Field experiments with bark humus — MoDo-Mylla

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Abstract. This preliminary 3-year field experiment with bark humus — MoDo-Mylla — revealed that an application of 28 tons d.m./ha of bark humus to a sandy soil increased the content of organic carbon by about 0.5 % and that application of 56 tons d.m./ha increased the organic content of the topsoil by about 1 %. Corresponding increases in organic carbon were obtained following application of 30 and 60 tons d.m./ha MoDo-Mylla to a clay soil.

The largest yield increase resulting from bark humus was obtained in the first year on the clay soil in Uppland. This increase amounted to 81 per cent at 30 tons d.m./ha and 108 per cent at 60 tons d.m./ha, in comparison with treatments without bark humus. Positive effects were also obtained in the second year in oats, while in the third year (winter wheat) the yield was similar in all treatments.

In the first year of the experiment on sandy soil in Dalarna there was no yield-promoting effect from the bark humus, probably because the experiment had been laid out on a newly ploughed ley. Positive effects of the bark humus appeared in the second and third years in the potato yields which were 10 % and 5 % higher in the third year at 56 tons d.m./ha of MoDo-Mylla than in the treatment without MoDo-Mylla.

No directly yield-promoting effects were noticed on the yield of straw. The determinations of bulk weight and 1 000-kernel weight revealed a clear trend towards increased kernel weight in the treatments with bark humus at both experimental sites.

The chemical analyses of grain and straw show that on the clay soil the addition of MoDo-Mylla resulted in decreases in the contents of nitrogen, phosphorus and potassium in the grain and, in addition to these, calcium in the straw. On sand soil the situtation is the reverse for nitrogen and potassium as an increase in these nutrients can be obtained following an application of bark humus. These differences in the nutrient content are probably linked with the yield levels.

Modern forest industries produce at barking stations considerable amounts of bark that must be disposed of in one way or another.

The disposal of bark is important for two main reasons. One being prevention of interference with the natural environment and the other being the return of natural resources into production.

Interference with the natural environment occurs through the accumulation of large quantities of bark — by dumping etc — in one place. This interference is seen foremost in water pollution. The biological breakdown of the bark involves the release of different organic compounds and elements which are leached by rain and melted snow into watercourses and into the ground water, with consequent pollution.

One means of bringing the natural resource — the bark — back into production is via pre-treatment with a biological decomposition process, i.e. composting. By means of this process the different components of the bark are converted into a product usable as a soil amendment and fertilizer on different soils and as an additive in various soil mixtures.

The Mo & Domsjö AB, Stockholm, has developed a bark humus product called MoDo-Mylla and this product has been subjected to an investigation under field conditions.

An investigation consisting of two field experiments was designed in co-operation with the Mo & Domsjö AB, from whom economic support was also received.

Results and discussion

Two experimental sites were chosen in different areas of Sweden, one in Dalarna at Näs Kungsgård, Dala Husby on a sand soil and the other on a clay soil in Uppland at Lilla Vallskogs gård, Marsta.

The object of the investigation was to use field experiments at different places to obtain information on the effects of the bark humus — MoDo-Mylla — in agricultural soils under normal conditions of management during a 3-year period. The experiments were laid out according to the following design:

	Expt. no.	
	C 68	W 303
A. Without bark humus	0	0
B. With bark humus	30 tons d.m./ha	28 tons d.m./ha
C. »—	60 »—	56 »—

Experiment C 68 in Uppland was laid out on a ploughed and harrowed field with oats as the previous crop. Experiment W 303 in Dalarna was laid out on a ploughed field which had previously been a 3-year ley.

MoDo-Mylla was incorporated to a depth of ca 15 cm by a rotary cultivator. In addition to MoDo-Mylla the plots received the following amounts of fertilizer:

Year	Expt. No. C 68	Expt. No. W 303
1971	250 kg/ha NP 26–6	200 kg/ha bone meal
		1 000 kg/ha algomin
1972	400 kg/ha NP 26–6	300 kg/ha bone meal
		350 kg/ha potassium sulphate
		25 ton/ha farmyard manure
1973	400 kg/ha NPK 20–6–6	200 kg/ha bone meal
	580 kg/ha calcium nitrate	200 kg/ha potassium sulphate
		400 kg/ha algomin

The composition of the MoDo-Mylla used in the experiments is given in Table 1, where it can be seen that 50 % of the airdried sample consists of organic carbon and that the material contains 30 % dry matter with an ash content of 6.7 % in the d.m. and a varying content of different elements.

Table 1. Composition of bark humus — MoDo-Mylla

Bulk weight		0.3	
Dry matter		30	%
pH		6.4	
Ash		6.7	% of d.m.
Organic carbon (C)		50	»
S-value		80	m.e./100 g d.m.
T-value		105	»
Kjeldahl-N		1.50	% of d.m.
NH_4-N		0.10	»
NO_3-N		0.10	»
Phosphorus	(P-AL)	80	mg/100 g d.m.
	(HCl)	110	»
Potassium	(K-AL)	160	»
	(HCl)	180	»
Calcium	(Ca-AL)	610	»
	(HCl)	2 000	»
Magnesium	(Mg-AL)	45	»
	(HCl)	63	»
Base saturation degree		76	%
Boron	(B)	8.2	mg/kg d.m.
Copper	(Cu)	7.5	»
Manganese	(Mn)	75	»
Zinc	(Zn)	67	»
Chromium	(Cr)	5	»
Nickel	(Ni)	7	»
Lead	(Pb)	10	»
Cadmium	(Cd)	0.5	»
Mercury	(Hg)	0.1	»

S-value = exchangeable base cations
T-value = CEC = cation exchange capacity

Tables 2 and 3 contain the analysis results of soil samples taken before the application of bark humus and after harvest for the different years. The subsoil was analysed only before the treatment in the spring 1971. The results of the organic carbon analyses in Tables 2 and 3 show that the increase in the carbon content was equally large in both experiments, i.e. 0.5 % in treatment B and about 1.0 % in treatment C.

Table 3 also shows that an addition of 1 000 kg/ha algomin increased the degree of base saturation to the normal level between the S-value (exchangeable base cations) and the T-value (= CEC = cation exchange capacity).

Table 4 contains yield figures from experiment C 68 in Uppland. They show that the largest yield-promoting effect of bark humus was obtained in the first

Table 2. Results of analysis of soil samples from experiment C 68, clay soil.

Analysis	Before treatment 1971		Topsoil, after harvest								
			1971			1972			1973		
	Topsoil	Subsoil 20–40	A	B	C	A	B	C	A	B	C
pH in H_2O	6.7	7.1	6.0	6.7	6.6	7.0	7.0	6.9	6.9	6.9	6.7
pH in $CaCl_2$	6.1	6.4	6.4	6.5	6.3	–[1]	–[1]	–[1]	6.4	6.3	6.2
S-value[2]	13.0	15.0	18.0	19.0	19.0	14.0	14.0	16.0	11.0	14.0	17.0
T-value[3]	18.0	23.0	18.0	19.0	21.0	19.0	20.0	22.0	11.0	16.0	23.0
Base saturation degree %	72	65	100	100	90	74	70	73	100	88	74
Org. C in %	1.2	0.6	1.4	2.0	2.3	1.6	1.8	2.3	1.5	2.0	2.2
Kj-N in %	0.14	0.08	0.14	0.16	0.16	0.15	0.15	0.16	0.15	0.15	0.16
P-AL mg/100 g	12.7	9.6	13.8	15.0	16.2	14.6	14.0	17.7	14.1	14.9	16.5
K-AL mg/100 g	15.0	14.5	17.5	17.0	16.5	20.0	19.0	20.0	16.0	17.5	16.5
Ca-AL mg/100 g	253	405	275	300	285	300	315	317	330	350	350
Mg-AL mg/100 g	17.0	21.5	16.5	16.5	17.5	15.2	18.0	18.2	14.3	14.9	16.1

[1]) No analysis carried out

[2]) S-value = exchangeable base cations, m.e./100 g soil.

[3]) T-value = CEC = cation exchange capacity, m.e./100 g soil.

Table 3. Results of analysis of soil samples from experiment W 303, sand soil.

Analysis	Before treatment 1971		Topsoil, after harvest								
			1971			1972			1973		
	Topsoil	Subsoil 20–40	A	B	C	A	B	C	A	B	C
pH in H_2O	6.0	5.7	6.3	6.1	6.0	6.6	6.5	6.5	6.4	6.4	6.3
pH 8n $CaCl_2$	5.3	4.9	5.5	5.5	5.5	–[1]	–[1]	–[1]	5.9	5.9	5.8
S-value[2]	1.0	2.0	5.0	6.0	6.0	6.0	6.0	7.0	6.0	7.0	8.0
T-value[3]	7.0	6.0	7.0	7.0	7.0	8.0	8.0	9.0	7.0	8.0	11.0
Base saturation degree %	14	33	71	86	86	75	75	78	86	88	73
Org. C in %	1.2	0.5	1.5	1.7	2.3	1.6	1.8	2.3	1.6	1.7	2.5
Kj-N in %	0.11	0.06	0.11	0.11	0.11	0.13	0.14	0.15	0.13	0.13	0.14
P-AL mg/100 g	6.4	2.5	6.8	6.8	7.4	10.2	10.8	11.0	11.6	11.9	12.1
K-AL mg/100 g	5.0	3.0	7.5	7.0	6.5	14.0	12.0	15.0	13.5	14.5	12.5
Ca-AL mg/100 g	80	58	130	125	123	156	140	143	121	121	133
Mg-AL mg/100 g	5.1	3.0	6.0	6.5	7.0	12.9	11.8	11.5	8.8	9.3	9.8

[1]) No analysis carried out.

[2]) S-value = exchangeable base cations, m.e./100 g soil.

[3]) T-value = CEC = cation exchange capacity, m.e./100 g soil.

year. The yield in the plots treated with bark humus increased considerably and was twice as large in treatment C as the yield in treatment A, without bark humus. This large difference can partly be explained by the experiment being sown relatively late, May 10, and the fact that in treatment A the emergence was hindered by severe drying-out of the seedbed, while in treatments B and C the moisture was retained by the bark humus. This was clearly visible at the emergence of the crop. In the following year the increase was similar in both bark humus plots, which yielded 5–6 % more than the yield from treatment A, without bark humus. In the third year there were similar yields in all three treatments, which is probably closely connected with the crop, the soil type, the year, and the relatively generous application of nutrients.

Table 5 contains yield figures from Expt. W 303 in Dalarna. They demonstrate the reverse effect of the bark humus application. In this experiment no yield increases were obtained in the year of fertilization. This is probably connected with the fact that the bark humus was applied to a ploughed ley. The ploughing of the ley meant that relatively large amounts of easily decomposable organic matter became available and consequently no increased effect was noticeable following further additions of organic matter in the form of bark humus. The effect of the bark humus became apparent in the second and third years, and in treatment C (the largest application of MoDo-Mylla)

Table 4. Yield figures from Expt. C 68 on clay soil, dt/ha. Means of 4 replications.

Year Crop	Variety	Yield dt/ha and relative values						Standard deviation % of mean
		A		B		C		
		dt/ha	rel. val.	dt/ha	rel. val.	dt/ha	rel. val.	
1971 Barley	Ingrid	15.7	100	28.4	181	32.6	208	±3.8
1972 Oats	Sol II	38.6	100	41.1	106	40.6	105	±0.7
1973 Winter wheat	Starke	52.2	100	52.5	101	52.2	100	±1.9
Mean		35.5	100	40.7	115	41.8	118	±2.4

Table 5. Yield figures from Expt. W 303 on sand soil, dt/ha. Means of 4 replications.

Year Crop	Variety	Yield dt/ha and relative values						Standard deviation % of mean
		A		B		C		
		dt/ha	rel. val.	dt/ha	rel. val.	dt/ha	rel. val.	
1971 Barley	Ingrid	13.4	100	12.2	92	13.4	100	±2.0
1972 Potatoes	Mgn Bonum	282	100	291	103	309	110	±3.2
1973 Potatoes	Grata	210	100	212	101	220	105	±2.4
Mean		168.5	100	171.7	102	180.8	107	±2.5

a clear yield increase was registered, 10 and 5 % respectively in comparison with the yield of treatment, A, without bark humus.

Table 6 contains figures of the straw yield from Expt. C 68 in the first and second years. The straw yield was not weighed in the final year owing to severe lodging over the entire experiment. Neither was the straw yield in W 303 weighed in the final year on account of the uneven amounts of weeds (*Chenopodium* and *Agropyron repens*).

Table 6 shows that the effect of bark humus on the straw yield was not uniform in the first and second years and that true effects of the bark humus did not appear, as can be seen from the mean value.

Table 6. Yield of straw, 1971—1972.

Expt.	Year	dt/ha		
		A	B	C
C 68	1971	16.4	19.0	18.4
	1972	37.7	35.7	36.1
Mean		27.1	27.1	27.3

The straw yield of experiment W 303 was not weighed in 1971 because of uneven occurrence of weeds in all plots. The same applies to experiment C 68 in 1973.

Table 7. Bulk weight and 1 000-kernel weight of cereals, 1971—1973

Expt.	Year	Bulk weight, g			1 000-kernel weight, g		
		A	B	C	A	B	C
C 68	1971	684	724	742	47.6	48.6	48.5
	1972	495	498	493	27.2	26.4	26.3
	1973	796	808	804	34.6	36.8	38.0
Mean		658	677	680	36.5	37.3	37.6
W 303	1971	532	538	536	36.1	36.4	36.8

Qualitative evaluation of the cereal grain was made by analysis of the bulk weight and the 1 000-kernel weight (Table 7). Differences in bulk weight were found between treatments A, B and C. The treatment without bark humus (A) had the lowest bulk weight, while treatments B and C, on average, had higher bulk weights in Expt. C 68 on clay soil. Expt. W 303 in Dalarna on sand soil revealed no differences between the treatments with and without bark humus. The 1 000-kernel weight analyses in Expt. C 68 showed that the bark humus treatments gave a somewhat higher value, as an average of all the experimental years, than the treatment without the bark humus. The same positive effect was obtained in the bark humus treatments in Expt. W 303, but not as noticeably as in C 68.

The chemical analysis of the grain (Table 8) shows that the contents of nitrogen, phosphorus and potassium in the bark humus treatments decreased somewhat in Expt. C 68 in the first year. This effect more or less disappeared in the second and third years. In Expt. W 303 in Dalarna there was no sign of a decrease in phosphorus while the nitrogen and potassium contents in barley grain increased in the bark humus treatments.

The analysis of the straw (Table 9) shows that the trend for the contents of nitrogen, phosphorus, potassium and even calcium in the first year was the same as for the grain in the C 68 experiment, i.e. that treatment A without bark humus had higher nutrient contents than treatments B and C with bark humus. The situation is reversed in Expt. W 303 on sand soil and is in agreement with the nutrient content of the grain in that the straw yield had a higher nutrient content in the bark humus treatments than the straw from the treatment without bark humus. This is primarily the case for phosphorus and nitrogen. These variations in grain and straw in the different experiments are probably connected with the level of the yields.

Table 8. Results of chemical analysis of grain

Analysis			C 68									W 303		
			1971 Barley			1972 Oats			1973 Winter wheat			1971 Barley		
			A	B	C	A	B	C	A	B	C	A	B	C
Nitrogen	(N)	% of d.m.	2.82	2.66	2.63	2.54	2.41	2.39	2.33	2.32	2.33	2.28	2.39	2.35
Phosphorus	(P)	»	0.39	0.35	0.31	—	—	—	0.42	0.41	0.41	0.34	0.34	0.34
Potassium	(K)	»	0.72	0.58	0.51	—	—	—	0.42	0.40	0.38	0.72	0.76	0.76
Calcium	(Ca)	»	0.06	0.06	0.06	—	—	—	0.06	0.06	0.06	0.07	0.07	0.07
Magnesium	(Mg)	»	0.15	0.14	0.14	—	—	—	0.13	0.13	0.13	0.13	0.13	0.12

— = No analysis carried out

Table 9. Results of chemical analysis of cereal straw

Analysis			C 68									W 303		
			1971 Barley			1972 Oats			1973			1971 Barley		
			A	B	C	A	B	C	A	B	C	A	B	C
Nitrogen	(N)	% of d.m	1.65	1.21	0.99	0.95	0.82	0.85	—	—	—	1.29	1.25	1.30
Phosphorus	(P)	»	0.20	0.16	0.16	0.11	0.11	0.13	—	—	—	0.14	0.18	0.18
Potassium	(K)	»	1.93	1.65	1.86	2.06	2.20	2.20	—	—	—	1.89	2.51	2.65
Calcium	(Ca)	»	0.54	0.50	0.42	—	—	—	—	—	—	0.65	0.66	0.61
Magnesium	(Mg)	»	0.08	0.08	0.08	—	—	—	—	—	—	0.10	0.09	0.10

— = No analysis carried out

SELOSTUS[1])

Kuorihumus (kauppanimi MoDo-Mylla) maanparannusaineena

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Tässä selostetuissa alustavissa 3-vuotisissa kenttäkokeissa kuorihumuksen (MoDo-Mylla) lisääminen maahan aiheutti orgaanisen hiilen pitoisuuden kohoamisen, 28 tonnia kuorihumuksen kuiva-ainetta hehtaarille lisäsi hietamaan muokkauskerroksen orgaanisen hiilen pitoisuutta 0,5 % ja 56 tn/ha 1 %. Kuorihumuksen lisääminen savimaahan (30 tn/ha ja 60 tn/ha kuiva-ainetta) aiheutti vastaavan suuruisen orgaanisen hiilen pitoisuuden lisääntymisen.

Suurimman sadonlisäyksen kuorihumus aiheutti ensimmäisenä koevuonna Uplannissa. Sadonlisäys verrattuna käsittelemättömään oli 81 % annettaessa 30 tn/ha ja 108 % annettaessa 60 tn/ha kuiva-ainetta. Positiivinen vaikutus havaittiin myös toisena vuonna ohralla, kun taas kolmantena vuonna (syysvehnä) sato oli sama kaikissa käsittelyissä.

Ensimmäisenä koevuonna Taalainmaan hiedalla kuorihumus ei parantanut satoa, todennäköisesti koska koe oli perustettu juuri kynnetylle nurmelle. Toisena ja kolmantena koevuonna ilmeni kuorihumuksen positiivinen vaikutus perunasatoihin, jotka olivat käsittelemättömään verrattuna toisena vuonna 5 % ja kolmantena 10 % korkeampia lisättäessä maahan 56 tn/ha kuorihumuksen kuiva-ainetta.

Olkisatoihin koekäsittelyillä ei ollut suoranaista vaikutusta. Tuhannen jyvän paino näytti lisääntyvän kuorihumuksen vaikutuksesta molemmilla koepaikoilla.

Savimaalla kuorihumuksen lisäys aiheutti jyvien typpi-, fosfori- ja kaliumpitoisuuden sekä olkien kalsiumpitoisuuden vähenemisen. Hietamaalla tilanne oli typen ja kaliumin kohdalla päinvastainen, siis näiden ravinteiden pitoisuus lisääntyi kuorihumuksen vaikutuksesta. Nämä ravinnepitoisuuksien muutokset ovat todennäköisesti yhteydessä sadon suuruuteen.

[1]) Selostuksen laatinut A. Jaakkola