Soil nutrient availability of new organic fertilizers formulations

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Abstract

A trial testing different regionally available organic fertilizers was established in 2018 in an organic apple orchard. Vinassa, clover pellets, horn shavings or a biodigestate were tested as the source of nutrients. Standard manure fertilization and no fertilization were considered as control treatments. To evaluate the effect of those treatments on the macroelements availability in soil the levels of nitrogen (N-NO_3), phosphorus (P) and potassium (K) were monitored during the trial. Furthermore, the products underwent a mineralization experiment to test the dynamic of N release. The studied products had different N mineralization rate which was paralleled by different soil availability. The biodigestate showed the fastest mineralization and also soil availability. Vinassa and the horn shavings appeared to have a steady N release dynamic and nutrients availability throughout the season. The clover pellet resulted to have a negative N mineralization rate up to 30 days, with limited N availability in the soil. A preliminary possible strategy in using the different formulations is proposed to match with plant nutrient needs and to increase soil nutrient content.

Keywords: Organic Fertilizers, Organic Farming, Eco-friendly strategies, Mineral nitrogen

Introduction

Today's organic orchards are intensive systems rarely exploiting biological N fixation, nor the ideal mixed organic farming system due to spatial decoupling of livestock and crop production systems. This can result in a lack of sufficient nutrients input on organic orchards (Martin et al. 2007), increasing the risk of soil nutrient depletion over time. Therefore, to improve fertilization strategies it is important to diversify the external inputs possibly with fertilizers having a low environmental impact: the use of recycled materials available at local level could thus be an important option to consider. Even though new organic fertilizers are becoming available from different sources, their influence on the soil fertility should be assessed. We have thus carried out trials to verify the nutrient availability and the N mineralization ratio of some promising new organic fertilizers.

Material and Methods

The trial was carried out in 2018-2019 in an experimental apple orchard located near Skierniewice (Central Poland). Different types of new fertilizers (vinassa – a stillage from yeast production, clover pellets, horn shavings manure and biodigestate) were evaluated and compared to unfertilized or dry granulated manure application (standard fertilizer) under a complete random block design with three repetitions per treatment. The fertilizers were applied to the field once a year, in springtime (May), in an amount to ensure the same level of supplied nitrogen (70 kg N/ha = 40 g N/tree). The N-NO_3 content in soil was determined at the beginning of each season (April) and further monitored every two months in the period from May to September; phosphorus and potassium content was measured at the beginning (May) and at the end (September) of each season. Potassium and phosphorus content were determined by standard method using ICP-OES; nitrates content was determined after extraction in 0.03N acetic acid with potentiometric method.

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An incubation trial to determine the dynamic of N mineralization was carried out at Laimburg Research Center with the same fertilizers (except the dry manure) on spring 2018. The organic nitrogen mineralization of the vinassa (VIN), clover pellets (CLPE) horn shavings manure (HRMA) and biodigestates (DGS) was measured and compared also with the non-fertilized control (KNTR). In each microcosm a fertilization of 90 kg N/ha concentrated three times was simulated, mixing together 250g dried and pre-incubated soil with each fertilizer individually. The microcosms were kept under controlled conditions (10°C, 70% WHC, 90% HR) and destructively sampled after 7, 14, 30 and 60 days. Samples were immediately extracted with CaCl2 (VDLUFA Metodenb. IA2.1.1) and N-NH_4 and N-NO_3 were determined with a flow analyser (SAT 450).

Results and Discussion

The initial levels of N-NO_3 in the soil recommended nitrogen fertilization (Tab. 1). However, after applying the different fertilizers, a different availability of N as well as of the other two macroelements emerged. The untreated control (KNTR) displayed a visible decreasing trend in the N-NO_3 content in soil up to the beginning of autumn. Addition of dry granulated manure (MANU) only slightly improved the levels of nitrates present in soil and slightly postponed the decreasing trend with levels of N-NO_3 observed in July and September not different from control. However, this fertilizer increased phosphorus and potassium content with respect to control. The clover pellet (CLPE) made N available at a slow pace, as the increase in nitrogen content was observed only in summer, while P was increased already at short time after application. This fertilizer was the only product showing a negative mineralization rate in comparison to the KNTR (Fig. 1).

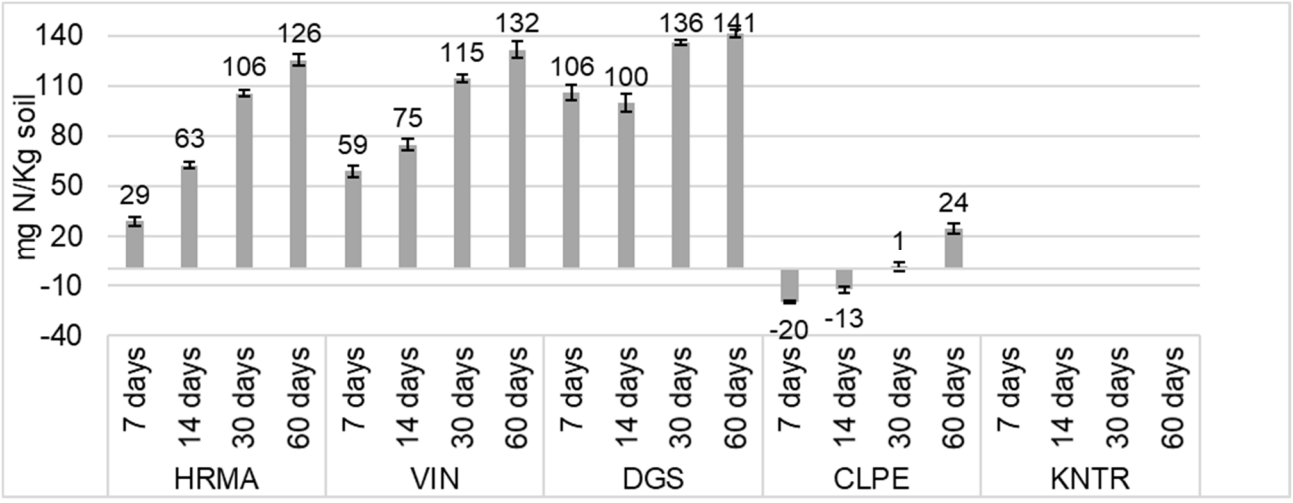

Figure 1: Mineral nitrogen (mean ± SE) measured within the microcosms during the two months trial. Control (KNTR) was posed as zero, to show the net mineral nitrogen gained due to the applied fertilizer.

Fertilization with horn shavings manure (HRMA) and the biodigestate (DGS) caused an initial rapid increase in NO_3 content in comparison to untreated control (Tab. 1). However, HRMA continued to steadily release N into the soil. On the other hand, the level of the other two macroelements (P and K) did not change significantly during the season for these fertilizers, suggesting that they should be used mainly as nitrate source. Vinassa (VIN) made both N and K available in large amounts immediately after its application, and the increased level of these macroelements was maintained during the whole season (Tab. 1). Interestingly, HRMA, VIN and DGS, to a lesser extent, showed a quite clear relation of the

mineralization rate with the length of incubation (Fig. 1), thus confirming the N availability dynamic observed in the field trial. However, DGS mineralization was much faster in the first two weeks, but the final degree of N mineralization reached a similar level for all three products. The most visible changes in NO_3 content in soil were observed after VIN and DGS applications (Tab. 1). It is worth saying, that these were the only two products having a liquid form.

Table 1: Dynamic of macroelements content in soil during the 2019 season in apple orchard under different fertilizing practices (means).

Macroelements content in soil during 2019 season (mg/l)								
Trial Variant	April	May			July	September		
	$N\text{-}NO_3$	$N\text{-}NO_3$	P	K	$N\text{-}NO_3$	$N\text{-}NO_3$	P	K
Control	34	15	60	116	6	16	54	156
Manure	22	21	86	451	6	14	80	372
Vinassa	25	80	58	436	30	22	74	417
Clover pellet	30	16	57	182	13	28	50	262
Horn shavings	20	30	55	125	16	25	41	134
Biodigestate	17	43	55	168	11	14	43	177

The complexities of using organic matter as a sole source of N has been pointed out (Carranca et al. 2018). The N-uptake dynamics of the crop are very important and an appropriate fertilization strategy should match them as much as possible. On the other hand, different organic fertilizers can have very diverse rates of nitrogen release (Kelderer et al 2008). These initial data are thus suggesting the possible use of DGS, also due to its liquid formulation, to provide N at the beginning of the season, due to its very rapid mineralization rate and quick availability to the plant even under cool soil conditions. VIN and HRMA could be considered for a steady provision of all three macroelements, while CLPE could be used to build up the organic nutrient content in the soil.

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