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DYNAMIC SOD MULCHING AND USE OF RECYCLED AMENDMENTS TO INCREASE BIODIVERSITY, RESILIENCE AND SUSTAINABILITY OF INTENSIVE ORGANIC FRUIT ORCHARDS AND VINEYARDS

Yearly report on soil and plant nutrition data (WORK PACKAGE 4: 2018-2019)

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The partners University of Hohenheim (UHOH, Germany, coordinator of the work package (WP), INHORT (Institute of Horticulture, Poland), LAIM (Research Centre Laimburg, Italy) and FGI (Fruit Growing Institute, Bulgaria) are involved in WP4. In designing the field trials in this WP, each partner (FGI, INHORT, UHOH) focuses on alternative fertilizers and waste materials present in the different regions of the trial location. In addition, each partner uses a control plot with zero fertilization and a plot fertilized with horn grit as a control. The amount of N applied in the trials depends on the productivity / yield level of the apple production system in the different countries / regions. The partner LAIM performs incubation experiments in microcosms to gain a better understanding on the N dynamics of the fertilizers used by the partners and open field pot trials with selected fertilizers.

Most important outcomes of the trial year 2018 provided by the consortium partners in WP4

INHORT

In spring 2018, the trial on testing alternative fertilizers was established in an organic apple orchard (variety Topaz (rootstock M9)) with 6 different treatments: unfertilized control, horn grit, and dry animal manure as commercial fertilizers, clover-grass pellet, stillage from production of yeasts (vinasse) and liquid biodigestate residues. The trial was located at the experimental orchard of INHORT in Dąbrowice, with 3 replications x 9 trees for each treatment (27 trees/treatment). The trial will continue in the years 2019 and 2020. The fertilization level was 70 kg N / ha. All fertilizers were applied in the tree strip on the second half of May. The trunk circumference of the trees was measured at the beginning of the trial. Leaf samples were collected in July for analyses of the nutrient status (N, P, K, Mg, Ca, Na, Zn, Fe, Mn, and B). No nutrient deficits or surpluses could be found based on leaf

analyses. Soil samples were collected once for standard nutrient analyses at the beginning of the trial. At the time of harvest, yield and commercial quality were determined. There was a trend of a higher total production for the treatments with horn grit in comparison to both control and other fertilizers. However, when only the fruits with commercial value are considered, clover pellet and liquid biogas digestate showed a higher yield. The trial was used to start the analysis of the effect of the treatments on soil biodiversity (see WP6).

LAIM

In summer 2018 twelve organic fertilizers (bone and horn meal, two stillage extracts, clover pellets, pea seeds, two digestates, clover grass silage, biogas digestate pellets, green compost, green compost + biochar (8:1 v/v) and a mushroom substrate) were tested as nitrogen fertilizers.

To understand if these products can be used in agriculture, bacteria and heavy metals content were examined, and trials to understand how much and how fast these substances release mineral nitrogen into the soil were performed. Every sample was mixed with 250g of soil and incubated for two months in aerobic conditions (10°C, 70% water holding capacity, 90% air moisture). The mineral nitrogen (Nmin) was periodically extracted and quantified, while at the beginning and at the end of the experiment a complete soil characterization was effectuated. Of the twelve products, the two digestates are the fastest nitrogen releasers, and they are releasing the larger quantity of mineral nitrogen. The two stillages also worked well too, but both required more time than the digestates to reach high mineralization levels. Unfortunately, not all the tested products worked as expected. A few products immobilized the mineral nitrogen and released only a small amount of it after more than one month. Digestate pellets showed minimal influence on the soil mineral nitrogen. Concerning clover silage and mushroom substrate the results are extremely negative, as in all the

four extractions performed the values of mineral nitrogen released were lower than in the control pots. Finally, the compost brings only a low quantity of mineral nitrogen, that was even lower when compost and biochar where mixed together. To better understand what happened to the soil after the two months of incubation the main soil parameters were measured. A few fertilizers (clover silage, digestate pellets and mushroom substrate) are slightly basifying the soil, while others (two digestates, peas seeds, one of the stillage and horn grit) are acidifying it, but the values remain quite close to the initial pH of 7.5 ± 0.2. The soil organic matter content increased in all the trials, while it remained quite constant (+5%) in the control. As expected, the organic carbon pool increased, as all the tested substances contain mainly organic matter. For what concerns the macro elements, phosphorous and magnesium increased in all the trials, particularly with the application of digestate pellets, the two bio-digestates and the two composts trials.

In spring 2019 LAIM started the open field pot trial, where a few substances selected from the previous laboratory trial will be tested. The two digestate, the stillages, dried peas and clover pellets will be tested on Gala Schniga SchniCo Red (rootstock M9). The trial will last two years and it is located in block 31 at the Laimburg Research Center (Vadena – BZ, Italy). A supply of 8 grams of nitrogen per tree will simulate a fertilization level of 32 Kg N / ha. Blooming intensity, fruit harvest, mineral nitrogen extractions and leaves analyses will give useful information to a better understanding on the use of these organic waste derived fertilizers.

UHOH

In spring 2018, the trial on testing alternative fertilizers was established in an organic apple orchard (variety Santana (rootstock M9)) with 9 different treatments: unfertilized control, horn grit and vinasse as commercial fertilizers, clover-grass pellets, clover-grass

silage, liquid biogas residues, compost and peas (spring sowing). The trial was located at the Competence Centre for Organic Fruit Growing (KOB) close to the lake Constance, the largest apple growing area in Germany and it will continue in the years 2019 and 2020. The fertilization level was 25 kg N / ha. All fertilizers were applied in the tree strip in April. Only the summer peas were sown one month earlier and incorporated in the soil on the day of fertilizer application. Prior to tillage, the germination rate and the biomass of the peas were determined. The trunk circumference of the trees was measured at the beginning of the trial. Blooming intensity and fruit set were estimated. Leaf samples were collected in July for analyses of the nutrient status (Cl, P, K, Mg, Ca, Na, Zn, Fe, Mn, and B). No nutrient deficits or surpluses could be found based on leaf analyses. Soil samples were collected once for standard nutrient analyses at the beginning of the trial. Mineral N content of the soil (Nmin) was determined at 9 dates during the growing season between March to October. Besides Nmin, Smin was determined in order to see if S application as fungicide alters S availability in the soil. Simultaneously, soil moisture was measured by Time-Domain-Reflectometry. Nmin in the soil initially increased – the highest in the treatment with liquid biogas residues - then decreased in July and increased again later in the year, showing the highest values in August and September. In contrast, Smin levels were highest in July. Due to the very dry year, fungicide application was very low and most likely did not influence the Smin contents in the soil. At the time of harvest, yield and fruit quality i.e. size, weight, color, sugar and acid content, starch degradation, fruit firmness, ash and nutrient concentrations (C, N, P, K, Mg, Ca, and Na) were determined in the apples. Due to very high temperatures, sugar content and fruit firmness were higher than the target value for the variety Santana. There were no significant differences in the nutrient concentrations in the fruits, in the fruit quality and yield level between the fertilizer treatments in the first trial year. However, the trend indicated that the spring peas which were incorporated in the soil showed the lowest yield levels.

In addition to the scientific field experiments, the partner FÖKO e.V. initiated several on-farm trials on soil fertility with apple growers in 2019.

FGI

The field trials at FGI start in 2019.

Conclusions for the first project year

All trials at the different locations were set up in accordance with the project plan and the first data were collected. Comparing the field trials and the incubation trials some differences in nutrient release were detected which will be explored in further trials. For the field trials, data collection will continue in project year 2 and 3. The alternative fertilizers differ in soil Nmin contents during the year. However, statistically significant differences were not detected in the first year of trial. In addition, the extreme weather conditions (very hot and dry) may have affected the outcome of the field trials.