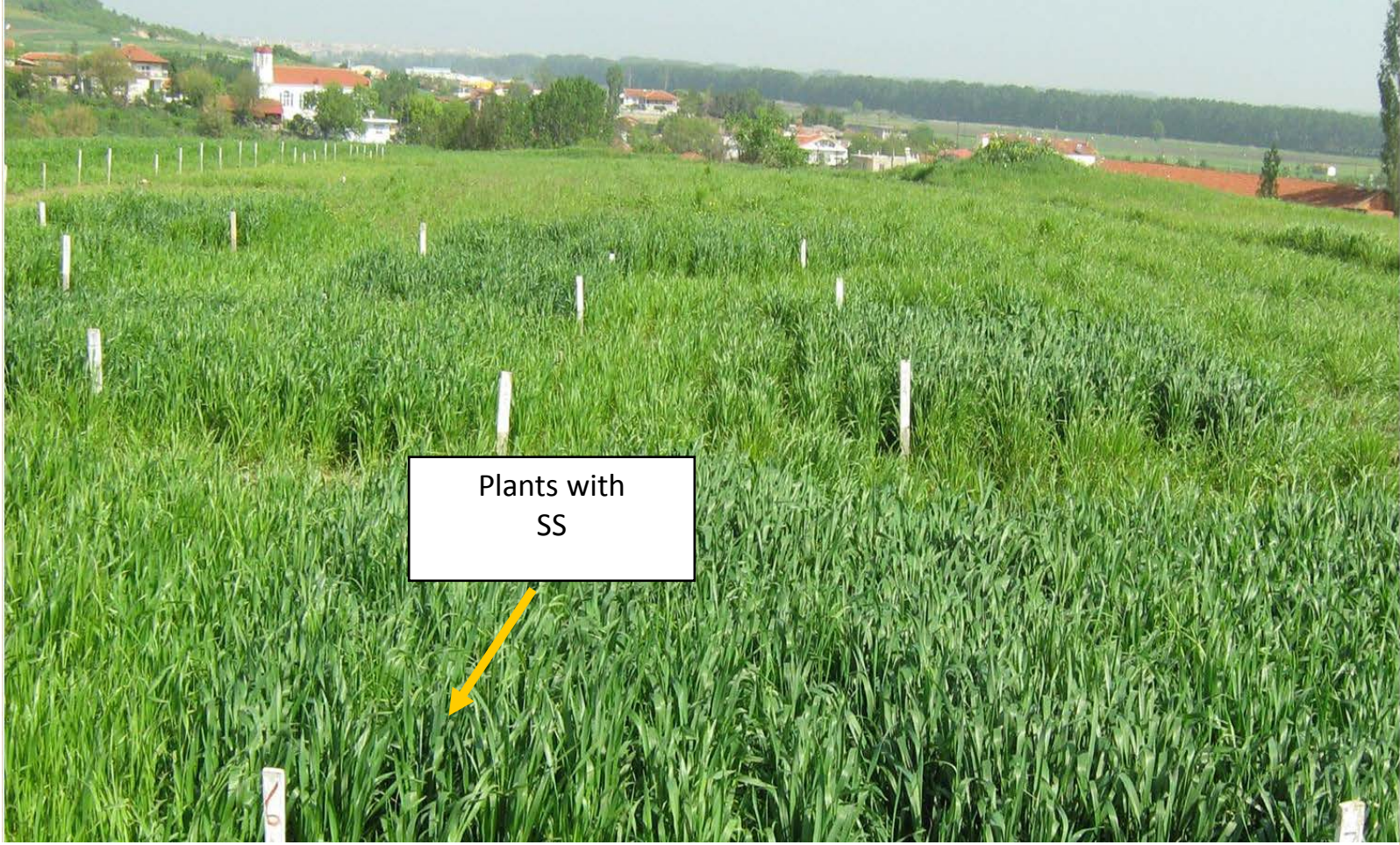


Conclusions

- The application of SS, even at the lower rate (20 Mg dry weight ha^{-1} yr^{-1}) resulted in grain yield similar to that obtained with the addition of IF.
- This SS rate was proved to be agronomically efficient for maize crop in the area, while at the same time it could be more acceptable by the farmers and the public opinion compared to the higher rates.
- Thus, SS could successfully replace IF needed to meet the nutrient demands of maize crop in the area, without increasing trace elements concentration in soil and in plant tissues.
- However, more research is required to study potential health safety issues based on a long-term evaluation.

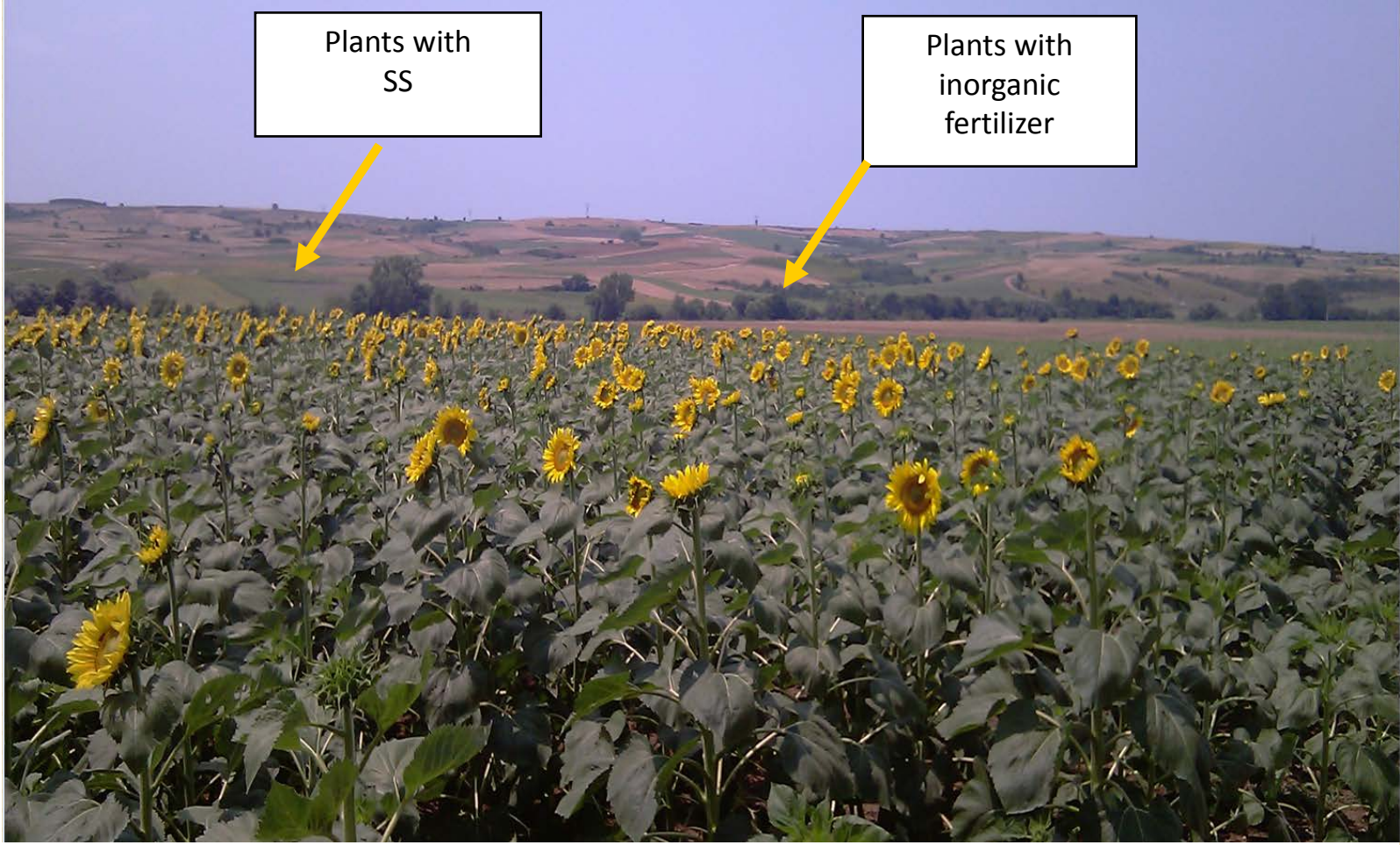


Irrigated maize crop grown with SS application



Wheat crop grown with SS application

Plant lodging due to high rates of SS



Rainfed sunflower grown with SS application

THANK YOY VERY MUCH FOR YOUR ATTENTION!