# Strip-till for maize in sandy loam soils: Importance of tillage depth, preceding cover crops and fertilization technique

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## Introduction

Strip-tillage is currently gaining interest as a conservation tillage technique in maize (*Zea mays* L.) and sugarbeet (*Beta vulgaris* L. ssp. *Altissima*) by research institutes in Belgium. Strip-till is expected to reduce the time and energy consumption of tillage, erosion and stimulate soil life in comparison with conventional moldboard ploughing. The practical feasibility on Belgian farms, is however still under discussion. There is little experience with this technique. The objective of this study was to measure the effect of (i) tillage technique (CT: conventional moldboard ploughing, NIT: non-inversion tillage, S: strip-till), (ii) preceding cover crop (R: rye *Secale cereale* L., WM: white mustard *Sinapis alba* L.) and (iii) strip-till tillage depth (16-25cm) on maize yield. Two experiments were conducted on sandy loam soil, experiment A in 2016 and experiment B in 2017.

## Material and methods

Experiment A and B (50°58'53"N 3°46'33"E, average annual temperature and rainfall: 9°C, 836 mm) had a split-plot and a strip-split-plot design, respectively, both with 4 blocks. In experiment A (C% 1.4, pH-KCl 5.5), rye was sown as cover crop in October 2015 after harvest of potatoes and decompaction of the tillage layer (25 cm). On April 19$^{th}$ 2016, 35 m³ ha$^{-1}$ cattle slurry was applied with a line spreading boom in treatments CT, NIT and in S1-S3. The soil was tilled with a cultivator (10cm) in CT and NIT. On May 2$^{nd}$, the rye in treatments S1-S6 was chopped with a flail mower. On May 9$^{th}$, treatments CT and NIT were tilled (30cm) by a moldboard plough and an Actisol cultivator for non-inversion tillage, respectively. A rotary harrow (8cm) was used for seedbed preparation. In S1-S6, the strip-till was carried out with a Carré INRO at different depths (see table) on May 9th. In S4-S6 this was combined with cattle slurry injection (35 m³ ha$^{-1}$). On May 9$^{th}$ the maize was sown (105 000 seeds ha$^{-1}$, 6cm depth, 75cm between rows) with additional 200 kg ha$^{-1}$ fertilizer (16-6-23(-2)(-5)) in the maize row. On May 11$^{th}$ 200 kg ha$^{-1}$ ammonium nitrate (27%N) was added as a top dressing on all treatments. In experiment B (C% 1.5, pH-KCl 6.0), white mustard (August 30$^{th}$, 20 kg ha$^{-1}$) and rye (October 7$^{th}$, 150 kg ha$^{-1}$) were sown as cover crops in treatments WM and R, respectively, after decompaction of the tillage layer (25cm). In R, glyphosate was applied (4 L ha$^{-1}$, March 29$^{th}$ 2017) and both cover crops were chopped with a flail mower (April 5$^{th}$ 2017). On April 10$^{th}$, 45 m³ ha$^{-1}$ cattle slurry was applied with a line spreading boom in treatments CT and NIT and the soil was tilled with a cultivator (10cm). On April 20$^{th}$, treatments CT and NIT were tilled (30cm) by a moldboard plough and a Carré Neoloab cultivator for non-inversion tillage, respectively. A rotary harrow (8cm) was used for seed bed preparation. In S1 and S2, the strip-till was carried out with a Carré INRO at 15 and 25 cm depth, combined with cattle slurry injection (45 m³ ha$^{-1}$) on April 20$^{th}$. On April 20$^{th}$ the maize was sown (105 000 seeds ha$^{-1}$, 6cm depth, 75cm between rows) with additional 200 kg ha$^{-1}$ fertilizer (16-6-23(-2)(-5)) in the maize row. The maize in both experiments was harvested as silage maize (A: September 19$^{th}$ 2016; B: September 7$^{th}$ 2017), with field trial

equipment. Subsamples were dried (72h, 70°C), to determine the total dry matter (DM) crop yield.

**Results and discussion**

Experiment A: Due to the cattle slurry injection in the tilled strip (S1-S3), the crop yield was significantly increased compared to slurry application to the surface (S4-S6). The crop yield in the strip-till treatments was however dramatically low, compared to CT and NIT. Increasing the tillage depth in strip-till, increased the crop yield. Shallow profile pits (40-50cm) revealed that maize roots explored the whole tillage layer in treatments CT and NIT. However, the maize roots were not capable of growing outside the tilled strip in S1-S6. Due to the very wet conditions in spring 2016 (>150% of the monthly average rainfall in March, April and May), the soil was not dry enough for good tillage practices at any moment during the sowing period. The combination of a too moist soil and the density of the rye roots, resulted in a very bad tillage with the strip-till machinery. With conventional moldboard plowing, this was not an issue. During June (>250% of the average monthly rainfall), the strip-till plots were regularly flooded for a few hours due to heavy rainfall.

Experiment B: There was no significant effect of the preceding cover crop, tillage method or tillage depth on the maize crop yield. In springtime 2017, the weather conditions were dry (April-June, 50% of the average monthly rainfall) and the soil was in good condition to be tilled. Although the soil in the strip-till treatments was better crumbled after white mustard, compared to rye (more and bigger soil cloths), the visual differences were small. Shallow profile pits revealed that maize roots in strip-till could easily spread outside the tilled strip.

**Table 1: Average Dry matter crop yield for the field trials in 2016 and 2017. Statistical significant groups are indicated with different letters (Tukey test) (NS: not significant).**

**Experiment A (2016)**

| Slurry Application (p<0.001) | Tillage method | Tillage depth (cm) | Crop yield (kg DM ha$^{-1}$) (p<0.001) |
|---|---|---|---|
| * | CT | 30 | 18 463$^{a}$ |
| | NIT | 30 | 16 404$^{ab}$ |
| Line Spreading Boom$^{B}$ | S1 | 15 | 8 029$^{e}$ |
| | S2 | 19 | 9 214$^{de}$ |
| | S3 | 23 | 9 913$^{de}$ |
| **Row Injection$^{A}$ | S4 | 15 | 11 868$^{cd}$ |
| | S5 | 19 | 13 711$^{bc}$ |
| | S6 | 23 | 13 991$^{bc}$ |

**Experiment B (2017)**

| Cover Crop (NS) | Tillage method | Tillage depth (cm) | Crop yield (kg DM ha$^{-1}$) (NS) |
|---|---|---|---|
| R | S1 | 15 | 22 667 |
| | S2 | 25 | 22 999 |
| | NIT | 30 | 21 862 |
| | CT | 30 | 22 215 |
| WM | S1 | 15 | 21 718 |
| | S2 | 25 | 23 741 |
| | NIT | 30 | 22 816 |
| | CT | 30 | 22 080 |

*In the treatments CT and NIT, the slurry was incorporated in the soil with a cultivator (10 cm) immediately after spreading.
**The slurry was injected simultaneously with the strip-tillage to a depth 10 cm shallower than tillage depth.

## Conclusion

We conclude that strip-till can achieve the same crop yields in silage maize as conventional moldboard ploughing and non-inversion tillage, however extreme wet conditions have a more adverse effect on strip-till than conventional or non-inversion tillage. In dry soil conditions, tillage depth and preceding cover crop have little effect on crop yield in strip-till. Based on experiment A, slurry injection in the row instead of surface application should be preferred in strip-till.