SCA0PEST PESTICIDE-FREE AGROFORESTRY CROPPING SYSTEM: EFFECTS ON WEED COMMUNITIES

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Abstract

SCA0Pest project tests a pesticides free agroforestry cropping system. The evolution of weed abundance, diversity and the ratios of weed/crops biomass have been assessed over 4 years within the cropping system and show that there are differences according to years, crops and farming practices. Weeds populations are gradually responding to changes in the system and related to management. Landscape seems to have an impact on the weed community structure as presence of grass strips does not.

Keywords: pesticide-free; cropping system; weed management; agroforestry

Introduction

Intensive use of chemistry has simplified the cropping systems and led to the set-up of monoculture and soil tillage reduction (Chikowo et al. 2009; Letourneau et al. 2011). Although pesticides use contributed to end yield losses by stabilizing infestations, it remains responsible for: i) soil *and* water pollution (Pardo et al. 2010) or/and biodiversity loses (Petit et al. 2010; Perronne et al. 2014), ii) appearance of resistance (Valantin-Morison et al. 2008), or again iii) economic issues due to products cost increase. Therefore, alternatives for pest control appear by end 20th century and are multiple: to adapt seedling rate and date, intercropping, mechanical weeding, rotation lengthening and diversification, variety mixtures use (Chikowo et al. 2009; Deytieux et al. 2012; Letourneau et al. 2011).

SCA0PEST project as a PECS (Productive and Efficient Cropping Systems, Grandgirard et al. 2014) tests a pesticides free agroforestry cropping system. The project aims at observing weed communities' evolutions within the cropping system, evaluating effectiveness of the alternative agricultural practices chosen. To this end: i) longitudinal weed density evolution is followed, ii) weed contamination from grass strips is characterized and iii) weed communities (species and traits) is described.

Materials and methods

By September 2013, the SCA0PEST PECS was set up within a 34 ha and 5-years old alley cropping agroforestry matrix (N49°28'21'', E2°03'55''). Each year, 6 over the 8 terms of the crop rotations are present on a 0.5ha acreage plot (P1 to P6) each and are separated by standard trees lines distant of 30m each other (Grandgirard et al. 2014).

Crop rotation includes in order sunflower ("ToLuz"; *Helianthus annuus*) alfalfa association, 2 years alfalfa ("Luz1", "Luz2"; *Medicago sativa*), winter wheat ("blé1"; *Triticum aestivum*), oilseed rape ("Colza"; Brassica napus), spring barley ("OP"; *Hordeum vulgare*), field bean ("FevH"; *Vicia faba*) and winter wheat again ("blé2"). Experimental follow up are organised yearly according to the Res0pest project experimental standards (Cellier et al. 2014). They are dedicated to measurement of crops sanitary status, assessment of the spatiotemporal weeds and pests' pressures, and their consequences on yields and harvest quality (Grandgirard et al. 2014). Each of the 6 plots has 8 measurement stations of $16m^2$ every 20m lengthwise (Figure 1). Distance between grass strips and stations varies from 5 to 14m. Each station includes a 0.36 m^2 quadrat. Weed characterization consist in 4 annual surveys during which i) all different species in the plot are inventoried and weed density is ii) estimated in each 16 m^2 stations (Barralis method) and iii) precisely determined in each $0.36m^2$ quadrat. Last survey includes a biomass sampling. Data analysis was done by using multivariate NMDS and PCA procedures and having recourse to Friedmann and Mann-Whitney post-hoc tests. Statistical analysis was performed using the R 3.3.1 package.

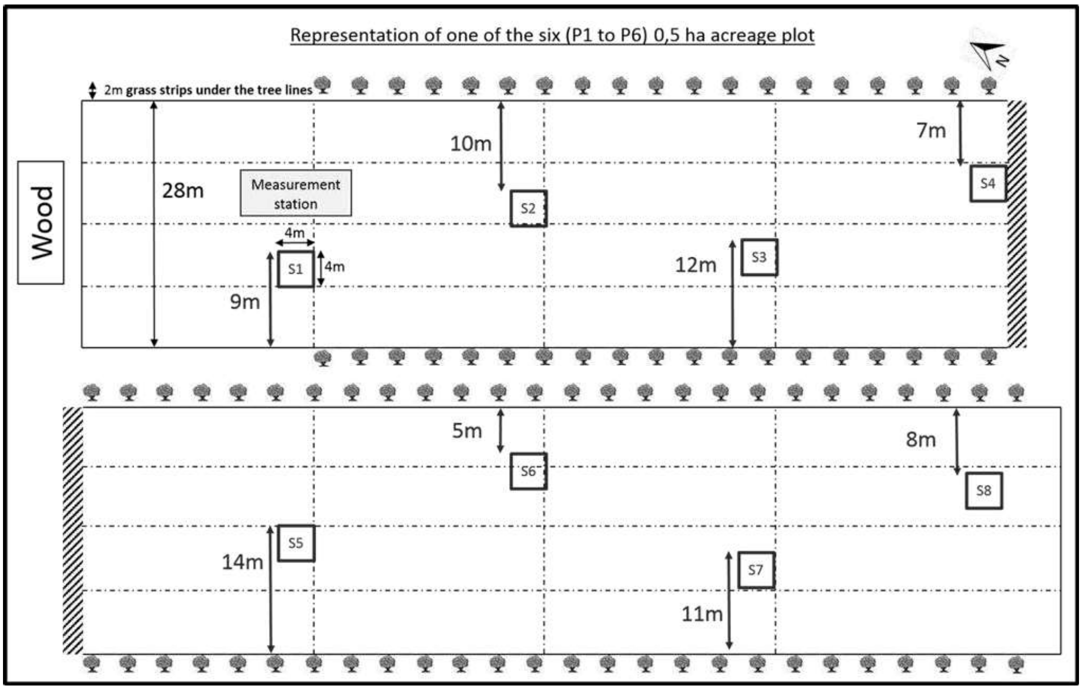

Figure 1: Schematic representation of a plot.

Results

Crops effect on weed density, diversity and dry matter. Friedman test on each plot followed by Mann-Whitney post-hoc paired test were used. Significant crop effect on weed density is observed on several plots. Weed density and dry biomass ratio on P1 plot are significantly higher for Luz1 compared to the years before and after. In the two plots (P1 and P6) where alfalfa cycle was completed (ToLuz – Luz1 – Luz2), weed biomass ratio decreases the second year of alfalfa (Luz2). OP always presents the lowest weed density. Cumulative histogram of weed species by crop (mixing plot and year) shows differences in floristic composition. NMDS (Figure 2) were realised for each year of study (2014 to 2017). Weed species composition differences between plots are stronger last year of study (2017). Weed species composition found in Luz1 and Luz2 seems to differ from other crops.

Effects of cultural interventions. Principal component analysis (PCA) showed links between group of cultural intervention variables and weed density, dry biomass ratio and diversity variables. Correlation and significance tests highlighted negative relations between weed density and the number of hoeing, total annual fertilization, cumulated fertilization, ammo nitrate fertilization; and positive relations with the number of grinding. Weed species richness is positively correlated with weed density but negatively correlated with the number of hoeing, total annual fertilization and cumulated fertilization. Weed dry biomass ratio is positively correlated with weed density and weed species richness.

Grass strips and landscape effects. Cumulative histograms of weed species in stations (S1 to S8) show a visual effect of wood distance (north-south gradient) but no effect of grass strips distance (middle-edges gradient).

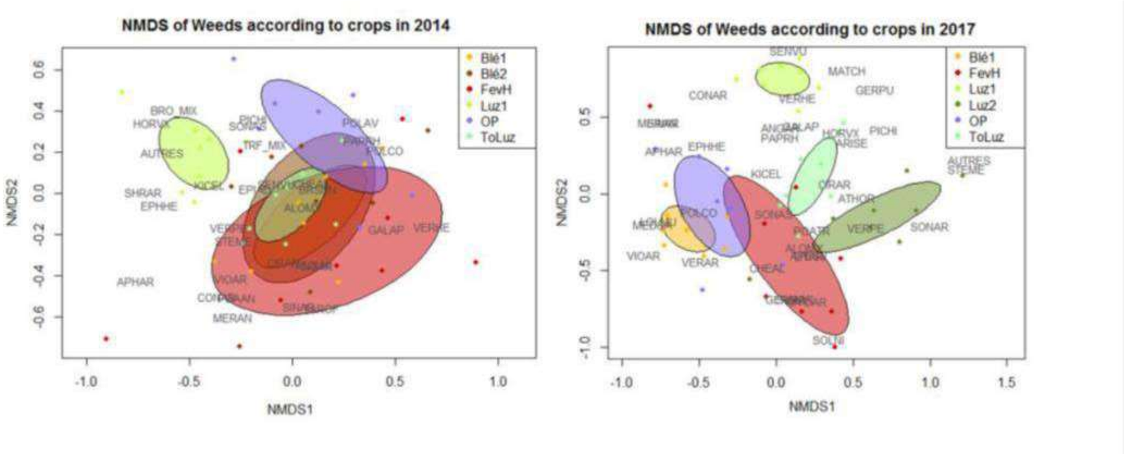

Figure 2: NMDS representations for years 2014 and 2017.

Discussion

Weed density and dry biomass ratio. Crops seem to influence weed density. Analysis did not show any year effect. Weed density differences depend on i) crop competitively potential (Chikowo et al. 2009), ii) specific technical managements (Valantin-Morison et al. 2008). First alfalfa year (Luz1) possesses the greatest weed density as spring barley (OP) possesses the lowest. Spring barley (OP) early sowed in the beginning of spring period often grow and develop before weed species. Sunflower alfalfa association (ToLuz) sowed later during spring period allows more weed species to install, increasing weed density the following year (Luz1). PCA and correlation test showed that certain agricultural practices influence more weed populations than others. Ploughing, hoeing and nitrogen fertilization were correlated with low weed density levels. In four years of study, global weed density did not seem to have negatively evolved. All the agricultural practices and solutions set up to compensate lack of pesticides use seem to maintain control on weed infestation.

Weed species richness. Global cropping system weed diversity remain high (70 different species). First four years of study did not prove weed biodiversity increase. Agroforestry and grass strips constitute habitat for animal and vegetal species (Marshall and Arnold 1995) increasing cropping system biodiversity. This should be considered in species richness calculation. Diversified crop rotation, agroforestry and lack of pesticides use enhance weed species richness compared to more simple cropping systems (Petit et al 2010; Marshall and Arnold 1995). Four years of study do not permit to know how weed communities will evolve on the long term.

Grass strips and landscape effects. Marshall and Arnold (1995) suggest that weed species presence depends on specific habitats within and around the field. Some species found in the grass strips were never found in the cultivated parts. Only few species were regularly found in both field and grass strips. Few species found in the field were never found in grass strips. At plot scale, distance from wood (landscape effect) influence more floristic composition than distance to grass strips.

Conclusion

First results of pesticide free agroforestry Sca0pest cropping system effects on weed communities did not show negative evolution in four years of study. Crop rotation and technical management seem efficient enough to avoid pesticides use. Weed diversity did not show neither positive nor negative evolution. Grass strips floristic diversity (lot of species not found in the fields) has not being precisely characterized but surely contributes to increase global species richness of the cropping system. Moderate grass strips management (one mowing per year) seems to prevent weed species from spreading into the field.

Weed floristic composition changed and adapted in the different plots under cumulated effects of crops, cultural interventions and year.

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