Understory management in alley cropping systems in France

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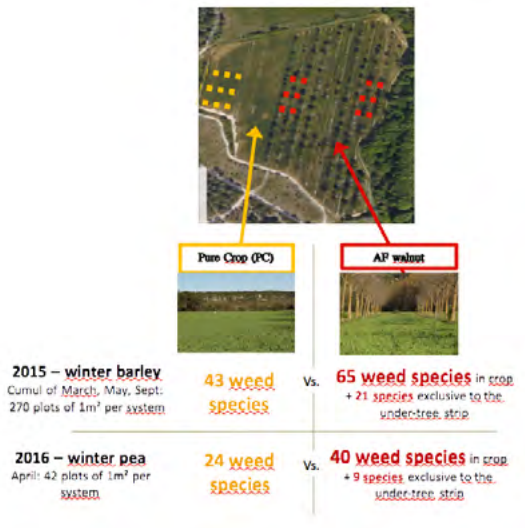
Non-crop vegetation strips under trees (before sowing the arable strips of the alley cropping system in Restinclières, Southern France, October 2014). *Ref : C. Dupraz*

Managing non-crop vegetation within the field

If trees and crops are the productive components of the agroforestry alley cropping systems, a third component must be considered: the non-crop vegetation at the tree strip.

This understory vegetation is the consequence of the difficulty of cultivating soil very close to the trunks without damaging trees. Even though this undisturbed habitat, analogous to a field margin, could be useful for enhancing beneficial biodiversity, it is commonly considered by farmers as a potential reservoir of weeds, which may disperse towards the crop alleys and, thereby, lessen crop production.

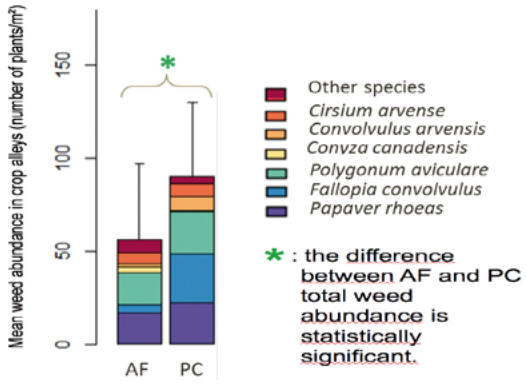


Comparison of plant richness found in the PC vs. the 20-year-old AF sections of the field

Does the weed community differ in agroforestry and pure crop fields?

To set the context for our investigation, we compared weeds in an agroforestry system (AF) vs. a pure crop system (PC), in the Restinclières Estate (southern France). Here, AF and PC crops have been managed according the same conventional cropping system (pea/winter wheat/winter barley rotation, chemical weeding), typical of the region, for 20 years. The only difference is the presence in the AF of hybrid walnut trees (13 m wide) and a spontaneous vegetation strip under the trees (last cultivated 7 years ago).

Our results show that weed species diversity was higher in the AF system for the two surveyed years. This is probably due to the heterogeneity of light and humidity conditions resulting from shading by trees (diversity of habitats), as well as the drift of some species from the tree strip (border effect) (Mézière et al. 2016). When accounting for the additional species we found within the understory strips, the plant diversity was even higher in the AF system. However, during the crop growing season of barley, in terms of abundance, weed infestation (i.e. all species together) was lower in the AF system than in the PC control. Results were similar in pea the following year (2016). When regarding the relative abundance for each species, we found that the most abundant species were similar in both systems, but always more abundant in pure crop (except for C. *canadensis*).



Weed abundance in barley (session of May 2015) in agroforestry (AF) and pure crop (PC) fields. Colours represent the relative abundance by species ("other species" include all the species with less than 3 individuals/m² on average).

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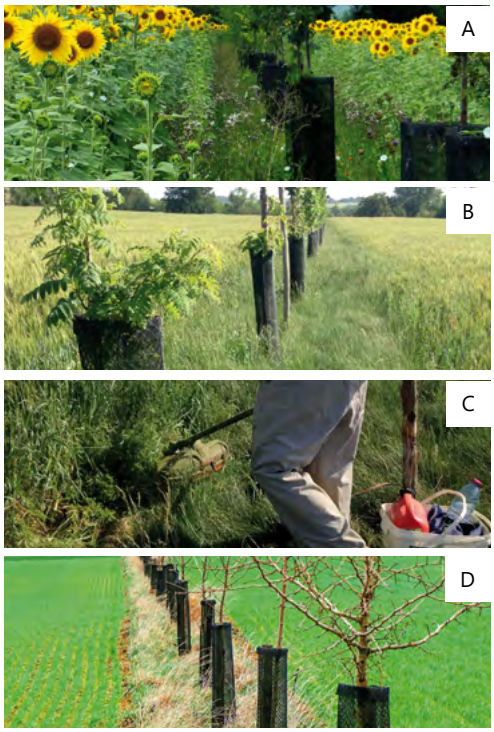
Advantages

The strips occupy a significant area of the field (3 to 10 %). This not only represents a direct loss of area for production, but strips can also host weed species that can spread to the crop. However, with planning, these strips can contribute to biodiversity conservation by providing habitats and resources for pollinators and pest predators, (Marshall and Moonen 2002) store high levels of carbon in soil (Cardinael et al. 2015) and, if planted with medicinal or fruit species, ensure an additional production service.



A: There are mainly common weeds on this tree strip [here: bindweeds (*Convolvulus arvensis*), poppies *(Papaver rhoeas*), thistles (*Cirsium arvense*), wild oats (*Avena* spp.)] in organic cropping system with tillage without any strip sowing at the plantation. *Ref: D. Mézière, central France, August 2016.*
B: Good covering fescue (*Festuca rubra*) sown at the plantation 6 years ago. *Ref: D. Mézière, South-West France, May 2017.*
C: First trial by a farmer of cutting wild oats (*Avena fatua*) and bedstraws (*Galium aparine*) before seed production to avoid dispersal towards crop alleys. *Ref: D. Mézière, South-West France, May 2017.*
D: A 7-year-old old mix-species plantation. Most fields are very young plantations. Currently, the effect of tree shading on the weeds community is less than that provided by the vegetation strip. The effects will need to be studied over several years when tree growth is significant. *Ref: J. Ploumarc'h, March 2017, South West-France.*

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Does the understory strip affect weed infestation in crops?

Weeds were surveyed in crop alleys of agroforestry systems at different distances from tree strips in the Restinclières site in southern France (10 fields), and in western France (10 fields). The results are reassuring, since it does not appear that the strip has a major affect on increasing weed infestation in either conventional-managed fields or in most of the organic-managed fields. One exception was spontaneous vegetation on the strips in some of the organic-managed fields. In these cases, weed infestation in crops was higher if pernicious weeds were present in the tree strips. Farmers should always keep a close eye on the species composition of the tree strip and be ready to act before problematic situations arise. Sowing the tree strips seems to be a very good approach to prevent the development of pernicious weeds.

Species typology according the risk of weed species dispersal from the strip towards crops and their harmfulness in crops for western France. (Donnet 2016)

Species only observed in the non-crop strip	Both in non-crop strip and in crop alley, but not very concerning (easy to manage and/ or short-distance dispersal)	Both in non-crop strip and in crop alley. Pernicious weeds.* To survey and control to avoid wide development in the strip	Both in non-crop strip and crop alley. Very pernicious weeds*, difficult to manage. To destruct imperatively when they develop within the non-crop strip (by crushing for example)
Agrostis canina *Festuca arundinacea*	*Epilobium tetragonum* *Picris hieracioides* *Picris echioides* *Torilis arvensis* *Dactylis glomerata*	*Alopecurus myosuroides* *Lolium multiflorum* *Vulpia myuros* *Bromus sterilis* *Bromus erectus* *Avena fatua*	*Cirsium arvense* *Convolvulus arvensis* *Cynodon dactylon* *Rumex spp.* *Sonchus asper* *Sonchus oleraceus*

*Level of harmfulness defined according to expert knowledge for the surveyed regions of western France (Charente and Charente-Maritime).

Suggestions for sowing the strip at the time of tree establishment

Although further research is needed, there are some initial common-sense steps that can be followed. For instance:

- sowing of melliferous species and providing small shelters with pruned branches to support functional biodiversity,
- using tillage-sensitive and perennial species to avoid weed dispersal and reduce the time and financial costs of weed control,
- sowing a mix with legumes to enhance tree growth.

Further information

Cardinael R et al. (2015). Impact of alley cropping agroforestry on stocks, forms and spatial distribution of soil organic carbon: A case study in a Mediterranean context. Geoderma 259: 288-299.
Donnet P (2016). Agroforesterie en grandes cultures: Evaluer l'effet des bandes enherbées sur le développement des adventices de la culture intercalaires. Mémoire de fin d'études, Bordeaux Sciences Agro. 32 p. + appendix.
Marshall EJP and Moonen AC (2002). Field margins in northern Europe: their functions and interactions with agriculture. Agriculture, Ecosystems and Environment 89: 5-21.
Mézière D et al. (2016). Arable weeds in alley cropping agroforestry systems: Results of a first year survey. 3rd European Agroforestry Conference, 23-25 May 2016, Montpellier, France.