The mineralization of commercial organic fertilizers at 8°C temperature

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Abstract

In organic production only organic fertilizers and soil conditioners can be used to supply the soil with nitrogen. The mineralization of these products is slow and so there can be problems with the supply of nitrogen, when the demand of the plants is high. The supply of nitrogen from organic products depends on the speed of their mineralization which is primarily influenced by the composition and formulation of their raw material.

In apple production in the Alps-region especially during spring problems with nitrogen supply are common. In that period, the weather conditions are sometimes bad, the temperature in the soil is low and mineralization starts slowly - apple trees demand more nitrogen than the soil can deliver.

To compensate the demand of the apple tree organic growers can not use mineral fertilizers but only organic fertilizers and soil conditioners whose mineralization rate is often unknown. There is a strong need in organic fruit production to receive more information about the behaviour of fertilizers in the soil especially concerning their N-release under different conditions.

To acquire that information, incubation experiments under controlled conditions (temperature, type of soil, humidity of the soil) were carried out in the laboratory to determine the mineralization-rate of different organic fertilizers and soil conditioners which are available in our region.

Keywords: nitrogen mineralization, organic fertilizers, incubation, nutrient content, salinity

Introduction

In apple orchards the nitrogen supply in spring is frequently a limiting factor, as low soil temperatures limit the activity of the plant roots. The trees mobilize their own nitrogen reserves stored in the stem and roots. During and shortly after bloom, when nitrogen demand is highest, the trees own reserves may become exhausted. The nitrogen supply from the mineralization of soil organic matter is not yet sufficient due to the low soil temperatures. It is therefore important to supply the plants timely in spring with fertilizer nitrogen (AICHNER and DRAHORAD, 2004).

This present paper describes an approach to test the mineralization of various commercial organic fertilizers with the aim to improve fertilizer efficiency and thus to reduce environmental impact, such as nitrogen leaching and economic loss.

Nitrogen mineralization is a microbial process and as such dependent on environmental conditions. The main factors affecting mineralization are temperature, soil humidity and chemical/physical soil conditions (SCHACHTSCHABEL et al., 2002).

The incubation trials were carried out under standardized laboratory conditions at a constant temperature of 8°C.

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Materials and methods

For the incubation trials plastic containers with a volume of 550 cm³ were filled with 250 g of air dried soil sieved through a 2 mm mesh. To each container an amount of fertilizer containing 57,7 mg N was added. This corresponds to the allowed maximum nitrogen application rate of 90 kg/hectare in South Tyrolean apple production, according to the guidelines of Bioland Südtirol (BIOLAND, 2006). Each fertilizer treatment was replicated 4 times and to each incubation series samples of only soil were added as untreated control. The containers were closed with perforated lids and incubated for 60 days in incubation chambers at 8°C. In order to ensure a sufficient oxygen supply, the chambers were opened at regular intervals for aeration. Water loss from the samples was compensated by adding distilled water.

The pattern of mineralization was monitored by taking analyzing subsamples from the containers at 5 intervals after the start of incubation. Soluble and exchangeable soil nitrogen (nitrate and ammonium) was extracted with a 0,0125 molar $CaCl_2$ solution. The sum of both fractions gives the content of mineral nitrogen. The net mineral nitrogen content was determined by subtracting the N min content of the untreated control from the N min content of each treatment. The rate of mineralization indicates the amount of added nitrogen mineralized in a given period of time.

Before and after incubation a detailed soil analysis was carried out to assess any changes which may have occurred during incubation.

Besides various commercial organic fertilizers also different types of liquid manure, soil conditioners and products on the basis of micro organisms were tested. Chemical fertilizers were used as reference.

Table 1 lists prices, composition and producers of the tested fertilizers.

Tab. 1: Product overview of tested fertilizers

Product name	Producer	Materials	Euro/100kg	Euro/N-unit
Sangue atomizzato	Cifo s.p.a.	Dried blood	195	15
Emosan	Agridelpa	Enzymatic hydrolyzed blood	95	19
Orgazot	Stradi Renzo	Dried blood	120	17,1
Organ Plus	Agridelpa	Vinasse	40	13,3
SVG Agrofertile	SVG Italia s.r.l.	Vinasse	5,1	1,5
Nutristart	Lievitalia s.p.a.	Vinasse	12	3,4
Agrobiosol	Sandoz GmbH	Fungal biomass	30	4,3
Fertilvegetal	Delta concimi s.a.s.	Seed cake from soya and maize	23	3,8
Manna Rizinusschrot	Wilhelm Haugh GmbH	Castor meal	36	7,2
Rigen Plus	Europa Trading s.r.l.	Seed cake	11,5	2,5
Ecolverdepiù	Sala s.r.l.	Seed cake	20	3,4
Eurofert	Zuech Fabio	Compost from oil cake from grape and olives	23	7,6
Compost	Happacherhof (OfL)	Compost from cow dung rich in straw	13,5/m3	3,8
Geovis	Nuova Geovis s.r.l.	Compost from organic waste and plant materials	12	4,8
Cattle manure	Happacherhof (OfL)	Cow dung rich in straw	xxx	xxx
Biogas slurry Prad	Biogasanlage Prad	Fermented liquid manure	xxx	2
Slurry normal Prad	Biogasanlage Prad	Liquid manure	xxx	2,5
Slurry normal Aldein	Biogasanlage Aldein	Liquid manure	xxx	2,5
Biogas slurry Aldein	Biogasanlage Aldein	Fermented liquid manure	xxx	2
Urea (Biuron)	AMI Agrolinz Melamine Intern.GmbH	Synthetic urea	40	0,9
Ammonium nitrate (Linzer NAC)	AMI Agrolinz Melamine Intern.GmbH	Synthetic Ammonium nitrate	24	0,9
Osmocote	Scotts Italia s.r.l.	NPK-fertilizer with Osmocote cladding	750	75
Triabon	Compo Agricoltura s.p.a.	NPK-fertilizer with Crotodur	308	19,3
Azocor 6	Fomet s.p.a.	Seed cake, horn meal and manure	13,9	2,3
Natural N8	SCAM s.p.a.	Fur, bristle hairs, leather and manure	24	3
Ecoferro 250 Plus	Formet s.p.a.	Manure and iron sulphate	21	7
Fertorganico	Ilsa s.p.a.	Leather and fur	20	1,8
Natural NP	SCAM s.p.a.	manure, leather, fur and row phosphate	24	8
Fertil	Ilsa s.p.a.	Fur and bristle hairs	22	1,8
Bioilsa 10 export	Ilsa s.p.a.	Fur and bristle hairs	23	2,3
Azocor 105	Fomet s.p.a.	Seed cake from soya and maize, horn meal, poultry feathers	26	2,5
Xena N12	Nuova Geovis s.r.l.	Poultry feathers and Blood	30	2,5
Guanito	Italpollina s.p.a.	Stillage, guano and poultry manure	25	4,2
Organagro	Nuova Concimer s.r.l.	Meat meal, feather meal, manure and poultry manure	9,6	3,2
Naturalmente	Nuova Concimer s.r.l.	Meat meal, feather meal, bone meal, manure	18,3	3,1
Ecoland	Siffert s.p.a.	Meat meal, bone meal, calcium sulphate, potassium sulphate	xxx	xxx
Ecolenergy	Sala s.r.l.	Hairs, feathers, seed cake	25	2,5
Prosol	Prosol s.p.a.	Rests coming from feeding industries	xxx	xxx
Agripollina pellet	Agrobios Italiana s.r.l.	Poultry manure	xxx	xxx
Italpollina	Italpollina s.p.a.	Poultry manure	13	3,25
Lysofert	Intrachem Bio Italia s.p.a.	Meat meal and fur	170	20,5
Lysodin Algafert	Intrachem Bio Italia s.p.a.	Meat meal and fur	550	78,6
Vignafrut	SCAM s.p.a.	Peat and chemical fertilizer	34	3,4
BactoFil	Agro Bios AG	Different microorganisms	8	xxx
Euroactiv agro	Eurovix s.r.l.	Milled barley und Molasses	2500	xxx
Ekoprop arboree	Kwizda Italia s.r.l.	Hackled mycorrhized roots, enzymes	1000	xxx
EM-A	EM-Italy	Different microorganisms	360	xxx
Macrolive	Elep s.p.a.	Different microorganisms	300	xxx

Results

1. Nitrogen mineralization after 14 and 60 days of incubation at 8°C

As listed in table 2, the synthetic fertilizers ammonium nitrate, Vignafrut and urea led to the highest levels of mineral nitrogen release both after 14 days and after 60 days at the end of the incubation period (rates ranging from 57 to 75 %) , followed by the vinasse Nutristart (56-57 %). The vinasses, among which also the products Organ Plus and Agrofertile were tested, showed generally the highest mineralization rates among the organic fertilizers, together with the slurries from biogas plants. Among the group of fertilizers containing animal or vegetal by-products, Guanito showed the highest mineralization rate with 33 % after 14 days and 44,3 % after 60 days.

The addition of microbial products to the organic fertilizer Eurofert led to only slightly higher and sometimes lower levels of mineralization than Eurofert on its own.

Compost, compost with BactoFil and fresh manure led to the lowest rates of mineralization (0,1 to 0,4 % after 14 days; -0,4 to 0,6 % after 60 days).

2. Variation of soil nutrients and salinity after 60 days of incubation at 8 °C

Table 3 list the increments of plant-available soil nutrients and of soil salinity. Zero-values stand for unvaried or reduced contents.

Soil pH remained unchanged after 60 days of incubation, as compared to the original soil (pH 7,4). The content of phosphates increased slightly (1 to 6 mg/100 g) in over 50% of cases. The highest increments were recorded for Guanito (+15 mg/100 g) and Naturalmente (+12 mg/100 g).

As for the potassium content, the highest increase was recorded for Ecoland 280 (+22 mg/100g). Also Eurofert and Eurofert with added microbial products showed significant increments.

For boron, copper and zinc only few and minor increments were recorded. The same applies for manganese, with the exception of the vinasses SVG Agrofertile and Nutristart, which reached an increment of 17 and 12 mg/100 g, respectively, after 60 days of incubation at 8°C.

As for magnesium, the highest increments were observed in the cases with added microbial products.

Soil salinity increased in all samples during incubation. The highest values were recorded for Ecoferro 250 Plus (+188 mg/kg) and Vignafrut (+126 mg/kg).

Tab. 2: Fertilizer ranking according to N-mineralization after 14 and 60 days

Product	14 days at 8 °C		60 days at 8 °C	
	rank (of 49)	in percent (%)	rank (of 49)	in percent (%)
Ammonium nitrate	1	75,6	1	71,9
Vignafrut MB	2	71,0	2	68,8
Urea	3	57,3	3	67,3
Nutristart	4	56,0	4	57,2
Biogasgülle Aldein	5	37,7	9	39,9
Biogasgülle Prad	6	36,2	13	37,4
Emosan	7	35,6	8	42,0
Organ Plus	8	33,9	5	46,2
Lysodin Algafert	9	33,7	6	44,8
Guanito	10	33,0	7	44,3
SVG Agrofertile	11	30,7	15	32,7
Naturalmente	12	30,0	11	39,1
Lysofert	13	29,6	12	37,9
Sangue atomizzato	14	27,9	10	39,5
Triabon	15	22,4	22	27,2
Ecolverdepiù	16	21,6	17	30,3
Osmocote	17	21,5	18	30,1
Ecolenergy	18	21,3	14	36,2
Italpollina	19	19,8	23	25,0
normale Gülle Aldein	20	19,6	28	23,2
Ecoland 280	21	19,5	19	29,1
Ecoferro 250 Plus	22	18,7	32	21,8
Normale Gülle Prad	23	17,6	35	19,7
Natural NP	24	17,4	29	23,1
Rizinuschrot	25	16,6	21	27,5
Natural N8	26	16,5	30	23,0
Azocor 6	27	16,5	24	24,4
Fertilvegetal 6	28	13,2	33	21,4
Prosol	29	12,3	16	30,5
Organagro	30	12,1	39	13,4
Agripollina pellet	31	11,7	38	14,6
Azocor 105	32	11,1	20	27,6
Bioilsa 10 Export	33	10,9	26	23,9
Agrobiosol	34	10,3	36	18,2
Fertorganico	35	10,1	27	23,6
Eurofert+BactoFil	36	7,6	41	9,0
Eurofert+Euroactiv agro	37	7,3	42	8,9
Orgazot	38	7,2	25	23,9
Eurofert	39	6,7	43	8,1
Eurofert+Ekoprop arboree	40	6,7	40	9,8
Fertil	41	6,6	31	22,0
Eurofert+EM-A	42	5,9	44	7,6
Eurofert+Macrolive	43	5,7	45	7,1
Xena N12	44	5,0	37	18,1
Geovis	45	2,9	46	5,3
Rigen Plus	46	2,8	34	20,0
Compost	47	0,4	47	0,6
Compost+BactoFil	48	0,3	48	0,5
Fresh manure	49	0,1	49	-0,4

Tab. 3: Increment of soil nutrients and salinity after 60 days of incubation at 8 °C

product	pH	P (mg/100g)	K (mg/100g)	Mg (mg/100g)	B (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Salt content (mg/kg)
Original soil	7,4	4	17	21	0,4	22	12	5,2	57
Bioilsa 10 Export	0	0	0	0	0	5	1	1	61
Fertilvegetal 6	0	0	0	1	0	7	1	1	51
Azocor 105	0	0	0	0	0	0	0	1	52
SVG Agrofertile	0	0	15	0	0	17	1	1	103
Nutristart	0	0	13	0	0	12	1	1	83
Normal slurry Prad	0	0	12	2	0	6	1	1	-
Biogas slurry Prad	0	0	13	2	0	8	1	1	-
Agrobiosol	0	0	0	0	0	0	0	0	49
Castor meal	0	0	2	0	0	6	1	1	41
Urea	0	1	0	2	0	1	1	1	63
Compost	0	9	5	5	0	1	0	2	-
Compost+BactoFil	0	9	4	4	0	1	0	2	-
Fresh manure	0	3	14	4	0	2	0	1	-
Eurofert	0	3	9	3	0	0	0	0	52
Eurofert+BactoFil	0	2	12	8	0	1	0	1	-
Eurofert+EM-A	0	3	13	8	0	2	0	2	-
Eurofert+Euroactiv agro	0	4	13	9	0	1	0	2	-
Eurofert+Ekoprop Arboree	0	3	13	8	0	1	0	1	-
Eurofert+Macrolive	0	1	4	0	0	0	0	0	-
Ammonium nitrate	0	1	0	1	0	0	0	1	59
Azocor 6	0	1	0	2	0	0	0	1	55
Natural N8	0	1	0	2	0	0	0	1	37
Ecoferro 250 Plus	0	1	9	6	1	0	0	1	188
Fertorganico	0	0	0	2	0	0	0	1	55
Natural NP	0	2	0	3	0	0	0	1	47
Sangue atomizzato	0	0	0	2	0	0	0	1	48
Emosan	0	0	0	1	0	0	0	1	47
Fertil	0	1	0	1	0	0	0	1	42
RigenPlus	0	2	0	2	0	2	0	1	45
Geovis	0	3	5	2	0	1	0	1	13
Italpollina	0	3	6	3	0	2	0	2	36
Guanito	0	15	2	5	0	2	0	1	59
Agripollina pellet	0	2	8	3	0	2	0	1	34
Xena N12	0	1	0	2	0	1	0	1	34
Organ Plus	0	1	2	1	0	3	0	1	31
Lysofert	0	0	0	0	0	1	0	0	50
Lysodin Algafert	0	0	0	0	0	1	0	0	47
Normale Gülle Aldein	0	3	5	0	0	1	0	0	30
Biogas slurry Aldein	0	2	7	0	0	2	0	0	36
Organagro	0	0	0	0	0	0	0	0	28
Naturalmente	0	12	12	5	0	2	0	0	91
Ecoland 280	0	2	22	0	0	0	0	0	113
Ecolverdepiù	0	0	0	0	0	0	0	0	47
Ecolenergy	0	0	0	0	0	0	0	0	45
Orgazot	0	0	0	0	0	0	0	0	58
Osmocote	0	4	1	0	0	0	0	0	106
Triabon	0	5	0	1	0	0	0	0	96
Vignafrut MB	0	6	13	0	0	0	0	0	126
Prosol	0	1	0	0	0	0	0	0	-

Summary

To acquire the information about the mineralisation of organic fertilizer and soil conditioners, incubation experiments under controlled conditions (temperature, type of soil, humidity of the soil) were carried out in the laboratory. The results of this paper give an indication about the rate of mineralization and thus the nitrogen-availability of some selected fertilizers at the relatively low temperature of 8° C. This constitutes useful information for the appropriate timing and dosage of fertilizer application in order to avoid both deficiency and excess of soil nitrogen. Other factors such as soil humidity and chemical-physical soil characteristics must however also be taken into consideration (TRÄNKLE, 2000).

Organic fertilizers have generally lower rates of nitrogen release than mineral fertilizers which moreover extend over a longer period of time. Some organic fertilizers however release nitrogen at a rate similar to that of synthetic fertilizers. Examples can be mentioned the vinasses Nutristart and Organ plus, Emosan, a blood-based fertilizer, the pelleted fertilizer Guanito or Lysodin Algafert, containing amino acids.

Microbial products, which according to the manufacturers should enhance the mineralization of organic matter, led to no significant increase of the rates of mineralization.

The increments of nutrient elements other than nitrogen during 60 days of incubation were rather limited. The highest increments were generally recorded in the case of the microbial products.

In all incubated samples an increase of salinity was noticed, ranging from 13 mg/kg (Geovis) to 188 mg/kg (Ecoferro 250 Plus).

This investigation about the nitrogen mineralization at 8°C gives indications about the optimal timing of application of each product, depending also on climatic conditions and nutrient demand.

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