FEN FERTILIZATION WITH POTASH IN THE LIGHT OF TESTS AT LETEENSUO EXPERIMENTAL STATION

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Numerous experiments intended to clarify the fertilizing questions of peat land have been established at the Experimental Station of Leteensuo and carried on through fairly long periods without interruption. Short-time reports of these experiments have been given in several connections. The results obtained over longer periods have recently been analysed with reference to the Sphagnum bog fertilizing tests, which have thrown light on the effects of nitrogen and phosphorus as well as potassium fertilization (5, 6). Moreover, TAKALA (6) has reported on the experiments arranged with a view to clarifying the effects of phosphate fertilization. In the following, the significance of potassium fertilization on the fen area of the Experimental Station of Leteensuo will be described on the basis of the results derived from three field tests. The persons supervising the experiments in different years have been mentioned in a previous publication (4, p. 2). With reference to shorter periods, these tests have been analysed by MALM (3) and HIRVENSALO (2). The author has previously examined the results of one of these tests over a longer period (5).

Test ground

The peat of the areas is forest sedge peat and their bog type prior to clearing was that of a wooded swamp with herbs and grasses. The depth of the peat layer is more than 2 m. The test areas are drained by open ditches dividing the land into strips 20 m in width.

The quality of the peat is illustrated by the chemical analyses made from the plot adjacent to the site of claying test No. 1 (7, p. 32; 8). The chemical composition of the clay and sand used as soil improving agents and the results of the soil analysis can also be found in the said publication by VESIKIVI (7, p. 34).

Arrangement of tests

Test No. 1. — The test area was cleared for cultivation in 1904. In 1905 clay was added as soil improving agent in a quantity of 400 m^3 per hectare. The test was started in 1905. The treatments were: 0, P (40 kg P_2O_5 per hectare), K (100 kg K_2O per hectare), PK, and PK plus liming. The location of the test plots can be seen from Fig. 1. Liming was done as follows: in 1905, 2 tons slaked lime per hectare; in 1923, 1927 and 1933, 1 ton per hectare each. Fertilization was carried out according to plan during the period of 1905—1918. In the years 1919—1922 all test plots were given phosphate and potassium fertilizer. From 1923 onwards, fertilization again proceeded according to the original test plan, but the fertilizer quantities given to root crops were doubled.

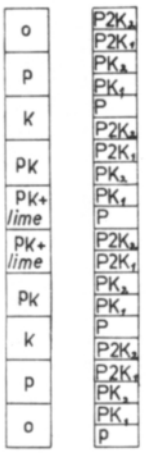

Fig. 1. The position of plots in the tests No. 1 and 2.

Test No. 2. — The test area is located adjacent to that of Test No. 1. No clay was added. The test was started in 1933, but its test plan was altered in 1937. Initially, it consisted of the following treatments: P (P= 40 kg P_2O_5 per hectare), PK_1 (K_1 = 60 kg K_{40} per hectare), PK_2 (K_2 = 60 kg K_{20} per hectare), $P2K_1$, and $P2K_2$. In 1937, K_{40} was replaced with the equivalent quantity of potassium sulphate and K_{20} with the equivalent quantity of K_{40}. The location of the test plots can be seen from Fig. 1.

Test No. 3. — Cultivation of the test area was commenced in 1921. One half of the test strip was clayed (adding 200 m^3 clay per hectare) in 1923 and in 1941. The potassium fertilizer quantities applied at first were: 0, 20, 40, 60, and 80 kg K_2O per hectare; in 1930 they were replaced by the following series: 0, 30, 60, 90, and 120 kg per hectare (see 5, p. 4). The notations employed in this paper with respect to the treatments in this test refer to the latter series. The entire area has been fertilized annually with phosphate fertilizer equivalent to about 300 kg superphosphate per hectare.

Crop yield results

The weather conditions during the test years have been described in a previous publication (4).

The annual crop yields in tests No. 1 and 2 can be seen from Tables I and II in the Appendix. The corresponding figures relating to test No. 3 have been published before (5).

Meadows. — The average annual hay crops obtained in the tests during the test period are shown in Tables 1—3 and in Fig. 2. Table 1 reveals that potassium fertilization has increased the hay crop yield, this increase being significant at a level of **95** %. However, the increase in crop yield obtained in the case of the PK treatment shows that potassium fertilization in combination with phosphorus

Table 1. Test No. 1. Average annual hay crop yields (during 19 years), kg per hectare.

Treatment	Crop yield	Increase in yield
O	2010	—
P	4840	2830
K	2770	760
PK	6510	4500
PK + lime	6640	4630
		666 *
		866 **
		1152 ***

had a remarkable compound effect; the crop yield increases produced by P and K individually add up to 3590 kg per hectare, whereas their use in combination increased the crop yield by 4500 kg per hectare.

The test plan of test No. 2 did not include a plot without treatment. The fertilizing effect of potassium alone is therefore unknown. However, Table 2 reveals that the use of potassium in addition to phosphorus has a remarkable effect. Potas-

Table 2. Test. No. 2. Average annual hay crop yields (during 8 years), kg per hectare.

Treatment	Crop yield	Increase in yield
P	3900	—
$PKso_4$	6100	2200
PK_{48}	6390	2490
$P2Kso_4$	6540	2640
$P2K_{42}$	6850	2950
		566 *
		762 **
		1010 ***

sium sulphate was somewhat less efficient than potassium salt, but there are no statistically significant differences between the effects of the different fertilizer types. Doubled potassium quantity, on the other hand, increased the crop yield with reference to that obtained with the single quantities in a degree approaching statistical significance.

No plot without treatment was included in test No. 3 either. It can be seen from the results shown in Table 3 and Fig. 2 that potassium fertilization increased the hay crops considerably from those obtained in the P treatment. On the unclayed test strip, the increase was higher than on the clayed strip in the instance of the first four potassium fertilizer quantities in the series, but the highest potassium fertilizer addition produced about equal crop yield increases on both strips. This serves to show that clay has a considerable potassium fertilizing effect (cf. 1) but also other effects which cannot be reproduced with potassium fertilization.

Table 3. Test. No. 3. Average annual hay crop yields (during 23 years), kg per hectare.

K_2O	Unclayed		Clayed [1]	
	Crop yield	Increase in yield	Crop yield	Increase in yield
0	1153	—	4402	—
30	3410	2257	5705	1303
60	5135	3982	6476	2074
90	6011	4858	6789	2387
120	6274	5121	7219	2817
			fertilizing	189 * 251 ** 323 ***
			claying	119 * 158 ** 204 ***

[1] Clay addition: twice 200 m³ per hectare.

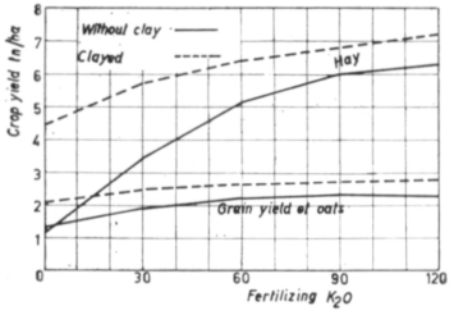

Fig. 2. Average annual hay crop yields and grain yield of oats in the test No. 3.

Cereals. — In likeness with the hay crop yields, the cereal crop yields have been presented in Tables 4—6 and in Fig. 2. It can be seen that potassium fertilization has resulted in an increased grain yield of oats in tests No. 1 and 3, while in test No. 2 potassium fertilization tended to cause a slight decrease in the crop yield, although there are no statistically significant differences. Nor can any effect of potassium fertilization on the grain yield of spring wheat be seen in the same test. On the other hand, the straw yield was increased also in this test. Possibly this is due to inundations, which occurred repeatedly in the spring several years running and which may have transported such quantities of mud to the test area that adequate potassium fertilizer action has been produced.

Root crops. — Root crops were cultivated during several years on the test area of test No. 1 only. The results reveal that potassium alone does not produce much of an increase in the crop yield. Potassium in addition to phosphorus has a remarkable effect.

Table 4. Test No. 1. Average annual grain and straw crop yields of oats (12 years) and barley (7 years), kg per hectare.

Treatment	Grain yield	Incr. in grain yield	Straw yield
		Oats	
O	1230	—	2180
P	2630	1400	4300
K	1490	260	2510
PK	3000	1770	5330
PK + lime	2860	1630	5050
		285 *	
		381 **	
		501 ***	
		Barley	
O	560	—	2130
P	1320	760	3900
K	820	260	2700
PK	1740	1180	4810
PK + lime	1940	1380	5010
		506 *	
		685 **	
		918 ***	

Table 5. Test No. 2. Average annual grain and straw crop yields of oats (5 years) and spring wheat (2 years), kg per hectare.

Treatment	Grain yield	Incr. in grain yield	Straw yield
		Oats	
P	2680	—	4310
$PKso_4$	2530	— 150	4950
PK_{48}	2670	— 10	5260
$P2Kso_4$	2600	— 80	4950
$P2K_{48}$	2590	— 90	5090
		Spring wheat	
P	1960	—	4380
$PKso_4$	1960	0	4700
PK_{48}	2080	120	4820
$P2Kso_4$	1870	— 90	4940
$P2K_{48}$	2040	80	4800

Conclusions

On the fen area of the Experimental Station of Leteensuo, with a peat layer consisting of forest sedge peat, potassium fertilization produced a considerable increase of the hay crop yield on the clayed as well as the unclayed bog, when phosphate fertilization had been added. However, clay displayed a considerable

Table 6. Test No. 3. Average annual grain and straw yields of oats (during 7 years), kg per hectare.

K_2O	Unclayed				Clayed			
	Grain yield	Increase in yield	Straw yield	Increase in yield	Grain yield	Increase in yield	Straw yield	Increase in yield
0	1335	—	3317	—	2087	—	4509	—
30	1883	548	4392	1075	2468	381	5205	696
60	2229	894	5099	1782	2612	525	5701	1192
90	2327	992	5424	2107	2710	623	5739	1230
120	2271	936	5557	2240	2771	684	6044	1535

Grain yield, fertilizing 160 * 217 ** 291 ***
claying 103 * 140 ** 187 ***

Table 7. Test No. 1. Average annual root and top yields of swede (during 4 years), kg per hectare.

Treatment	Root yield	Incr. in root yield	Top yield
O	5230	—	2530
P	21540	16310	10560
K	6300	1070	2650
PK	29850	24620	11840
PK + lime	32480	27250	13190
		12790 *	
		20838 **	

potassium fertilizing effect and also other effects, which probably cannot be reproduced by fertilization.

The effect of potassium fertilization on the summer cereal crop yield was different in different tests. In two of them, potassium fertilization increased the grain yield but not in the third. The results obtained in this latter instance are thought to have been influenced by the addition of mud through the action of floods.

Potassium fertilization had remarkably increased the root crop yields.

When phosphate fertilization had not been added, the effect of potassium fertilization was small asa rule.

There was no marked difference between the effects of potassium salt and potassium sulphate, although it should be noted that the tests did not contain any treatments with potatoes as the experimental crops, which might show up this difference most clearly.

Appendix I. Annual crop yields in test No. 1, kg per hectare $\times 10^{-1}$.

Year	Test plant	Treatment				
		0	P	K	PK	PK+lime
1905	Oats grain	89	240	101	275	222
	straw	102	297	110	328	243
1906	Turnip roots	826	1069	709	949	1061
	tops	448	520	454	534	526
1907	Swede roots	1616	3373	1892	4390	4530
	tops	687	1138	758	1299	1261
1908	Pea seed	75	177	97	137	133
	haulm	105	244	109	227	216
1909	Oats grain	122	239	151	295	235
	straw	196	361	204	444	353
1910	Sugar Beet roots	219	1048	453	2719	1816
	tops	225	655	540	2750	1813
1911	Oats grain	172	242	163	289	240
	straw	283	420	266	452	393
1912	Sugar Beet roots	136	617	258	832	864
	tops	158	856	379	1742	1635
1913	Oats with Vetches, green fodder	233	477	189	459	430
1914	Swede roots	255	1759	151	1389	1366
	tops	124	799	58	579	625
1915	Pea seed	30	78	22	67	51
	haulm	113	301	65	276	228
1916	Oats grain	97	225	113	263	295
	straw	217	491	264	558	512
1917	Spring Wheat grain	55	171	54	254	246
	straw	260	553	232	721	702
1918	Swede roots	47	995	97	1450	1820
	tops	37	645	65	795	980
1919	Barley grain	47	82	72	138	166
	straw	299	367	282	494	470
1920	No results					
1921	1st year ley hay	449	644	395	618	706
1922	2nd » » »	647	731	655	705	772
1923	3rd » » »	289	589	232	674	586
1924	4th » » »	289	491	240	649	613
1925	5th » » »	70	380	550	695	700
1926	6th » » »	30	265	425	500	530
1927	7th » » »	10	245	200	415	395
1928	8th » » »	20	245	320	475	487
1929	9th » » »	15	278	40	560	610
1930	Oats grain	93	147	122	244	231
	straw	227	359	303	596	599
1931	Turnip roots	156	1237	116	4139	4800
	tops	75	765	60	1420	1560
1932	Barley grain	14	32	18	82	87
	straw	165	295	235	480	430

Appendix I. Annual crop yields in test No. 1, kg per hectare $\times^{-1}$.

Year	Tes plant		Treatment				
			0	P	K	PK	PK+lime
1933	1st year ley	hay	155	420	255	780	745
1934	2nd » »	»	90	453	108	735	720
1935	3rd » »	»	91	372	119	720	619
1936	4th » »	»	55	348	58	665	685
1937	Spring Wheat	grain	56	112	68	163	172
		straw	101	241	120	354	393
1938	Potato		931	1163	1235	1405	1414
1939	Barley	grain	59	82	112	109	136
		straw	231	325	292	401	486
1940	Swede	roots	172	2488	379	4710	5275
		tops	164	1640	180	2063	2408
1941	Barley	grain	55	109	59	180	200
		straw	364	455	396	416	421
1942	1st year ley	hay	348	630	460	636	608
1943	2nd » »	»	340	713	368	778	895
1944	3rd » »	»	432	667	365	740	768
1945	4th » »	»	346	747	301	809	886
1946	5th » »	»	113	530	112	590	639
1947	6th » »	»	38	451	53	633	642
1948	Oats	grain	114	332	147	373	385
		straw	174	395	173	412	494
1949	Oats	grain	238	352	340	417	401
		straw	331	620	488	646	674
1950	Barley	grain	91	232	116	274	311
		straw	214	426	261	504	548
1951	Oats	grain	104	300	118	316	315
		straw	156	382	178	438	440
1952	Oats	grain	123	366	182	382	345
		straw	262	481	342	780	666
1953	Barley	grain	40	96	72	70	92
		straw	148	396	254	426	450
1954	Oats	grain	112	206	123	202	236
		straw	240	354	266	408	442
1955	Barley	grain	84	288	121	365	362
		straw	70	462	169	643	699
1956	No results						
1957	Oats	grain	75	209	101	199	138
		straw	130	352	151	386	361
1958	Oats	grain	133	296	125	343	345
		straw	299	642	270	942	888

Appendix II. Annual crop yields in test. No. 2, kg per hectare x 10^{-1}.

Year	Test plant	Treatment				
		P	PK_{40}	PK_{20}	$P2K_{40}$	$P2K_{20}$
1933	Potato	759	932	937	1118	1068
1934	Potato	2414	2676	2554	2591	2780
1935	Barley grain	129	149	142	147	148
	straw	441	492	479	491	487
1936	1st year ley hay	575	666	753	731	763
	Treatments changed	P	PK K_2SO_4	PK_{48}	P2K K_2SO_4	$P2K_{48}$
1937	2nd year ley hay	597	731	804	810	816
1938	3rd » » »	285	575	578	632	622
1939	4th » » »	216	435	463	525	567
1940	5th » » »	160	419	414	400	428
1941	Oats grain	290	225	277	213	231
	straw	370	415	409	383	1384
1942	Potato	968	1203	1290	1188	165
1943	No results					
1944	» »					
1945	Barley grain	187	168	197	165	191
	straw	532	525	560	517	558
1946	Spring Wheat grain	228	232	239	234	226
	straw	433	462	466	471	470
1947	Spring Wheat grain	163	160	177	140	182
	straw	442	478	497	517	489
1948	1st year ley hay	441	562	592	577	584
1949	2nd » » »	361	533	561	575	652
1950	3rd » » »	396	742	786	817	856
1951	4th » » »	482	828	805	827	885
1952	Oats grain	327	343	365	366	343
	straw	586	680	785	744	732
1953	No results					
1954	Oats grain	128	114	110	148	158
	straw	284	340	392	352	366
1955	No results					
1956	» »					
1957	Oats grain	284	258	241	223	223
	straw	395	426	436	431	417
1958	Oats grain	309	326	343	351	342
	straw	519	613	608	554	645

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SELOSTUS:

MUTASUON KALILANNOITUKSESTA LETEENSUON KOKEIDEN PERUSTEELLA

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Kalilannoitus on Leteensuon pitkäaikaisissa kokeissa lisännyt huomattavasti heinäsatoja sekä savetulla että saveamattomalla mutasuolla, jotka ovat saaneet fosfaattilannoituksen. Savella on ollut huomattava kalilannoitusvaikutus, joskin myös muita vaikutuksia, joita lannoituksella ei voitane korvata.

Kevätviljasatoihin kalilannoitus on vaikuttanut eri tavoin eri kokeissa. Kahdessa kokeessa se on lisännyt jyväsatoja, mutta ei yhdessä. Viimeksimainitun kokeen tulokseen lienee vaikuttanut tulvan koealueelle kuljettama liete.

Juurikasvien juurisatoa kalilannoitus on lisännyt huomattavasti.

Mikäli fosfaattilannoitusta ei ole annettu, on kalilannoituksen vaikutus jäänyt yleensä vähäiseksi tai lähes olemattomaksi kaikilla kasveilla.

Kalisuolan ja kaliumsulfaatin välinen eroavuus on ollut lähes olematon, joskin on todettava, ettei koekasvina ole ollut perunaa, jolla näiden lannoitteiden välinen ero tulisi ehkä parhaiten esiin.