Effect of liquid cattle manure on corn yield and macronutrients & on soil fertility, in comparison to the common & recommended inorganic fertilization

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Introduction

- Application of organic fertilizers instead of inorganic fertilizers
- One of the environmental long-term approaches to sustainable agriculture
- Economically feasible

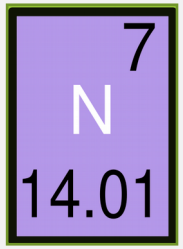
In Greece:

- Intensive livestock produces a substantial amount of manure
- Production of approximately 80000 Mg of N from 1996 to 2013
- Almost the 30 % of it came from cattle breeding according to FAO

Soil application

Animal manures

- Appropriate N source, supply crops with readily available mineral N
- Also they contain organic N, long term effect on crops & soils



Field application

Improvement of soil properties

- Chemical
- Physical
- Biological

Environmental impacts

- Application may exceed crop needs
- Water pollution & eutrophication
- NO_3 leaching, P run- off, NH_3

Farmers

Slow effect on crop yield & their variability in short time

Nitrogen efficiency

Affected by the liquid or solid fraction

Liquid slurries

Have high N efficiency due to

- Low dry matter
- Low C/N
- High mineral N

Studies

Should be performed in medium- and long-term periods

Corn & dairy cattle

Two economically important activities

Often related in many agricultural lands

Objectives

Investigation of:

- The effects of liquid dairy cattle manure on corn:
  - Yield
  - Macronutrients' content & uptake
- In comparison to:
  - Common &
  - Recommended inorganic fertilization for corn

Evaluation of:

- The effect of manure application on soil:
  - Fertility (available macronutrients)
  - Chemical properties

Materials & Methods

- The size of the plots was almost 48 m^2

- The experimental design was a randomized complete block design (RCBD), with 4 fertilization treatments, replicated 6 times

i. Manure: 80 Mg ha^{-1} y^{-1} (wet weight)

N: 250 kg ha^{-1} y^{-1}
P: 55 kg ha^{-1} y^{-1}
K: 200 kg ha^{-1} y^{-1}

II. Common Inorganic Fertilization:

N: 260 kg ha^{-1} y^{-1}
P: 57 kg ha^{-1} y^{-1}

iii. Recommended Inorganic Fertilization:

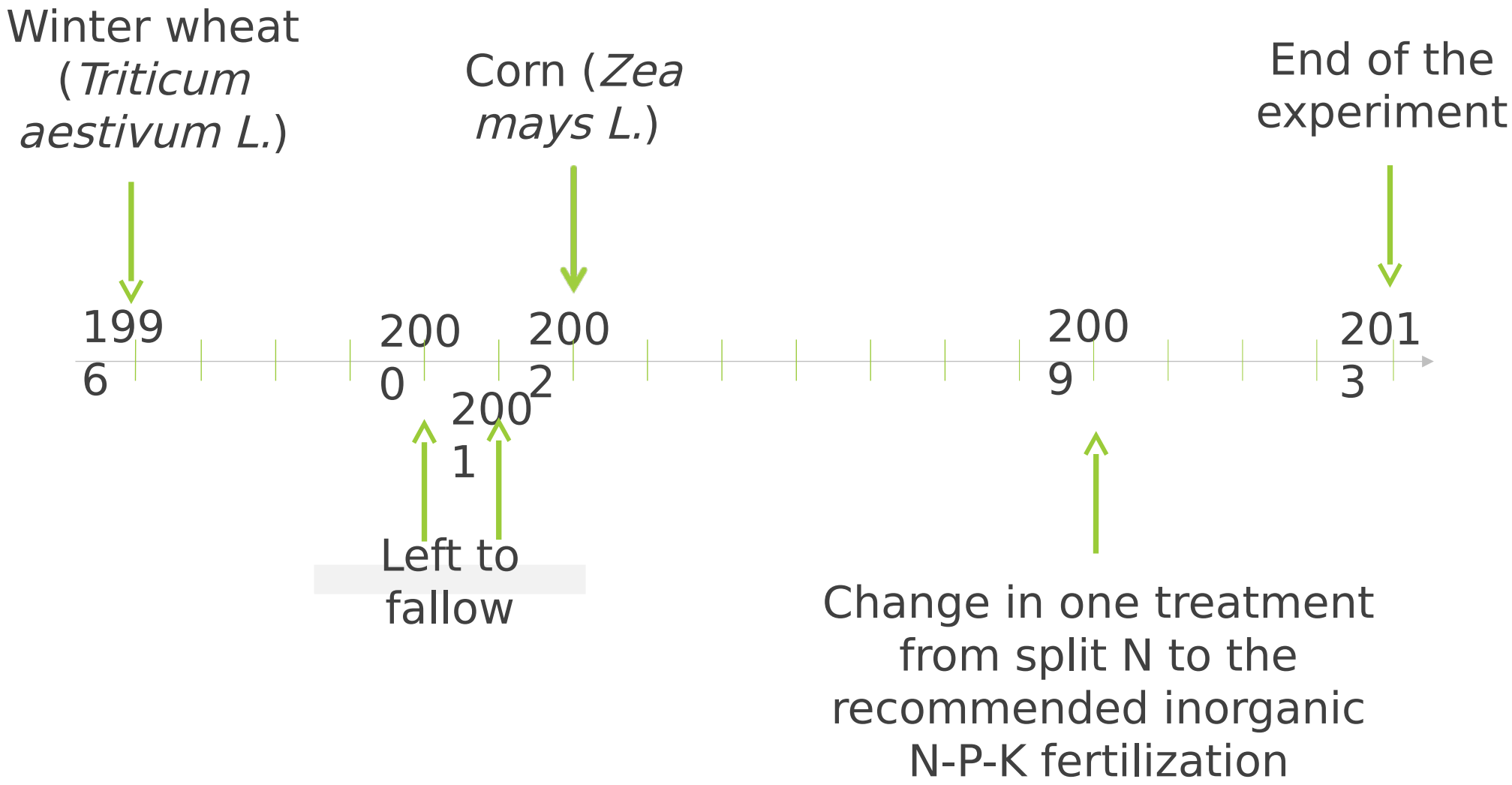
N: 230 kg ha^{-1} y^{-1}

Experiment

Field of the Farm of Aristotle University of Thessaloniki, Greece

During the years of 2009-2013

Field background



Soil & plant sampling & analysis

Soil

- Composite surface samples 0-30cm
- Before corn sowing
- pH (1:2 H_2O)
- EC_{se}
- Kjeldahl-N
- OC (wet oxidation)
- Available NO_3-N, P, K

Plant

- Collected at the R3 growth stage (silage)
- Dry aboveground biomass (65 °C)
- Total N, P & K
- Plant uptake
- Grain yield (harvest)

Statistical analysis

- Within the same year ANOVA
- LSD at $p = 0.05$

Results & Discussion

Effect of liquid dairy cattle manure on corn yield, nutrient content & uptake

Fig1. Dry aboveground biomass yield of corn at the R3 growth stage, the years of 2009-2013

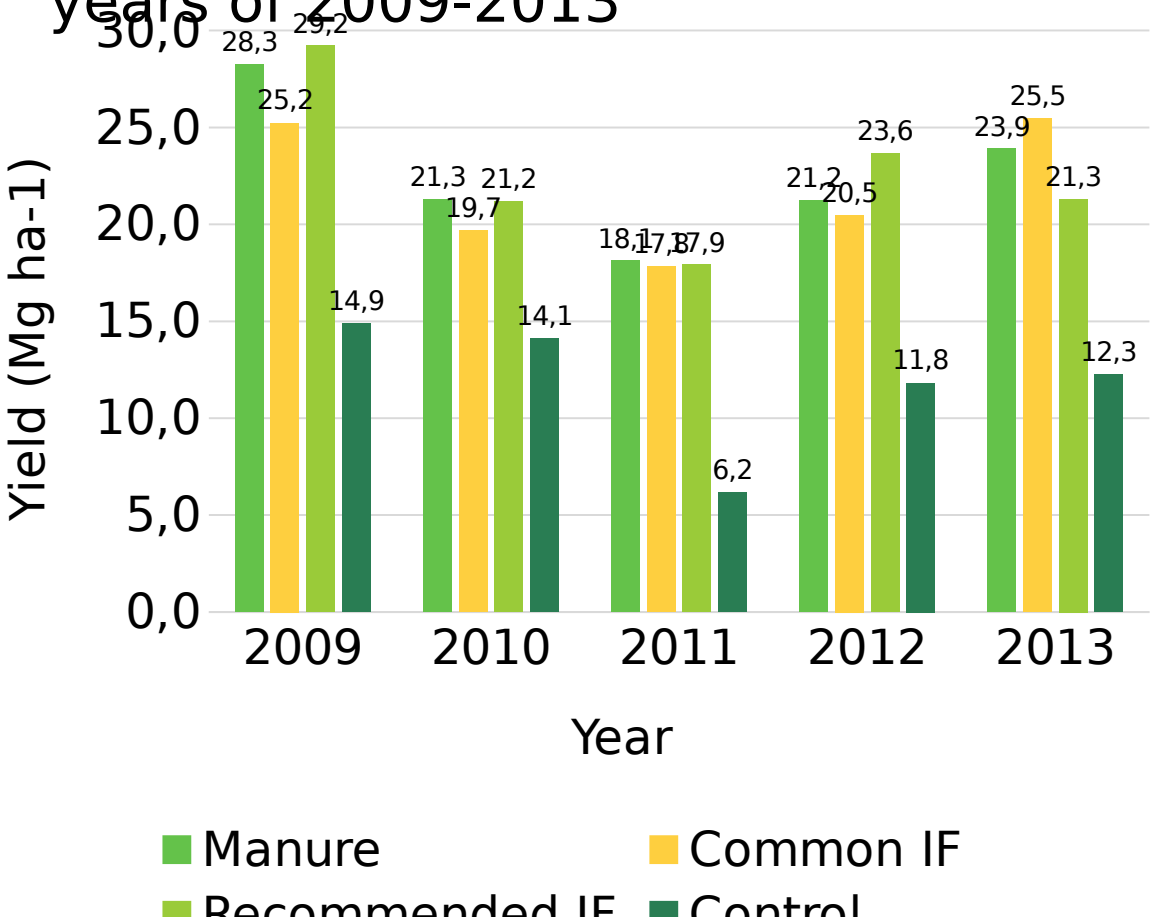
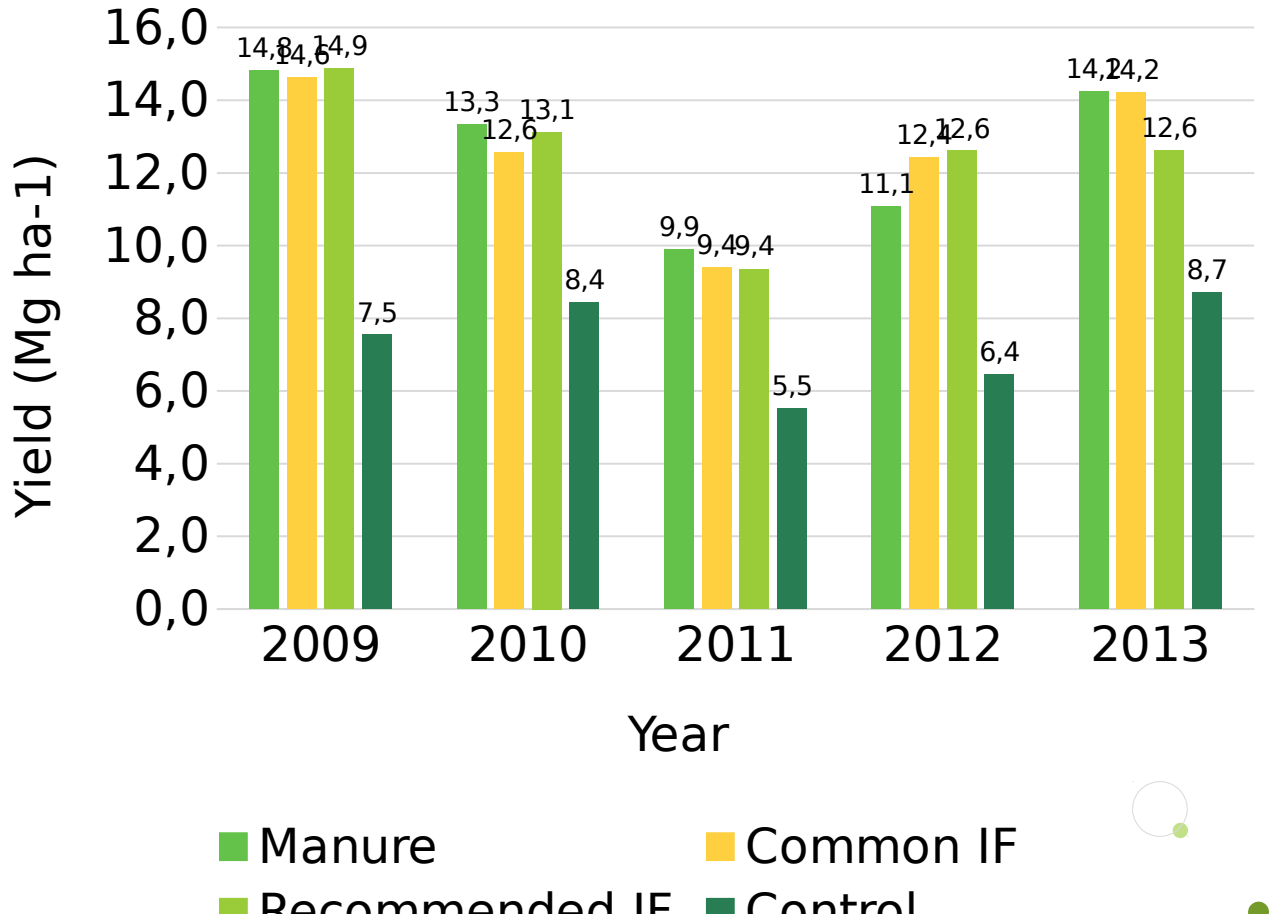


Fig2. Grain yield of corn at harvest, the years of 2009-2013



Macronutrients' uptake by corn plants at the R3 growth stage

	Year				
Treatment	2009	2010	2011	2012	2013
	N (kg ha^{-1})				
Manure	291a	200a	177ab	188a	206ab
Common IF	254b	196a	134bc	186a	235a
Recommended IF	276ab	201a	183a	191a	172b
Control	126c	100b	131c	103b	93c
	P (kg ha^{-1})				
Manure	27a	37a	30a	43a	44a
Common IF	27a	31ab	29a	39a	43a
Recommended IF	30a	32ab	31a	46a	34b
Control	18b	25b	11b	23b	21c

Macronutrients' uptake by corn plants at the R3 growth stage (continued)

	Year				
Treatment	2009	2010	2011	2012	2013
	K (kg ha^{-1})				
Manure	170b	206a	157a	127a	108a
Common IF	133bc	94b	163a	118b	113a
Recommended IF	236a	178a	170a	129a	100a
Control	91c	104b	55b	74c	58b

Effect of liquid dairy cattle manure on soil properties

pH

- Remained unchanged
- Range 7.9-8.5

EC_{se}

- Remained unchanged
- Range 0.35-0.97
- Lower than 2 dS m^{-1}

OC

- Significant increase in certain years
- But it was not consistent during the whole period
- OC range 7.6-11.2 g kg^{-1}
- Total N range 0.84-1.24 g kg^{-1}

Total N

C/N

- No significant differences
- Range 7.1-12.7

Soil available macronutrients', the years of 2009-2013

	Year				
Treatment	2009	2010	2011	2012	2013
	NO_3-N (mg kg^{-1})				
Manure	14.1a	9.4a	9.3ab	24.0a	22.7a
Common IF	11.2bc	8.2ab	7.8bc	26.3a	22.7a
Recommended IF	13.0ab	8.0ab	10.9a	23.8a	19.0b
Control	9.8c	7.1b	7.2c	19.0b	15.6c
	Olsen-P (mg kg^{-1})				
Manure	18.5a	39.2a	27.3a	37.1a	35.4a
Common IF	7.8b	14.6b	9.3b	17.8b	22.8b
Recommended IF	8.5b	10.7c	10.5b	10.6c	10.0c
Control	4.9b	5.1d	3.8c	9.7c	8.5c

Soil available macronutrients', the years of 2009-2013 (continued)

	Year				
Treatment	2009	2010	2011	2012	2013
	Exchangeable K (mg kg $^{-1}$)				
Manure	95.2a	130.0a	145.7a	165.3a	172.3a
Common IF	61.5b	88.8b	84.7c	89.2c	132.5b
Recommended IF	63.5b	98.7ab	116.8b	128.0b	146.8ab
Control	65.5b	73.6b	80.3c	92.2c	130.7b

Conclusions

Repeated annual applications of liquid cattle manure into soil, at rates comparable (regarding N) to the common or recommended inorganic

- Enhance crop yield and macronutrients' uptake, at levels higher or similar than the inorganic fertilization
- Maintain soil fertility with the increase of soil available NO_3-N, P & K
- Attention should be given in the case of N & P, because of the possible loss of NO_3-N by leaching and of P by run-off


Thank you for your
attention !!!