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Alternative fertilizers from nutrient-rich wastes for organic crops

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Introduction

A main challenge in optimizing organic crop production is the need to acquire alternative source of nutrients to satisfy the growing demand, and to reduce the conventional manure importation. In parallel, the production of organic wastes with high content of organic matter and nutrient is increasing worldwide. Therefore, their use in agriculture can potentially contribute to close the nutrient cycles.

Our aim was to investigate how the combination of different wastes sources for more optimal NPKS ratios affects their fertiliser value.

Fertilizers

Table 1. Nutrient applied (kg ha^{-1}) in each treatment.

Treatments	N	P	K	S
Single				
Control (C)	0	0	0	0
Control+K (CK)	0	0	120	0
Control+N (CN)	60	0	0	8
Control+NK(CNK)	60	0	60	8
Fertigro* (F)	73	7	7	29
Cattle manure (M)	53	11	49	14
Digested cattle manure (DM)	57	14	73	9
DM+organic fraction of house wastes (DM+KOD)	54	12	61	8
Mixtures				
DM+F	65	10	40	19
DM+KOD+F	63	9	34	19
DM+F+ash straw (DM+F+ASH)	65	14	112	19
DM+KOD+F+ASH	64	13	101	23

Table 2. Selected properties of the organic wastes used in this work.

	F	M	DM	DM+OFMSW	ASH
Dry matter (%)	17.1	8.2	5.65	4.31	58.1
pH	6.25	7.27	8.26	8.26	11.9
NH_4-N (g kg^{-1} fw)	1.36	1.93	2.15	1.87	0.00
NO_3-N (g kg^{-1} fw)	0.00	0.01	0.00	0.00	0.00
WEP (g kg^{-1} fw)	0.94	0.31	0.32	0.31	0.11
TN (g kg^{-1} fw)	12.0	3.81	3.61	3.09	1.01
TP (g kg^{-1} fw)	1.20	0.76	0.90	0.69	5.27
TK (g kg^{-1} fw)	1.20	3.48	4.64	3.54	95.4
TS (g kg^{-1} fw)	5.34	0.99	0.60	0.47	6.89
TN (g kg^{-1} dw)	70.1	46.7	63.9	71.7	1.73
TC (g kg^{-1} dw)	427	389	381	349	162
TP (g kg^{-1} dw)	7.00	9.33	16.0	16.0	9.07
TK (g kg^{-1} dw)	7.00	42.7	82.0	82.0	164.1
TS (g kg^{-1} dw)	31.1	12.2	10.7	10.8	11.9
C/N	5.61	18.6	15.0	13.4	93.5
C/P	49.9	45.7	24.3	23.8	17.8
N/P	8.89	2.46	1.62	1.78	0.19

Field experiment

A field experiment was developed within the Long Tern Nutrient Depletion Trial, where soil annually receives 60:10:60:25 kg ha^{-1} of N:P:K:S (University of Copenhagen, van der Bom et al 2017). Twelve fertilization treatments (Table 1) were applied three days after spring barley was sown (April 2019) in micro-plots (2x2 m) randomly distributed within four replicate blocks. The main properties of the fertilizers are presented in Table 2.

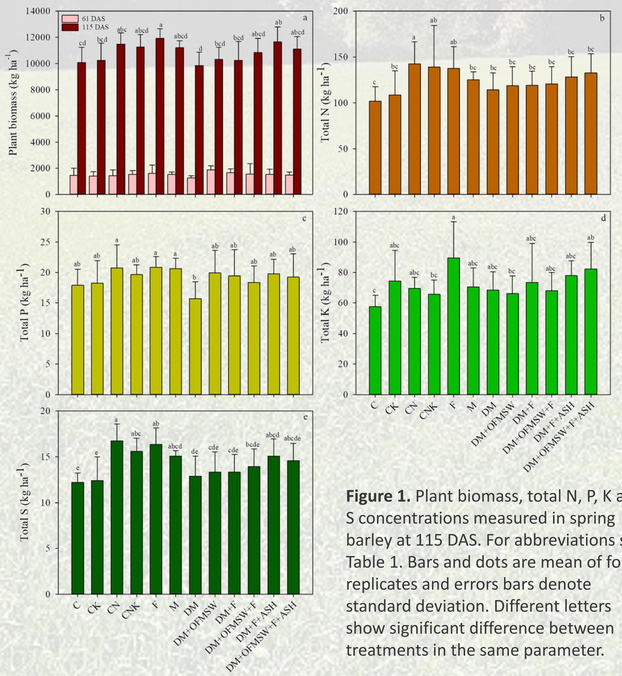
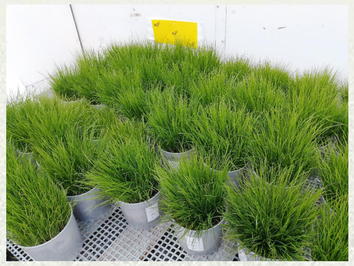


Figure 1. Plant biomass, total N, P, K and S concentrations measured in spring barley at 115 DAS. For abbreviations see Table 1. Bars and dots are mean of four replicates and errors bars denote standard deviation. Different letters show significant difference between treatments in the same parameter.



Pot experiments

Four pot experiments were developed investigating the nutrient release from different fertilizers applied single and combined. For this, ryegrass was grown in soil from the field experiment in a growth chamber, and the treatments varied in each experiment (see Figure 2) to apply the desired amount of 50 mg P g^{-1}, 150 mg N g^{-1}, 180 mg N kg^{-1} and 118 mg S g^{-1}. The rest of the nutrients were applied in abundance. Ryegrass was cut three times to quantify plant biomass and nutrient uptake.

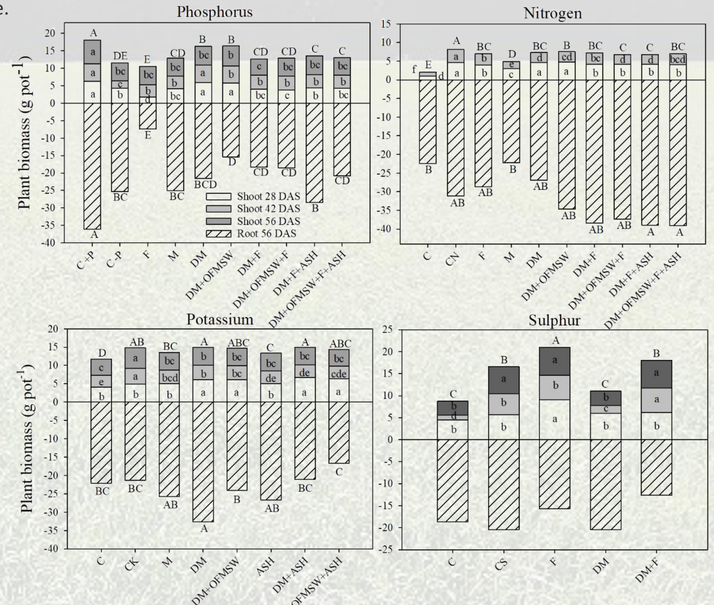


Figure 2. Shoot and root biomass for Ryegrass. For abbreviations see Table 1. Bars and dots are mean of four replicates and errors bars denote standard deviation. Different letters show significant difference between treatments in the same parameter.

Findings – Field experiment

- The application of different organic wastes increased plant biomass reaching similar values as the positive control (specially F and DM+F+ASH), showing **the potential of the organic wastes to supply nutrient available for plant uptake under field conditions**.
- N uptake was similar in the most of the treatments, but **F increased N uptake in Spring Barley to similar values to the positive controls**
- **The combination of DM with F (rich in S) and ASH (high K content) increased their fertiliser value, increasing spring barley biomass compared to their single application of DM**.

Findings – Pot experiments

- **All fertilizers tested in single and combined addition supplied enough K and N for plant growth**, with values similar than those observed for their respective positive controls, except for M in N experiment where plant biomass was lower than the positive control.
- P release from the single or combined fertilizers was lower than the one observed for the positive control, and only **M, DM, DM+OFSW, DM+F+ASH and DM+OFSW+F+ASH showed significantly higher plant biomass than the negative control**.
- **F released enough S and N for plant growth, however higher rates of F application (P based experiment) reduced plant growth probably due to the high salt content in F**

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