# 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 cm<sup>3</sup> 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<sub>2</sub> 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

Organ Plus       Agrideipa       Vinasse       40       1         SVG Agrodertile       SVG Italia s.r.l.       Vinasse       5.1         Agrobiosol       Sandoz GmbH       Fungal biomass       30         Ferrilvegetal       Deta concimi s.a.s.       Seed cake from soya and maize       23         Marna Rizinusschrot       Wilnelm Haugh GmbH       Castor meal       36         Rigen Plus       Europa Trading s.r.l.       Seed cake       20         Eurofert       Zuech Fabio       Compost from oil cake from grape and oilves       23         Compost       Happacherbti (OL)       Compost from organic waste and plant       12         Catter manure       Happacherbti (OL)       Compost from organic waste and plant       12         Biogasaniage Prad       Liquid manure       xxx       SXX         Slury normal Adein       Biogasaniage Adein       Fermented liquid manure       xxx         Biogas Surup Adein       Biogasaniage Adein       Fermented liquid manure       xxx         Surup normal Adein       Biogasaniage Adein       Fermented liquid manure       xxx         Biogas Surup Adein       Biogasaniage Adein       Fermented liquid manure       xxx	Product name	Producer	Materials	Euro/100kg	Euro/N- unit
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SVG Agrolentile   SVG Italia s.r.l.   Vinase   5.1     Nartistant   Lievitalia s.p.a.   Vinase   12     Agrobiosof   Sandoz GrnbH   Fungal biomass   300     Ferrilvegetal   Delta concini s.a.s.   Seed cake from soya and maize   23     Manna Rizinusschrot   Wilhelm Haugh GmbH   Castor meal   366     Rigen Plus   Europa Trading s.r.l.   Seed cake   11.5     Ecoherdepio   Sala s.r.l.   Seed cake   23     Gompost from organic waste and plant   12     Goois   Nuova Geovis s.r.l.   Compost from cow dung rich in straw   35.5     Gogas slamy Prad   Biogasanlage Prad   Fermented liquid manure   xxx     Slury normal Ardein   Biogasanlage Aldein   Eremented liquid manure   xxx     Slury normal Ardein   Biogasanlage Aldein   Eremented liquid manure   xxx     Mardolizon   AMI Agrolinz Melamine Intern.GmbH   Synthetic urea   40     Ammonium nitrate   Mal Agrolinz as p.a.   NeK-fertilizer with Crotodur   308     Maco 6   Formet s.p.a.   Seed cake, hom meal and manure   13.6     Maco 7   Mal Agrolinz as p.a.   Seed cake, hom meal and manure   14     Vaca (Buron)   AMI Agrolinz as p.a.   Seed cake, hom meal and manur	Orgazot	Stradi Renzo	Dried blood	120	17,1
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	e e				XXX
	• •				XXX
			-		XXX 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).

Pro lost	14 days	s at 8 °C	60 days at 8 °C			
Product	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	20	19,5	19	29,1		
Ecoferro 250 Plus	21	18,7	32	29,1		
Normale Gülle Prad	22	17,6	32	19,7		
Natural NP	23		29	23,1		
Rizinuschrot	24 25	17,4	29			
Natural N8		16,6		27,5		
Azocor 6	26 27	16,5 16 5	30 24	23,0		
		16,5	33	24,4		
Fertilvegetal 6	28	13,2		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. 2: Fertilizer ranking according to N-mineralization after 14 and 60 days

Tab. 3. Increment of s	1								Salt
product	pН	Р	K	Mg	В	Mn	Cu	Zn	content
product	<b>P</b>	(mg/100g)	(mg/100g)	(mg/100g)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(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	
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	-
1 10301	0	1	0	0	U	0	0	0	

Tab. 3: Increment of soil nutrients and salinity after 60 days of incubation at 8  $^{\circ}\text{C}$ 

# 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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