CONFIDENTIAL*

DEEP LOOSENING OF SOIL, 1981

NAS 205 ML (SA96)
1st year

SUMMARY

In autumn 1980, several different machines were used to deep loosen a sandy loam soil. These machines were a Wye double-digger, an NCAE winged subsoiler, used as a two pass complete loosener or a one pass subsoiler, and a Paraplow.

Deep placement of 350 kg/ha of phosphate and potash was possible with two of these machines and these treatments were carried out to compare with soil loosening alone and with extra P & K ploughed down.

Deep soil loosening or the application of extra phosphate and potash did not affect the yield, 1,000 grain weight or the P and K content of the grain of Igri winter barley.

OBJECT

To evaluate techniques of deep soil loosening, and to monitor their effects on soil conditions and crop performance in an arable rotation. Also to test the value of deep placement of phosphate and potash fertilizer. This experiment is part of a series being co-ordinated by ADAS Eastern Region Soil Science Department.

TREATMENTS

1. Control - mouldboard ploughing, no deep loosening or phosphate and potash placement.
2. Extra phosphate and potash, ploughed down in autumn
3. Wye double-digger, no phosphate and potash placement
4. Wye double-digger, with phosphate and potash placement
5. NCAE winged-subsoiler, complete loosening, no phosphate and potash placement
6. NCAE winged-subsoiler, complete loosening, with phosphate and potash placement
7. NCAE winged-subsoiler, one pass, no phosphate and potash placement.
8. Howard Paraplow, no phosphate and potash placement.

These treatments were applied in four randomised blocks.

METHOD

On 9 September 1980, the site was sprayed with Gramoxone at 2.8 l/ha. In preparation for the 1982 sugar beet crop, factory waste lime was applied at 12.5 t/ha on 12 September.

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Treatment 3 was carried out on 16-17 September with the Wye double-digger. This machine consists of a power driven rotor with pick tines loosening the subsoil behind the tractor wheel in the furrow bottom. This loosened soil is then covered by topsoil from a single furrow plough attached behind and to the side of this rotor. The soil was ploughed to 23 cm with overall loosening to 38-40 cm. This machine was also used for treatment 4 when 350 kg/ha of phosphate and potash (as a 0.20.20 granular compound) was incorporated into the subsoil. This was started on 17 September but after one block had been completed, there had been considerable wear on the tines. A new set of pick tines was obtained, fitted, and the three remaining blocks were treated on 19 September.

On 18 September, treatments 5 & 6 were carried out using two passes of the NCAE winged subsoiler. This machine has large tines with wings at their base working at varying depths in the soil. Different tine spacings and depths were used for the two passes, to give complete loosening of the soil to 40-46 cm. On treatment 6, 350 kg/ha of phosphate and potash were incorporated into the subsoil. An equivalent amount of phosphate and potash was applied to treatment 2 and both treatments 1 and 2 were ploughed to 23 cm using a four furrow reversible plough.

Treatment 7 was carried out on 19 September using the NCAE machine as a one pass subsoiler at 38-40 cm penetration. The Howard Paraplow (treatment 8) was also used at 38-40 cm penetration. This machine has sideways-slanted legs which move the soil at depth but leave the surface relatively undisturbed. A 3-leg version of the Paraplow was used in this experiment.

On 24 September, the site was sprayed with Cleansweep at 2 l/ha and seedbed preparation was by one pass of a springtine harrow across all plots on 27 September. The trial was drilled (using a Carier drill) with Igri winter barley (dressed with Muridal) at 157 kg/ha on 28 September.

Weed control was by the application of Mofix 500L (bromofenoxim + terbuthylazine) at 1.7 l/ha on 30 October. CMPP was applied on 6 April 1981 as 3.5 l/ha of Methoxone M. A nitrogen top dressing of 150 kg/ha was applied as a split dressing, with 95 kg N/ha being applied on 27 March when the crop was tillering (G.S. 25-28) and a further 55 kg N/ha on 5 May. At this time, the crop was at the second node detectable stage (G.S. 32). A fungicide was also applied on 5 May (Bayleton BM at 1 kg/ha) to keep the crop relatively disease free.

The barley was all badly lodged, but was successfully harvested on 31 July and 3 August.

Particle size distribution, organic matter, pH and the nutrient status of the soil was determined before the trial started. This was carried out to 60 cm depth and in 10 cm sections.

Water content was determined on four treatments (control, Wye double-digger, NCAE complete loosener and Paraplow) at various times during the season, using neutron probe access tubes. Free water retention was also determined on 30 April, four days after 80.2 mm of rain had fallen on 24-26 April.

RESULTS

Particle size distribution and nutrient status of the soil at the start of the trial are summarised below.

Particle size distribution (%)

Depth (cm)	C. Sand >600	Sand 210-600	F. Sand 105-210	V.F. Sand 60-105	C. Silt 20-60	Silt 2-20	Clay <2 µm
0-10	2.3	34.6	22.1	8.4	9.8	7.8	12.0
10-20	3.0	34.4	21.9	8.2	9.0	7.1	11.7
20-30	2.5	33.9	22.4	8.5	8.4	7.4	12.1
30-40	2.7	30.0	22.0	8.6	8.9	8.1	13.0
40-50	3.1	31.5	20.8	7.7	8.6	8.3	16.2
50-60	3.2	28.1	18.6	7.6	8.4	9.4	20.8

This experiment is sited on a sandy loam soil and is classified as being in the sandier Ashley soil series.

Soil Analysis

Depth (cm)	pH	P mg/l	P Index	K mg/l	K Index	Mg mg/l	Mg Index	% O M
0-10	8.0	38	3	93	1	52	2	1.5
10-20	8.1	40	3	108	1	52	2	1.5
20-30	8.0	44	3	130	2	58	2	1.6
30-40	8.1	28	3	115	1	53	2	1.2
40-50	8.1	23	2	108	1	53	2	1.1
50-60	8.0	18	2	104	1	49	1	1.0

Soil pH was very high, and uniform down through the profile. Organic matter content was relatively low at 1.5 - 1.6 % down to 30 cm and very low below this depth. Soil analysis generally showed an index in the topsoil of 3 for P, 1-2 for K and 2 for Mg. There was a tendency for nutrient levels to be highest at 20-30 cm depth.

Soil water content

Soil water content and free water retention on 30 April to a depth of 140 cm as measured by neutron probe access tubes are detailed below.

Water contents (mm)

Treatment	Mean of winter water content measurements (11 Dec, 10 Feb, 2 April)	Depletion by 17 July	Rainfall 30 April-17 July	Total water use 30 April - 17 July
Control	393.9	65.5	123.9	189.4
Wye double-digger	375.6	73.5		197.4
NCAE Complete	365.9	84.6		208.5
Paraplow	391.1	79.2		203.1

Depletion of soil moisture by the crop was greatest for the NCAE complete loosener and the Paraplow and least for the control.

Water for the 11 week period was between 17 and 19 mm per week.

Free water retention (mm)

Treatment	Mean of winter water content measurements 11 Dec, 10 Feb, 2 April	Rainfall 24-26 April	30 April	Free water on 30 April
Control	393.9	80.2 mm	427.3	33.4
Wye double digger	375.6		391.1	15.5
NCAE Complete	365.9		398.0	32.1
Paraplow	391.1		401.8	10.7

Free water retention four days after heavy rainfall was similar in the 140 cm depth profile, between the control and the NCAE complete loosening treatment, although the mean of the winter quantities was different. Over 40% of the rainfall was retained in the profile below 30 cm depth on these two treatments. For the Paraplow and Wye double digger treatments, free water retention was approximately 19% and 13% respectively of the rainfall and all was below 50 cm depth after four days of drainage.

Grain yield and grain size

Treatment	Grain yield at 85% DM (t/ha)			1,000 grain weight at 100 % D.M. (g)		
	PK −	PK +	Mean	PK −	PK +	Mean
	(ESE ±0.054)		(ESE ±0.076)	(ESE ±0.37)		(ESE ±0.52)
1. Control	6.35	6.54	6.45	47.5	46.9	47.2
2. Wye double digger	6.33	6.30	6.32	47.3	46.6	47.0
3. NCAE Complete	6.51	6.44	6.48	47.8	48.1	48.0
Mean	6.40	6.43	6.41	47.5	47.2	47.4
4. NCAE Subsoiler	6.47	-		46.3	-	
5. Paraplow	6.53	-		46.3	-	
Grand Mean			6.43			47.1
S.E./plot (21 d.f.)	±0.108 or 1.7 % of G.M.			±0.75 or 1.6 % of G.M.		

1. Grain yield at a mean of 6.4 t/ha was good for this year.
2. The coefficient of variation of 1.7 % for grain yield was exceptionally low indicating very uniform conditions across blocks and between treatments.

3. Although there were some statistical differences these were inconsistent and were significant as a result of the exceptionally low coefficient of variation.
4. Overall no method of subsoil loosening has improved on the control yield.
5. Extra P & K has not improved yield, a not unexpected effect from previous trials on the farm.
6. 1,000 grain weight has not been affected by deep soil loosening or by extra P & K.

% P & K in grain

Treatment	% P		% K	
	PK		PK	
	-	+	-	+
	(ESE ±0.004)		(ESE ±0.001)	
1. Control	0.41	0.42	0.44	0.45
2. Wye double digger	0.41	0.42	0.46	0.43
3. NCAE Complete	0.41	0.41	0.43	0.45
Mean	0.41	0.42	0.44	0.44
4. NCAE Subsoiler	0.41	-	0.43	-
5. Paraplow	0.40	-	0.45	-
S.E./plot (21 d.f.)	±0.0082 or 2.0%		±0.0223 or 5.1%	

None of the treatments had any significant effect on the concentration of P and K in the grain.

M.N & D.B.S.
(+ M.F. Harrod)