DOMINO final project summary

Project purpose

The aim of the project DOMINO was to reduce external inputs in intensive organic fruit orchards for pest control and fertilization and to improve the overall productivity and sustainability of this agroecosystem. Our aim was tackled by increasing orchard biodiversity, adaptation of plant protection strategies to new demands and more adapted fertilisation strategies using efficient recycling of organic residues. In addition, these new management practices were expected to give a possible additional cash flow by the introduction of secondary cash crops. Finally, the project results should lead to the design of mixed orchard systems more resilient to climatic and socio-economic challenges.

Final project summary

The research activities developed innovative management strategies in intensive organic fruit orchards by the use of i) dynamic “living mulches” such as stoloniferous cash crops in the row and the sod with leguminous between the rows for weed control; ii) fertilization by recycled soil amendments and leguminous crops to increase resource use efficiency and improve ecosystem services and iii) partly closed covering net systems to support non chemical pest and diseases control. Living mulches, namely herbaceous plants with good attitude in covering the soil, showed their capability for establishing and maintaining a "good degree of biodiversity", providing several additional ecosystem services. Species taken from local ecosystems provided significant advantages in terms of plant resilience and soil cover under the tree rows. For example, wild strawberry plants gave excellent results in Central Italy. Similarly, Potentilla was capable to fully cover the strips within three months in Switzerland. Winter pea yielded very good results either in the German and the Swiss experiments. Nitrogen was released after mowing, just in time to satisfy at least partly the needs of the trees. Mint was tested in Poland, Germany and France with excellent (or, at least, quite good) results in terms of soil covering capacity, weed control, and biomass production, without problem for fruit quality and apple root growth. The transnational experiments highlighted that mulching species are highly site-specific.

Different alternative fertilisers and fertilisation strategies, namely recycled organic matters and nutrients, clover grass-based materials, leguminous intercrops and non-contentious commercial

fertilizers were used as nutrient sources in intensive organic apple orchards. The organic fertilizers with a higher rate of mineralisation (and mostly likely those in liquid form) appeared to positively stimulate different "layers" of the soil biodiversity. The organic fertilisers with longer mineralisation rate showed different path in the impact of soil biodiversity, which could positively affect also different ecosystem services related to climate change mitigation such as C sequestration. So, nitrogen availability from peas and clover-grass based fertilisers depended strongly on application dates and times of incorporation, which can result in insufficient N availability during the period of intensive plant demand. While, the liquid fertilizers biogas digestates, Lumbreco form earthworm compost and stillage showed very good fits to the N demand of the trees in spring due to a quick N release after application. The exploitation of locally produced organic fertilisers hence assured the recycling of nutrients and provided externalities valuable for the processes related to management of wastes and safe water supply. However, a full assessment of the whole production process would be needed to fully appraise the carbon footprint of any organic fertilizer.

The orchard performance under partly closed covering systems was quantified in order to validate the reduction of external inputs use. Trials were carried on apple and under different environmental and managing systems. Top plastic covering and lateral netting systems were applied to reduce foliage wetting and to prevent insect attacks. The tested system allowed to reduce losses, or at least produced the same results of the organic sprayed plots, in terms of both infected fruits and infection intensity. The system induced reduction on number of fruits damaged by the codling moth, and more generally the feeding damages were markedly lower, while no significant difference was found for 'other feeding' damages, mainly caused by grubs and caterpillars. The rain-proof roof allowed to reduce the wetting of the fruits mainly in the top part of the trees limiting post-storage losses caused by post-storage scab. The effect of covered systems on beneficial insects, whether they are free to move across the canopies or not, was not clear.

The added value of the different strategies was appraised in terms of generation of eco-services and biodiversity improvement, considering soil microbiota, mesofauna, entomofauna and flora diversity. Both organic fertilisers and living mulches represented a sustainable solution for organic orchards management as long as they were adapted to the specific orchard conditions. It is expected that the establishment of the proposed solutions can cause a positive "domino" effect on biodiversity, better fruit quality and overall sustainability of the fruit cropping systems. Diversified and stratified mixed cropping systems in highly intensive organic orchards can exploit different layers above and below ground, in contrast with the current partially conventionalized monoculture.

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