Effects of organic materials and cover crop on SOM and disease suppression in potatoes

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Introduction

Intensive potato production is often conducted on sandy soils, with intensive soil tillage reducing the content of soil organic matter (SOM) in the topsoil (0-20 cm). Reduced SOM gives reduced soil water holding capacity and increased resistance to soil tillage but may also increase the incidence of potato fungal disease such as scurf. Cover crops and application of organic materials to the soil may counteract this situation.

Hypotheses

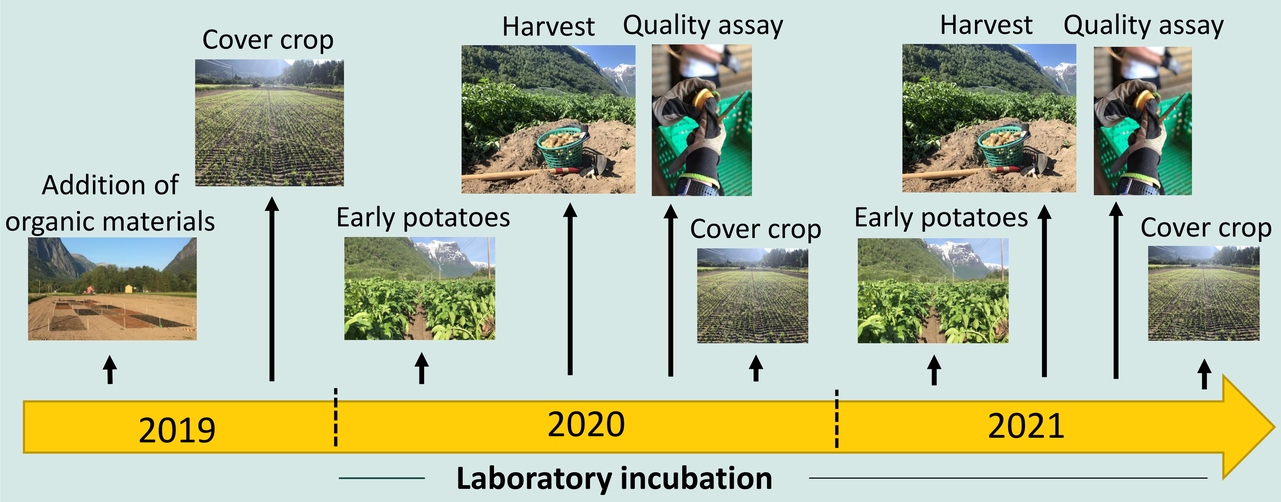
(i) A single addition of organic materials to soil and the presence of cover crop will increase SOM and therefore improve soil conditions, leading to decreased appearance of potato diseases;

(ii) Because of differences in the recalcitrance of C in the applied materials, after 2 years, SOM concentrations will be the highest in treatments receiving one application of biochar + liquid digestate, followed by solid digestate, and farmyard manure;

(iii) Soil respiration measured in laboratory reflects a decrease in SOM under field conditions 2 years after application.

Methods

We assessed under field conditions with cover crop (**CC**) and without cover crop (**NCC**) the impact of a single application of organic materials **B+LD**, **SD**, and **FYM** (Tab. 1) on SOM (including MAOM and POM) and extractable nutrients, tuber yields and marketable potatoes. Potatoes received the normal amount of fertilizers and pesticides. The same amount of C was applied in each treatment. Complementary, we also performed a 2-yr lab incubation with the same OM applied in soil sampled from the experimental field, recording CO_2 emissions as a proxy for decomposition of soil C and applied OM. At the end of the lab incubation, we assessed microbial C content and fungus : bacteria ratio.



Results

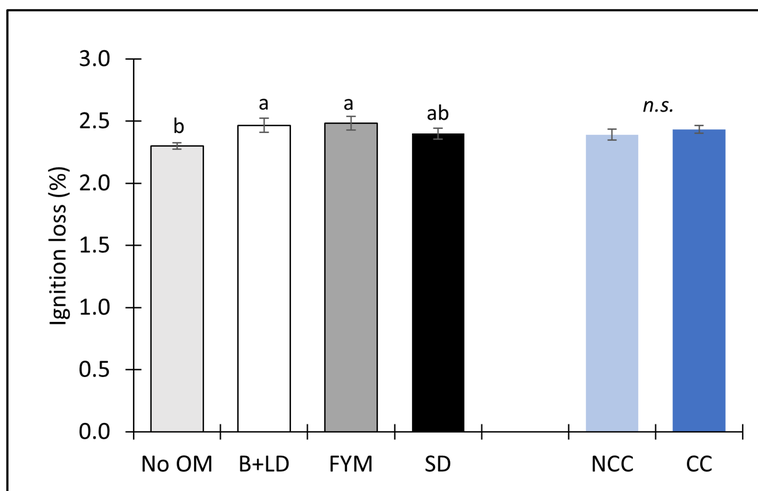


Fig.1 Mean values (2021) of SOM (ignition loss) in sandy soil amended with organic materials in 2019 and mean effect of cover crop.

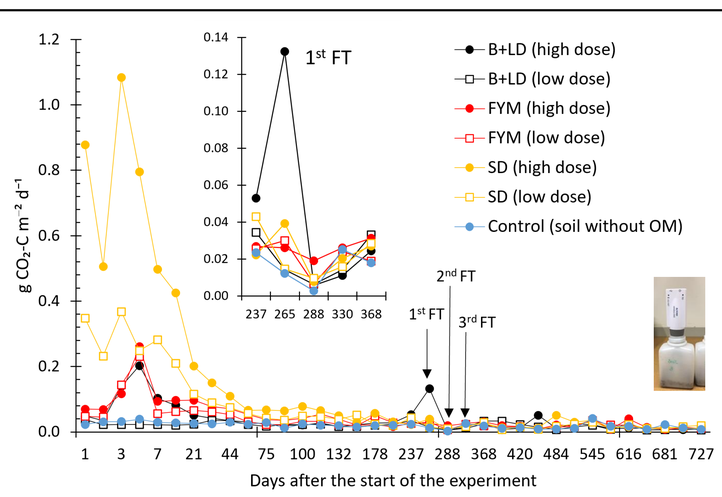


Fig.2 Daily CO_2 fluxes as g CO_2-C m^{-2} d^{-1} from sandy soil amended with OM and effect of freeze-thaw events (FT).

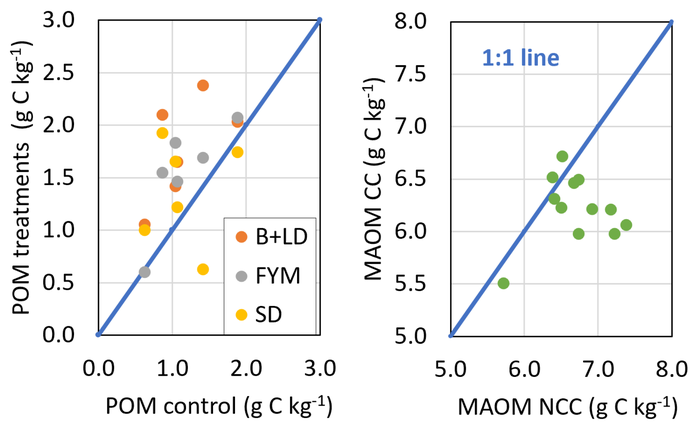
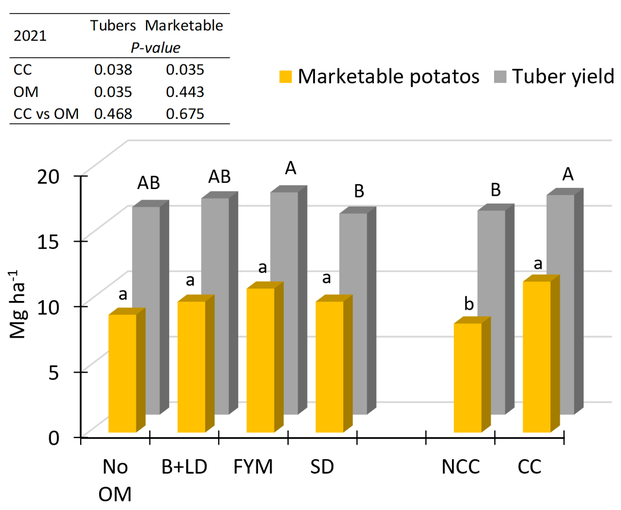


Fig.3 Relations between POM carbon concentrations in the treatments and control, and MAOM carbon concentration in the CC and NCC.



2021	Tubers	Marketable
	P-value	
CC	0.038	0.035
OM	0.035	0.443
CC vs OM	0.468	0.675

Fig.4 Tuber yield and marketable potatoes (Mg ha^{-1}) after 4 moths of storage in 2021.

Tab.2 Mean values (2021) for soil pH and ammonium acetate lactate (AL) extractable nutrients (mg/ 100 g air-dry soil)

Characteristics	No OM	B+LD	FYM	SD	NCC	CC
pH	5.01	5.05	5.13	5.28	5.08	5.15
P-AL	19.2	21.5	19.0	20.2	21.5	18.4
K-AL	9.0	9.7	10.3	9.0	9.7	9.3
Mg-AL	5.3	5.7	7.0	5.7	5.8	6.0
Ca-AL	36.7	37.2	40.0	44.3	38.4	40.7
Na-AL	3.0	3.0	4.7	3.7	2.8	4.3

Tab.3 Microbial carbon, fungi to bacteria ratio, decomposition rate, and mean resident time of the different types and rates of organic materials incubated for 727 days

OM	Applied rate	MBC (µg C g soil $^{-1}$)	F:B	(-k)	MRT (years)
B+LD	High	988	2.1	0.155	6
	Low	928	2.0	0.031	32
FYM	High	742	1.5	0.118	8
	Low	1292	2.8	0.147	7
SD	High	1140	2.5	0.334	3
	Low	1040	2.2	0.321	3
No OM	Control	679	1.3	-	-

Tab.1. Abbreviations

No OM = No organic material added
B+LD = Biochar mixed with liquid digestate
FYM = Farmyard manure
SD = Solid digestate
CC = Cover crop
NCC = No cover crop
FT = Freeze-thaw events
MAOM = Mineral associated organic matter
POM = Particulate organic matter
MBC = Microbial carbon
F:B = Fungus : Bacteria ratio
-k = Decomposition rate
MRT = Mean residence time

Conclusions

- A single addition of organic materials in 2019 increased SOM, especially in FYM and B+LD, while CC did not significantly affect SOM content.
- SD treatments have the largest pool of labile compounds, and the lowest MRT in a sandy soil.
- In 2021, the C concentration in POM was high in the treatments that received organic inputs, while MAOM-C was high in the treatments without cover crop.
- Cover crop significantly increased potato yield in 2021.
- In 2021, the number of marketable potatoes after 4 moths storage was increased by 37% in the treatments with cover crop.
- In 2020, potatoes were sorted out mainly because of some deformed defects, and in 2021 because of black scurf, grown and micro cracks, and deformed potatoes.
- Organic amendments did not increase tuber yield compare to the control, but the proportion of marketable potatoes tended to be 11-22% higher in the amended soil.

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