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MANAGEMENT OF A PERMANENT COVER CROP IN AN ORGANIC FARMING SYSTEM

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Abstract: The current societal, political and regulatory context is bringing farmers to search and develop low-input cropping systems, particularly in organic farming. Sowing a permanent cover crop is a practice of interest for those systems. Several functions can be highlighted: enhancing the symbiotic activity of the cover crop species to bring nitrogen into the system and limit the use of exogenous fertilizers, weed control through canopy competition, and erosion mitigation in sloping plots.

In organic agriculture, the non-chemical management of a permanent cover crop can be difficult and existing mowing solutions can only be done in the fallow period. Thanks to the collaboration between ARVALIS and an agricultural machinery manufacturer, an inter-row mower prototype was created to manage the cover crop into the main crop. This mowing is made possible by the tractor's self-guiding system, which is also used for sowing the permanent cover crop and the main crop.

This technique has already been tested in the south of France where a trial with alfalfa and wheat was carried out. The first results are very encouraging; in the situation where alfalfa is mowed three times, wheat yields reach 26.6 q/ha and 13.9% of protein. To confirm these initial results, a larger-scale experiment was set up with other permanent cover legumes species and different mowing methods using the innovative inter-row mower prototype.

The innovative nature of this technique for managing permanent cover crop thus offers multiple perspectives for the agro-ecological systems of tomorrow.

Introduction: Organic farming systems are facing two main limiting factors: weeds control and nitrogen availability.

Indeed, weeds compete crops for light, mineral elements and water. However, they could have positive effects by increasing biodiversity; some weeds can limit soil compaction, when others are indicative of soil quality. Thus, in organic agriculture (OA) it is imperative to integrate weed management and control into the cropping system.

The other challenge in OA is to make the best use of natural processes to provide nitrogen to crops through the nitrogen fixation by legumes, and inter-cropping nitrogen sequestration by cover crops. Moreover, the availability of organic fertilizers will decrease, particularly because of the regulatory change for the use of pig slurry and poultry droppings in OA, and the increasing development of organic farming.

Permanent cover crop in organic farming systems is dealing with these two issues, but its management is today only possible during the fallow period, and is not satisfying. Since 2016, in the South of France, ARVALIS is experimenting a new permanent cover crop management practice in OA, which allows new agronomic perspectives for organic farming systems.

Material and methods: The principle of this practice is to separate the cover crop and the main crop in space to be able to manage them separately. Sowing and management of both crops is thus realised with a tractor's self-guiding system. The permanent cover crop is mowed in-between the main crop rows, during its growth, with an inter-row mower especially designed for experimenting this practice.

In the 2016 spring, alfalfa was sown as the permanent cover crop at a spacing of 30 cm, under a sunflower sown at 60 cm, using a tractor equipped with a GPS RTK autoguiding system. It has been then possible to hoe and harvest the sunflower while preserving alfalfa. The following fall, the wheat is sown at 30 cm spacing, between alfalfa rows, using the RTK tractor. Then, the alfalfa is mowed for the first time, with the inter-row mower prototype, the following spring in order to limit competition from alfalfa and weeds on wheat and provide nitrogen. This mowing also acts as a mulch between rows which limits evaporation and weed emergence. After the wheat harvest, the interest is to let the alfalfa develop as a fallow period cover crop for its weeding effect and its ability to fix nitrogen. Then, the next crop is sown, in direct sowing or strip-till sowing, between the alfalfa rows. And so on for as many years as alfalfa provides its agronomic services. In this experimentation, three years of wheat were conducted in the alfalfa cover crop to test the limits and technical performances of this system under different climatic conditions. In 2018, four alfalfa managements are experimented, with four repetitions: no mowing, two late mowing, two early mowings and three mowings.

Results: The experimentation had shown encouraging yield and proteins content results, even if the results are not statistically significant (see the below table). Tests conducted in 2018 seems to show, in tendency, better yield results with two early and three inter-rows mowings. To go further, the amount of nitrogen (N) absorbed by the wheat has been calculated to understand the nitrogen dynamic into this cropping system; it seems to increase over years, with a cumulative effect. The calculation formula is the following:

$$N \text{ absorbed (kg N/ha)} = (((\text{Proteins content (\%)} / 5.7) * \text{Yield (q/ha)}) / 0.5) * 1.25.$$

Table: Experimentation results from 2017 to 2019

Years	Terms – Mowing methods	Wheat yield (q/ha)	Proteins content (%)	Nitrogen absorbed by wheat (kg N/ha)
2017	2 early mowings	13.66	12	72
2018	No alfalfa mowing	Not harvested	/	/
	2 late mowings	19.4 a	14.2	121
	2 early mowings	24.3 a	14.2	151
	3 mowings	26.6 a	13.9	162
2019	2 early mowings	40	11.2	196

Discussion: The experimentation set up by ARVALIS has made possible to combine agricultural machinery, digital technology and agronomy to manage a permanent cover crop in organic farming. Experimentations need to continue to verify initial results. The management of a permanent cover crop could answer agroecological issues but references need to be created in the long run and under different production contexts: carbon soil storage, greenhouse gases emissions, erosion control, biodiversity, return on guidance system and inter-row mower investment, working time, profitability, effects on phosphorous nutrition, on soil life... A new multi-year experimentation has been set up in spring 2019 to experiment the

management of several species of permanent legume cover crops in a crop rotation. The impacts on the multi-performance of the organic farming systems will be evaluated (economic, agronomic and environmental results).

Disclosure of Interest: None Declared

Keywords: agro-ecology, mowing, organic agriculture, permanent cover, self-guiding system