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Legume green cover in vineyards

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The influence of permanent green cover variants on grapevines without mechanical soil management has been investigated during the last years with respect to different parameters like soil composition or nitrogen supply. The perennial green crops have not been plowed, but mowed several times a year, leaving the organic matter to decompose and mineralize in an undisturbed soil ecosystem. We can assume from leaf nitrogen values that without the addition of any mineral fertilizer, the supply of the grapevines with nitrogen reach a sufficient level in the third year of permanent legume green cover (SPRING et al., 2003). Soil parameters indicate a sufficient nutrient supply of potassium and phosphorus in the fourth year, which is further supported by the measurements of the grapevines' investment in flowers (number of panicles per stalk). The biological soil activity has already been raised to a depth of at least 60 cm during the first year after sowing deeply rooted legumes like alfalfa.

A permanent green cover with perennial grasses negatively influenced the grapevines: soil nitrogen and number of flowers significantly decreased within three years.

Among the diurnal lepidopteran species found in the vineyards, 11 could potentially profit from plant species in the legume green cover because they are known as food plants for their larvae. Many imagos have been observed sucking nectar on alfalfa or clover flowers.

A green cover with alfalfa, sainfoin and clovers has been proven to be an effective suppressor of problematic weeds and neophytes.

2. Benefits of green cover

Green cover has a long tradition in viticulture. A spontaneous vegetation has often been tolerated to protect soils. This attitude changed dramatically during the last decade of industrialization mainly because of the use of herbicides which offered an easy way to keep the vineyards “clean and proper” and avoided any possible competition with the vines. However, bare soils are very vulnerable to erosion and washout of nutrients. As a consequence of decreased biological activity, harmful substances will be broken down much less efficiently as a consequence of decreased biological activity and will be easily transported into the ground-water. Soil pores will fill get with silt, surfaces will be encrusted with salts and precious humus in slopes will be carried off by the rainwater. There will be need for an extreme supply of nutrients as one consequence, leading to weak and spoilt vines and therefore characterless wine.

A functional green cover provides:
– a good water balance in soils
– activation of soil life and therefore enhanced nutrient cycles
– an improved soil structure
– protection against erosion
– healthier plants
– a higher biodiversity above and below ground

– a more effective buffering and decomposition of toxins
– better build up of humus and sink of carbon

3. Review of green cover in vineyards

Numerous studies about the effects of green covers on grapevines have already been carried out. The most abundant subjects were correlations between soil management and agronomically important factors like yield, vigor and levels of sugars/acids in the grapes. One must bear in mind the complexity of interactions among climate, green cover, soil and vines to understand why some of the results seem to be contradictional. Nevertheless, a meta-analysis of 32 international projects could line out some important trends (FLÜGEL 2007):

4. Methods

Organic farming: all trial fields are managed with a progressive ecological approach. No industrial or synthetic products are used in these fields except for a very limited application of copper preparations against pathogenic fungi. No irrigation took place during the trials. The control field has already been managed for several years under a conventional regime with application of NPK-fertilizer, herbicides (bare soils) and fungicides. All data were collected from lots planted with the the grape variety Pinot Noir, cultivated within a small, well-defined area in the core of "Domaine Mythopia" above St-Léonard, Valais, Switzerland (789 m ASL., coordinates 46°16'12'' N 7°24'27'' E).

The soil parameters were measured in external laboratories. The leaf nitrogen values were estimated with the N-tester of the company Yara (one model only, no type label) just before the accumulation of sugar in the grapes started (véraison, around middle of August). All the leaves measured were growing in the grape zone of the vines.

	positive	negative	no influence	other factors	mixed
yield	9 %	52 %	19 %	9 %	11 %
wine quality*	32 %	11 %	42 %	3 %	6 %
diseases**	96 %				4 %
overall	51 %	14 %	19 %	16 %	

Tab. 3: evaluation of 32 research projects on green cover in vineyards
*** no information given in 6% of the studies**
**** only one third of the studies could be evaluated**

		fraction
alfalfa	*Medicago sativa*	18 %
sainfoin	*Onobrychis sativa*	18 %
bird`s-foot trefoil	*Lotus corniculatus*	10 %
red clover	*Trifolium pratense*	16 %
white clover	*Trifolium repens*	8 %
black medic	*Medicago lupulina*	9 %
melliferic mix		21 %

Tab. 1: legume green cover mix

5.Results

Legend: g = grasses, l = legumes, ch = biochar, co = compost, pl = plowed, figure = years with green cover

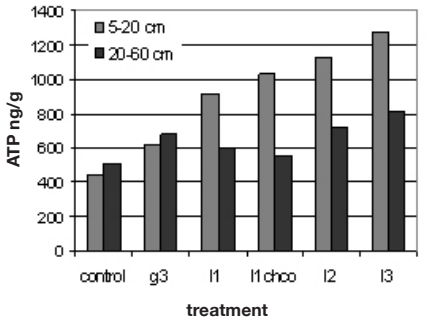

Fig. 1: soil microbial biomass

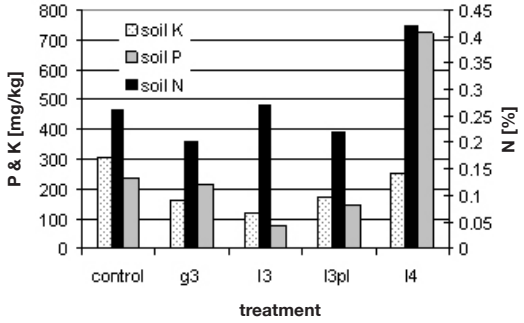

Fig. 2: soil nutrients

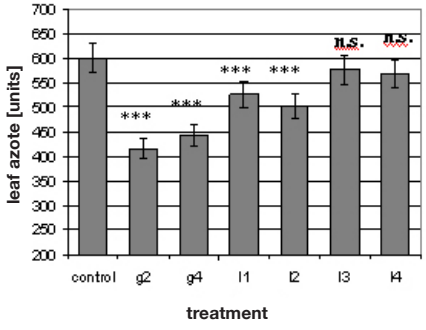

Fig. 3: leaf azote in vines (veraison, years 2006–2009)

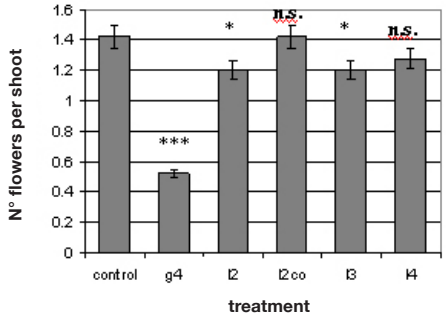

Fig. 4: strength of bloom

6.Discussion

The main purpose of a permanent greening with legumes is to establish autonomous nutrient cycles giving the vines a sufficient supply of nutrients without the use of mineral fertilizers. To achieve this, symbiosis between mycorrhizal fungi and rhizobacteria must be stimulated. The buildup of humus should be encouraged not only because humus is a living reservoir of nutrients, but it also binds climatically active CO2. A diversified network of nutrient exchange and communication among the vines, greening and soil organisms should improve the vines' intrinsic defense mechanisms. This in turn allows a reduction in the application of pesticides. Working the soil profoundly and/or regularly must be avoided, because such intrusions set free nitrogenic gases, which are potent greenhouse gases. Plowing disturbs the microbiological community and destroys established symbiotic networks.

The results show that it is possible to provide a sufficient supply of nutrients just within two to three years, among other factors depending on the history of soils. Application of soil ameliorants like compost or biochar increases the microbial biomass and can compensate the lack of nutrients in the first two years of green cover establishment. In very dry regions, potential competition for water can be avoided by rolling the green cover in the beginning of periods without or with little precipitation (device: rolojack, www.rolojack.com).

Permanent green legume cover is also recommended for perennial cultures like fruit orchards. The importance of soil condition and history should not be underestimated, when sowing for the first time,because it is crucial for the establishment of the symbiosis between alfalfa or other legumes and their specific rhizobia. The legumes will profit from nutrient reserves left from former mineral fertilization in the soil rather than invest in symbiosis and in fixing nitrogen from the air (PERRET 1982). This can lead to competition for nitrogen among the grapevines (see Fig. 3 and 4). To compensate this effect, compost application and application of green cover in every second row only are recommended in these first critical years. Future trials will show whether these measures will help. Furthermore, the symbiotic bacteria can be absent in soils that have been treated with pesticides for a long time and the input of air nitrogen can therefore be delayed. Preliminary inoculation of the seeds with the corresponding rhizobia species should help in this case.

Subjects for future research will be the interaction between endomycorrhizal inoculants with grapevines, green cover and application of biochar.

7.Literature

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A comprehensive version of this article is found in:

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