Weeds and crop yields under conservation tillage in organic farming

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Despite conservation tillage being promoted in organic farming to improve soil fertility, several factors hinder its development. Koepke (2003) reported that organic farmers generally use conventional tillage systems with a mouldboard plough and occasionally till to a greater depth than in conventional agriculture. Indeed, ploughing presents some advantages compared to conservation tillage in organic farming, preventing soil compaction in deeper soil layers and controlling weeds (Peigné *et al.*, 2007). In order to assess the feasability and effects of conservation tillage in organic farming, conventional ploughing and conservation tillage systems were compared in organic arable farming. Field experiments were conducted in 2 locations of France in order to compare the effects of different tillage systems on soil fertility, weeds and crop developments. This abstract present some results on weeds and crops yields.

Methodology

Field experiments were set up in 2 locations of France, in Rhône Alpes (A) and Pays de la Loire (B) since 2005 and 2006 respectively (table 1). 4 tillage systems were compared on a completely randomised block with 3 replicates: 1) mouldboard ploughing (MP, 30 cm depth), 2) shallow mouldboard ploughing (SMP, 20 cm depth), 3) reduced tillage (RT) with a tine tool (15 cm depth) and 4) no tillage or very superficial tillage (NT). On site A, NT was managed under a cover crop of alfalfa and rye during the first and fourth years of experimentation respectively, and with a 5-cm-deep tillage during the other years. On site B, NT consisted in a 5-cm-deep tillage, except in 2007 when lupine was harvested before maturity to stop weed infestation, and wheat directly sown in a clover implanted after lupine. Mechanical weed control was carried out on each plot, except when a cover crop was sown. Weeds (density, diversity and biomass) and crops (yield components and total yields) were measured on four 0.25-m^2 sub-plots per plot at emergence, flowering and harvest stages.

Table 1 : Description of the 2 experimental locations

Site	Localisation	Conversion to OF	Soil type	Climate	Crop rotation (cover crop)
A	Lat. 45°49'9.44"N Long. 5° 2'2.62"E Altitude 180 m	1999	Sandy loam (fluvisol)	Continental and degraded oceanic climate	Alfalfa (2001-2004) – Maize (oat)– Soybean – Winter wheat (rye) – Soybean – Winter wheat (2009) (alfalfa)
B	Lat. 47°42'15"N, Long. 1°1'60"O Altitude 70 m	2000	Silty (cambisol)	Oceanic climate	Fababean (initial state)– Winter wheat – Lupine crop (clover) – Winter wheat – Maize (2009)

Results and discussion

At site A, weed infestation in NT treatments was high in 2005 where maize was sown directly under a cover crop (Figure 1). This was due to a high previous infestation of the alfalfa cover crop in 2005. In 2008, weed infestation in NT treatments was due to a low seed quality and a low weed control by the rye cover crop in 2008. High weed levels were also found in NT in 2006 and 2009 despite the application of very superficial tillage (5 cm) associated with hoeing and harrowing. These techniques are generally used to control weeds but they were ineffectual faced with their high density. Crop yields were always lower in NT than in MP and SMP treatments, except in 2007 (Figure 2). Prior to 2008, RT was similar to the ploughing treatments in terms of weeds infestation and yield as it was reported by Berner *et al.* (2008) and Krauss *et al.*(2010) in Switzerland (except yields which were better in RT). From 2008 the performance of RT decreased, probably because of frequent rainfall events which limited mechanical weed control. Consequently, weeds levels increased and impacted the performance of RT since 2008. At site B, RT and NT presented very high levels of weeds (except in 2006, Figure 1) decreasing yields in 2007 and 2008 (Figure 2). On both sites, SMP and MP were comparable over the whole rotation. They presented the lower levels of weed infestation and the higher crop yields

(Figures 1 and 2). RT and NT leaded to higher weeds infestations after 2-3 years of their adoption and consequently crops yields decreased compared to the ploughing treatments.

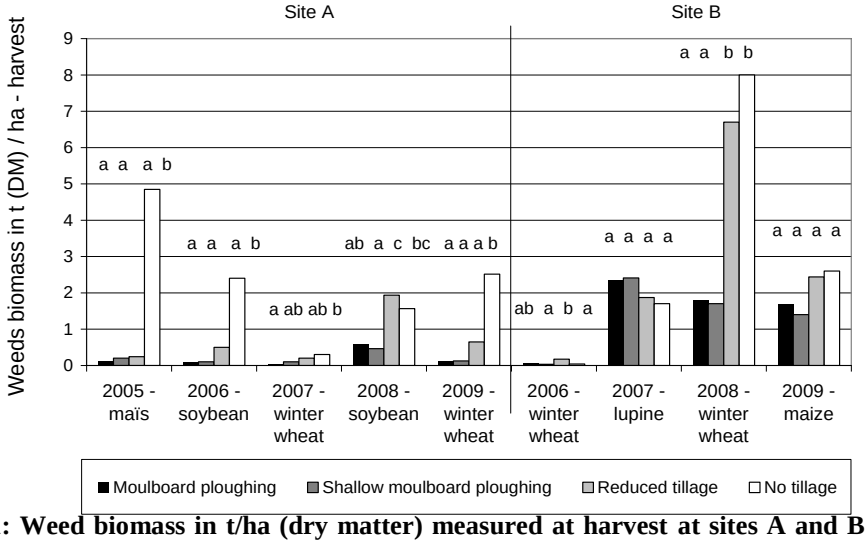

Figure 1: Weed biomass in t/ha (dry matter) measured at harvest at sites A and B - from 2005 to 2009. Bars of a given year marked with the same letter are not significantly different at *p<0.05*

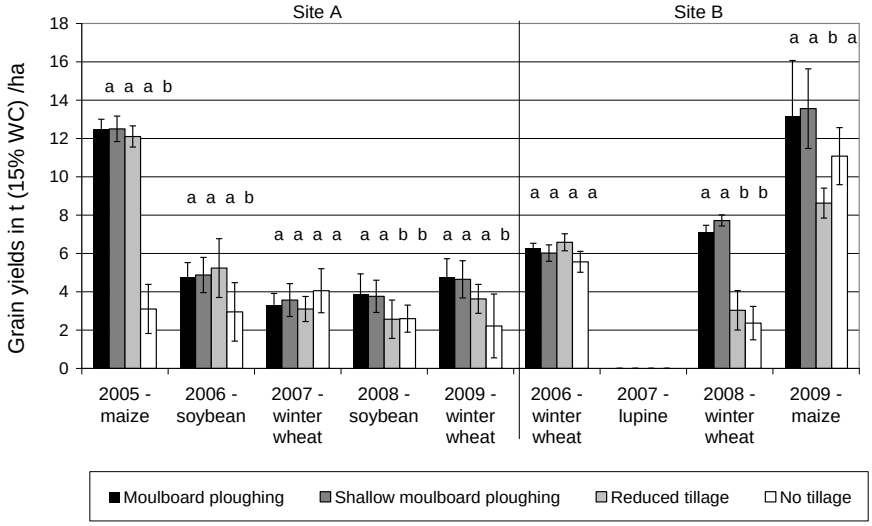

Figure 2: Grain yields in t/ha (water content 15%) at sites A and B - from 2005 to 2009. Bars of a given year marked with the same letter are not significantly different at *p<0.05*

Conservation tillage in conventional agriculture tends to make the cropping systems more dependent on herbicides. Organic farming principles could solve this problem. However, direct drilling under a cover crop in organic farming remains difficult. We need innovative techniques, such as knife roller and adapted cover crops. Reduced tillage is possible if weeds are well controlled with mechanical tools, such as hoeing for spring crops, i.e. maize in 2005 and soybean in 2006 (site A). If though weed infestation increases during one year, it will be difficult to control it in subsequent crops in case of reduced tillage.

References

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