



Maize growth and yield responses to conservative tillage system and starter fertilization strategies

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Introduction

Strip-tillage can decrease maize cultivation costs compared to plowing, but it might decrease the grain yield due to a slower early crop development. **Starter fertilization** is used to improve early-season nutrient uptake, nutrient use efficiency and plant growth. The aims of this study were to assess the effects of the adoption of **strip tillage** and different **starter fertilization strategies**, including digestate, on maize growth and yield. Only first-year effects were here evaluated.

Materials and Methods

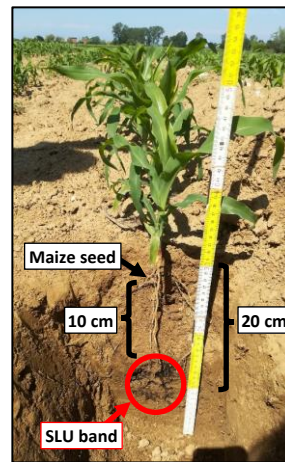
Field experiments were carried out in 2019 and 2020 in Piemonte, NW Italy, at i) Carmagnola (sand 36% and clay 7%; Typic Udifluent) and ii) Poirino (sand 26% and clay 13%; Fluventic Haplustepts).

At each site, in a split-plot design, we compared two **tillage systems**:

- **ST** (strip-tillage), 25 cm-deep on 25 cm-wide tilled strips and 50 cm-wide non-tilled strips with standing maize residues;
 - **PLOW**, where the soil was ploughed at 30 cm depth;
- and **two starter fertilizers**, plus an unfertilized control (**NT**):
- **SLU** (digestate) injected as a 20 cm-deep band by a slurry tank equipped with injector tools (202 kg N ha⁻¹ and 69 kg P₂O₅ ha⁻¹)
 - **DAP** (diammonium phosphate) distributed in 5 cm-deep bands on the side of the maize rows (27 kg N ha⁻¹ and 69 kg P₂O₅ ha⁻¹).

To equal N supply, urea was applied in top-dressing.

Normalized difference vegetation index (NDVI) was measured weekly from 3-leaf stage to tassel emission. Anthesis was determined and expressed as days after sowing (DAS) and at maturity grain yield and grain moisture were recorded. Data were analyzed through a mixed ANOVA model and the means were compared using the Bonferroni post hoc test at P ≤ 0.05.



Results

Compared to **PLOW**, **ST** determined less favourable soil conditions at both sites, resulting in lower NDVI due to lower plant growth rate and density. **DAP** showed the highest early vigor and canopy development at both sites and tillage systems, **SLU** was intermediate between **DAP** and **NT** (Fig. 1).

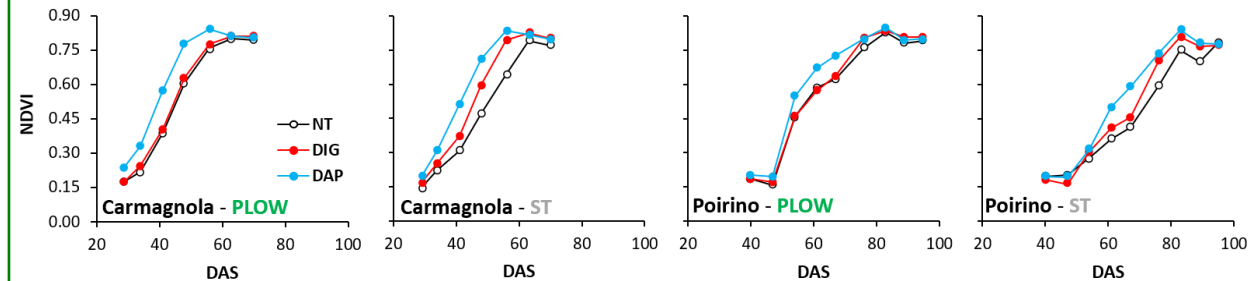


Figure 1. Effect of starter fertilization within each site-tillage system combination on the maize canopy development expressed as NDVI from three-leaf stage to tasseling during the 2020 growing season

Compared to **PLOW**, **ST** delayed flowering (+2.2 days), and increased the grain moisture content (+1.2%) (Tab. 1). The delay of flowering was greater at Poirino (+3.4 days) compared to Carmagnola (+1.1 days). **SLU** increased the grain moisture content by 0.8% compared to **DAP**, that resulted drier by 1.9% than **NT**. In both tillage systems, at Carmagnola **SLU** and **NT** showed similar grain moisture contents, while at Poirino **SLU** did not differ from **DAP**. The grain yield was not affected by tillage system, while **DAP** and **SLU** recorded similar and higher (+1.6, +1.8 t ha⁻¹) grain yield than the **NT** treatment.

Tab. 1. Effect of site, tillage and fertilization on maize date of flowering, grain moisture and yield.

Factor	Source of Variation	Flowering (DAS)	Grain moisture (%)	Grain Yield (t ha ⁻¹)
Site	Carmagnola	87.5 b	24.4 b	16.4 a
	Poirino	101.7 a	25.6 a	15.5 b
	P(F)	< 0.001	< 0.001	0.013
Tillage	PLOW	93.5 b	24.4 b	15.9
	ST	95.7 a	25.6 a	15.9
	P(F)	< 0.001	< 0.001	n.s.
Starter fertilization	NT	97.0 a	26.0 a	14.8 b
	SLU	94.4 b	24.9 b	16.6 a
	DAP	92.4 c	24.1 c	16.4 a
	P(F)	< 0.001	< 0.001	< 0.001



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Conclusions

This study highlighted that **ST** was a suitable technique in different pedo-climatic conditions, without any yield reduction, **although it could delay plant development**. The deep injection of digestate as a starter fertilizer showed moderate advantages on maize early development, and allowed to achieve the same yield as the mineral starter fertilization.