Evaluation of different ground covers to maintain botanical biodiversity in viticulture

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Abstract: The plant species richness of vineyard inter-row groundcover can maintain biodiversity of plants and arthropods, and could improve conservation biocontrol by reducing pest insect pressure. Five different seed mixtures were tested during two years on a Bordeaux vineyard plot Château Les Vergnes (Gironde, France). The initial plant composition and its evolution over time were studied in 2009 (first year after 2008 autumn sowing) and 2010 through exhaustive botanical monitoring during the growing season (April-July). Large differences were observed in plant species composition and abundance, even though the existing seed bank seems of major influence on the species richness. The farmers' management of the plot (mowing, machine passing) shows a strong selection pressure on the plant species present in the seed mixtures.

Key words: ground cover, viticulture, botany, biodiversity

Introduction

Inter-row groundcover is now part of the usual practices of most winegrowers in Western Europe, at least when it is adapted to the local context (soil, climate …). Its main objective is to regulate the plant vigour through competition for water and/or nitrogen between vines and groundcover. It also maintains soil structure, avoids compaction and reduces erosion (ITV, 2002). The presence of groundcover also contributes to the ecological connectivity between the different habitats of vineyard landscapes (forests, hedgerows, meadows) and the plot itself.
This experiment aims to test five different strategies: Sowing of three different seed mixtures, seeds collected on a local meadow, and 'spontaneous' vegetation from the seed bank. The main objective is to measure the impact of these treatments on the groundcover botanical diversity, and the potential impact on the vines.

Material and Methods

The experimental plot

The 1 ha plot, planted in 2005 at 3300 plants/ha on shallow clay-lime soil is located at château Les Vergnes (Les Lèves et Thoumeyragues, Gironde, France). The experiment started in autumn 2008 (sowing) using a randomized block design. Botanical surveys were done three times in May/June, July and August 2009, and three times in June, July and August 2010.
Five different treatments and 11 replicates were tested:

1. **RFWC** : Sowing , red fescue/white clover 5g/m²
2. **HORT** : Sowing, horticultural flower mixture, (13 species Nova-Flore), 3g/m²
3. **CONT** : No seeds applied, control expressing seed bank (Control)
4. **HAY** : Seeds applied through hay (harvested in meadow of the Château)
5. **WILD** : Sowing, custom made mixture of 22 "wild flowers" from Nova Flore, 3g/m²

Details on mixtures 2 (HORT) and 5 (WILD) in table 1.

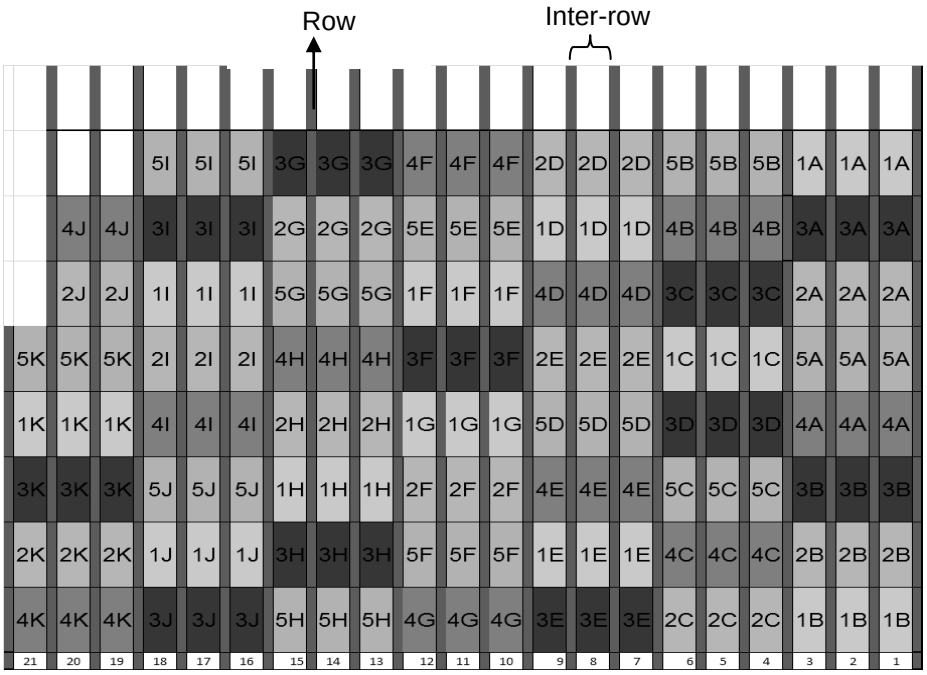

Figure 1. Map of the plot with each sub plot (modalities 1 to 5, reps A to K)

Table 1: Composition of seed mixtures 2 (**HORT**) and 5 (**WILD**).

Species list of HORT (Nova Flore) : <u>*Achillea millefolium*</u>, ***Adonis aestivalis***, *Anthemis tinctoria, Bellis perennis,* ***Cheiranthus cheiri,***, ***Coriandrum sativum***, *(Echium plantagineum), Lotus corniculatus,* ***Matricaria reculata***, *Medicago lupulina,* ***Myosotis alpestris*** *; Saponaria ocymoides,* ***Silene pendula*** (13 species)
Species list of WILD (Nova Flore) : <u>*Achillea millefolium*</u> *; (Agrimonia eupatoria) ; Anthemis tinctoria ; Bellis perennis ,* ***Centaurea cyanus*** *; Centaurea scabiosa ; Crepis biennis,* <u>*Daucus carota*</u> *; Festuca rubra dawson ;(Festuca ovina 'spartan)'*, *Galium verum ;* ***Hypericum perforatum*** *; Hypochoeris radicata; Lotus corniculatus 'bako' ; (Lychnis flos- cuculi) ; Medicago lupulina ; Origanum vulgare,* ***Papaver rhoeas*** *; (Prunella vulgaris) ; Sanguisorba minor, (Scabiosa columbaria),* ***Silene vulgaris*** (22 species)

IN BRACKETS (Plant species never observed), in BOLD: **Species in strong regression between 2009 and 2010**, UNDERLINED: <u>dominant species in 2010</u>

The botany survey

An exhaustive botanical survey was done in 2009 on the whole surface of the plot through three sessions in May/June, July and August. Three surveys were done in 2010 (one third of the surface of each plot) in April, June and July 2010. During each session each single species is recorded, and the percentage of ground cover of each single species and of each major group of plants ('Monocots', 'Fabaceae' , 'other dicots' and 'bare soil') was recorded (% of surface covered, Braun-Blanquet scale). Identification was based on Blamey & Grey-Wilson (1991); Bonnier & De Layens (1986); Bonnier (1971), Grey-Wilson (1994) and Hanf (1982).

Plant vigour measurement

Vigour of a vine can be measured through the chlorophyll content of leaves, which is strongly correlated to the nitrogen nutrition of the plant (Decante *et al*., 2009). This is measured on 30 leaves of each sub-plot according to the standard protocol by Hydro N Tester (Norsk Hydro ASA, Norway).

Data analysis: In order to compare the composition of the different treatments, we calculated Hamming distance (H) using the formula H= (1-J) (Cesar & Daget, 1997) where J is the Jaccard coefficient. (A∩B) = number of common species in A and B and (A∪B) = total number of species found in A and B

$$J(A,B) = \frac{(A \cap B)}{(A \cup B)},$$

Results

Richness

The 2009 survey shows a very high number of species in all treatments (fig. 2), due to the natural seed bank of the soil. A drop in the species richness is observed through June, July and August; mainly due to mowing pressure (annual species disappear). The hamming distance between the different treatments was decreasing during the season. Modalities 3 (CONT) and 4 (HAY) show the biggest loss in terms of species number between June and July (20%). Treatments 4 (HAY) and 5 (WILD) seem the richest but this was not significant. Some perennial species were observed only from 2010 onwards.

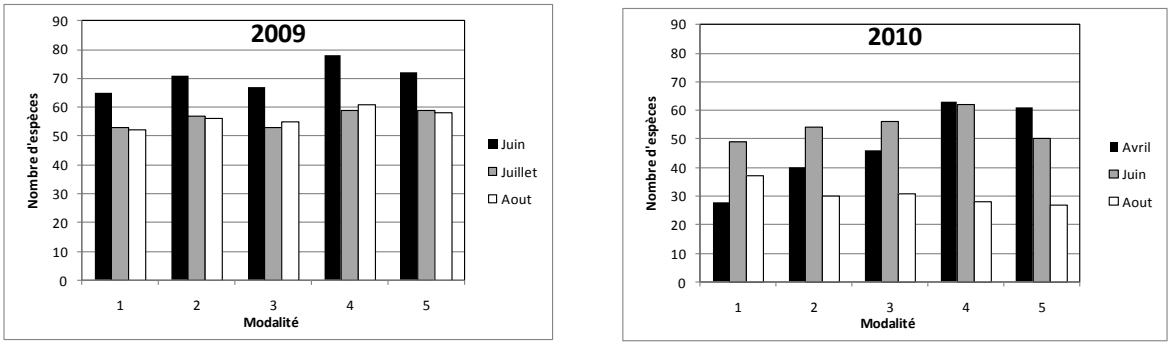

Figure 3a,b : Total plant species richness of each of 5 modalities among the three sessions of botanical survey (2009 and 2010)

Number of total species on the plot

In 2010, 107 species were recorded in all. This number is slightly lower than 2009 but this might be due to the change in the survey protocol (only one third of the plot was assessed). In 2010 as well the richness of each modality seems to change during the season. All modalities show a huge reduction of richness in August, probably due to a very dry summer, but this effect seems to differ from one treatment to another. Species richness is lowest for RFWC with 61 species. HORT and CONT contain 70 species each, HAY shows 76 species and WILD seems to be the richest with 78 species.

Again a large number of species is recorded in addition to the sown species. The seedbank already present in the soil (control) is expressing itself. That is why we calculated the Hamming distance between the CONT and the other treatments (table 3)

The distance between the control and the sown treatments is small or medium for all modalities, whatever the session of the survey. We can conclude as a consequence that the seed bank of the soil plays a dominant role in the groundcover diversity, for all treatments.

Table 3: Hamming distance between CONTROL and sown treatments 1, 2, 4, 5 in 2010.

Session	April				June				August			
Treatment (x)	1	2	4	5	1	2	4	5	1	2	4	5
Hamming (H) distance between CONT and treatment x	47	47	44	54	33	38	36	42	40	45	50	28

Treatments: 1 = RFWC; 2= HORT, 4 = HAY, 5 = WILD. H<20 : very small difference, 20<H<40: small difference, 40<H<60 : medium difference, 60<H<80 : big difference, 80<H: very big difference.

Impact on the plant vigour

Measurements did not show any significant difference between the groundcover and the chlorophyll content of the vines

Discussion

Variation inside treatment

For the five different treatments, we noticed an average richness (calculated on the basis of 11 replicates) clearly lower than the total richness. Seed bank originated plant communities do change from one replicate to another, due to differences of soil etc. (Cornwell and Grubb, 2003). The most important variability between replicates is recorded for treatment 3 (CONT), and confirms this hypothesis. The treatment 4 (HAY) also shows a huge variability, this is due to a high diversity of seeds, distributed non-homogeneously in the hay.

Variability between treatments

Richness results show that RFWC is the poorest treatment: total richness of 29 and 49 species respectively for the first and second session in 2010, average richness 11.6 and 11.9 species. This low diversity is probably due to the strong competition of this mixture on seed bank expression.

HAY is the richest regarding the two first sessions of 2010 (63 and 62 species). Nevertheless, the average richness (16.57 and 19.6) is not the highest among the five different treatments. This indicates that there is a huge number of species with low frequency of occurrence. The total richness can be explained by the rich community of the collection meadow but its distribution is heterogeneous. What is more, the plants of this treatment are local species and therefore most likely to resist to local conditions (dry soil, …). The sown treatments RFWC, HORT and WILD were more homogeneous among replicates. Even if big differences were recorded between treatments, all strategies of groundcover shown a common basis provided by the seed bank of the soil.

This experiment allowed highlighting the main characteristics of different strategies concerning groundcover. The HAY treatment seems most interesting for the botanical diversity of groundcover. However the CONT shows good results in terms of diversity, without any effort. Future observations (in 4-5 years) should confirm this and more knowledge is still required to follow the evolution of the groundcover and be able to translate experimental results into technical advice.

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