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Instituut voor Cultuurtechniek en Waterhuishouding
Wageningen

SPRINKLING OF GRASSLAND

I. Layout of the experimental field

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C O N T E N T S

1. INTRODUCTION

Due to an intensive grassland utilization in a climate with dry spells, the application of sprinkling on the Dutch dairy farms increases strongly. Data about this development are given by VAN BOHEEMEN and DE WILDE (1979) and the STUDIECOMMISSIE WATERBEHOEFTE LAND- EN TUINBOUW (1980).

The increase of supplemental irrigation by sprinkling has originated a need for data about the water use and the growth of a herbage at different levels of water and nitrogen supply. Up to now this need is covered by the results of sprinkling experiments carried out in the period 1950-1965. Recently the results of these experiments have been reviewed (VAN BOHEEMEN, 1981). Because soil water measurements have not been performed during the experiments, the water use of the grass on the different sprinkled and unsprinkled fields has been reconstructed by estimating the potential evapotranspiration and the water delivering capacity of the soils. The measured additional seasonal herbage mass of the sprinkled fields could be related to the calculated additional seasonal evapotranspiration and the growth conditions. Thereby, the seasonal herbage mass on the sprinkled fields has been taken as measuring-staff for the growth conditions.

The determination of the evapotranspiration was too rough to calculate the effect of sprinkling exactly and to make analysis for parts of the growing season. This limits the usefulness of the results for studies into the additional herbage growth under sprinkling. Another complication is that the experiments were carried out under different circumstances with regard to weather conditions, soil fertility, grass species, grassland management etc. The influence of each of these factors could not be distinguished. This situation has lead to a planning of new experiments, focussed on the growth and the water use of the herbage and performed on fields with different levels of water supply, different levels of nitrogen supply and a management based on the present standards.

This note forms the first phase in reporting on the results of the new experiments and data found in literature. The two following chapters give a brief description of the organisation and the location of the experiments. After that, information on the soil conditions and the different treatments is given. Finally the botanical composition of the herbage is characterised.

2. ORGANISATION

The field experiments have been executed on the experimental farm Aver-Heino, a regional research centre for cattle husbandry in the eastern part of the Netherlands, where sprinkling experiments on grassland are carried out since 1976 under the auspices of the Advisory and Experimental Station for Cattle Husbandry. These experiments had been focussed on the changes in herbage growth as a result of the application of sprinkling.

In the research program for the period 1981-1984 measurements of soil water conditions and water uptake by the grass could be incorporated. Interesses shown by other disciplines have lead to a further extension of the research program, e.g. measurements of the effect of sprinkling on the root development, the leaching of nitrogen fertilizers and the uptake of nitrogen by the grass.

The research program prepared ultimately for the period 1981-1984 consisted of contributions by the Institute for Land and Water Management Research, the Advisory and Experimental Station for Cattle Husbandry, the Institute for Soil Fertility and the Centre for Agrobiological Research. It was aimed on a simultaneous determination of the effects of sprinkling mentioned above.

3. LOCATION

As site for the experiments a soil profile with a deep water table was preferred, so that quantifying of a possible contribution to the water supply of the vegetation by capillary rise could be omitted. On the farm Aver-Heino some lots are situated on sand ridges, where the groundwater table seldom rises higher than 175 cm below surface. On one

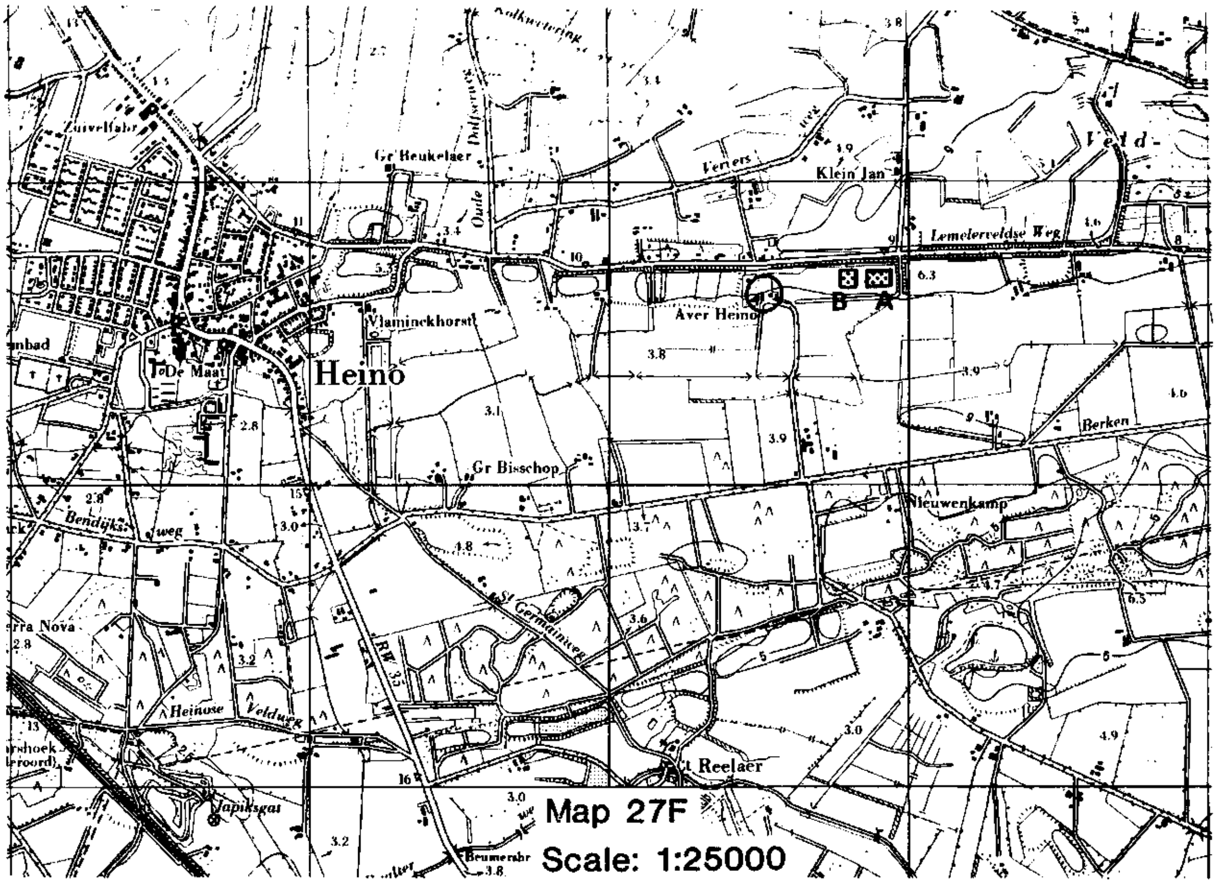

Fig. 1. Location of the field selected for the experiments (O, buildings of farm Aver-Heino; A, area used in the first experimental year; B, idem in the subsequent years)

of them (Fig. 1), partly bordered by oak edges, the experiments have been done.

The parcel selected for the study is part of an extensive grassland area. An exception formed a parcel at a small distance from the experimental field where during the first and second experimental year maize was grown (Fig. 2).

The group of relative small rectanglers and squares on the right side of Fig. 2 indicates the location of the plots used in the first year. The other group shows the location of the plots, on which the experiments were continued.

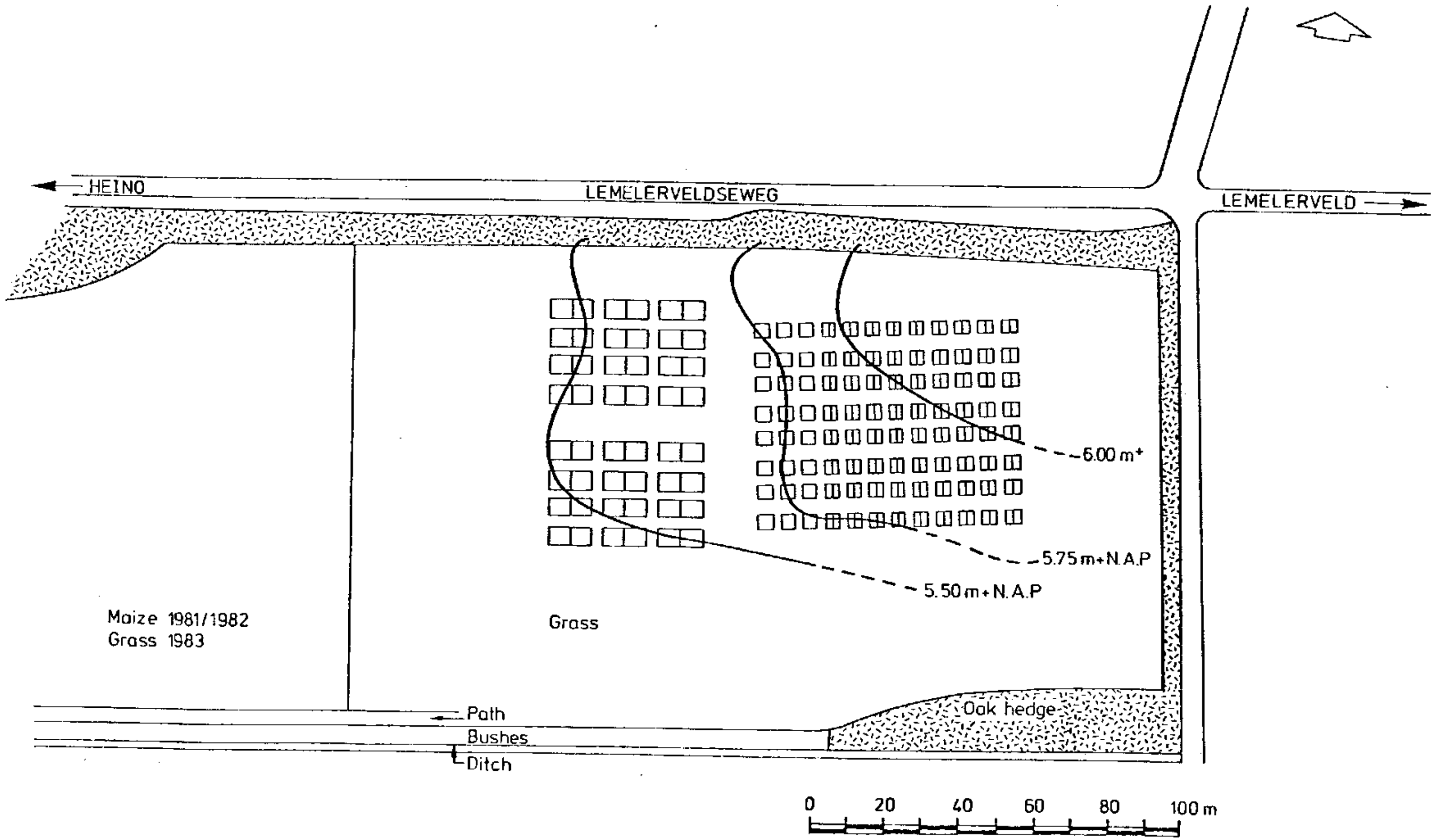

Fig. 2. Location of the plots occurring on the field selected for the experiments

4. SOIL CONDITIONS

The soil map of the lot choosen for the field study (Fig. 3) forms a result of a soil survey of the farm Aver-Heino (HAANS and DOMHOF, 1953). The soil was classified as Eh1, a so-called black, deep humous, old arable soil. According to the present classification system, based on morfometric instead of genetic criteria, this soil is called a black 'enk' earth soil (DE BAKKER and SCHELLING, 1966). If the American system (7th approximation) is applied, the soil is labelled a sandy, silicious, mesic plaggept (DE BAKKER, 1979).

Descriptions of plaggen soils, a group of soils with the same origine as enk earth soils, are given by STARING (1856), NIEMEIER and TASCHENMACHER (1939), EDELMAN (1950), FASTABEND and VON RAUPACH (1961),

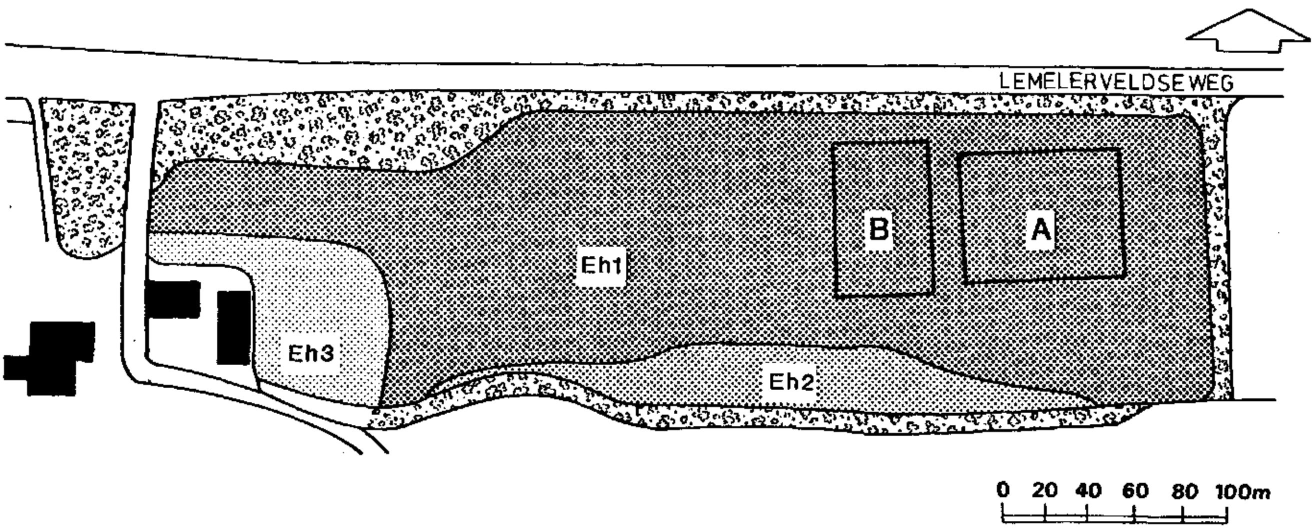

Fig. 3. Soil map of the lot selected for the experiments (after Haans and Domhof, 1953)

Eh1: black, deep humous, old arable land

Eh2: idem with hydromorphic phenomena in the layer 0-120 cm below surface

Eh3: black, humous, old arable land (diggen down)

A : area used in the first year

B : area used in the subsequent years

: farm buildings

: oak hedge

PAPE (1970), CONRY (1974), DE BAKKER (1979) and ECKELMANN (1980). Their genesis relates with the transport of a mixture of manure and plaggen, a Dutch and German term for sods, to arable land. The mixing would have been taken place in cowsheds and sheepfolds, where heather sods, grass sods, forest litter, peat litter and sand were spread as bedding and absorbing material. By putting for centuries the mix on the arable land the original profile was buried by a humous cover. On the Eh1-soils this cover has a thickness of 70-110 cm, a black to grey-black colour and scattered bleached sand grains (HAANS and DOMHOF, 1953). The black colour indicates, as generally assumed, the deposit of manure mixed with heather sods.

The humous top of the soil at the experimental field, in which practically all plant roots can be found, has a number of typical properties as mentioned by FASTABEND and TASCHENMACHER (1961), PAPE (1970), CONRY (1974) and ECKELMANN (1980). The most important chemical properties are:

- an organic matter content of about 6%
- a strongly acid reaction, pH $\approx$ 4
- a high cation-exchange capacity of about 15 meq per 100 g soil
- a low base saturation of about 8%
- a low availability of trace elements
- a high total phosphate content of more than 100 mg P_2O_5 per 100 g soil, of which only 10-15% is available for uptake by plants
- a high C/N-ratio of about 20

The physically most remarkable properties are: fine structure, friable consistence, good internal drainage, good aeration, moderate water holding capacity with a good part of it available for plants, low resistance for root penetration, good tillable and good trafficable.

The subsoil formed originally a podzol with a B2-horizon in which the organic matter is largely amorphous (humus podzol), developed under hydromorphic circumstances in so-called cover sand, an aelian deposit. Cementing of the B2-horizon has hardly happened.

The horizons distinguished in the soil profile are mentioned in Table 1. The soil texture data in the table form results of field estimations. They agree fairly well with results of analyses in the laboratory (Appendix 1). An exception forms the numbers concerning the loam fraction in the B2-horizon.

Table 1. Field description of the soil profile on the experimental field (mainly after Wösten, 1983). Loam and sand form mineral parts <50 µm and >50 µm, respectively

Horizon	Depth	Organic matter content (%)	Loam fraction (%)	Median of sand fraction (µm)
A1an1	0 - 30	5	12	155
A1an2	30 - 82^5	7	9	160
B2	82^5- 97^5	-	12	160
C11g	97^5-160	<0.5	5	165
C12g	160 -230	<0.5	8	130
CG1	230 -240	<0.5	25	130
CG2	240 -290	<0.5	16	145
G	290 -320	<0.5	20	140

Depth (cm - surface)	Number of samples	Density	
5	7	1.50	(σ=0.03)
10	26	1.48	(=0.05)
15	7	1.30	(=0.12)
20	23	1.38	(=0.07)
25	6	1.42	(=0.03)
30	19	1.41	(=0.04)
35	2	1.37	(=0.00)
40	17	1.35	(=0.03)
45	2	1.33	(=0.02)
50	19	1.32	(=0.03)
55	2	1.30	(=0.00)
60	16	1.25	(=0.04)
65	2	1.25	(=0.02)
70	18	1.28	(=0.03)
80	15	1.32	(=0.06)
90	14	1.46	(=0.03)
100	5	1.52	(=0.03)
110	17	1.52	(=0.04)
120	2	1.55	(=0.03)
130	8	1.58	(=0.04)
150	7	1.63	(=0.02)
180	2	1.65	(=0.00)

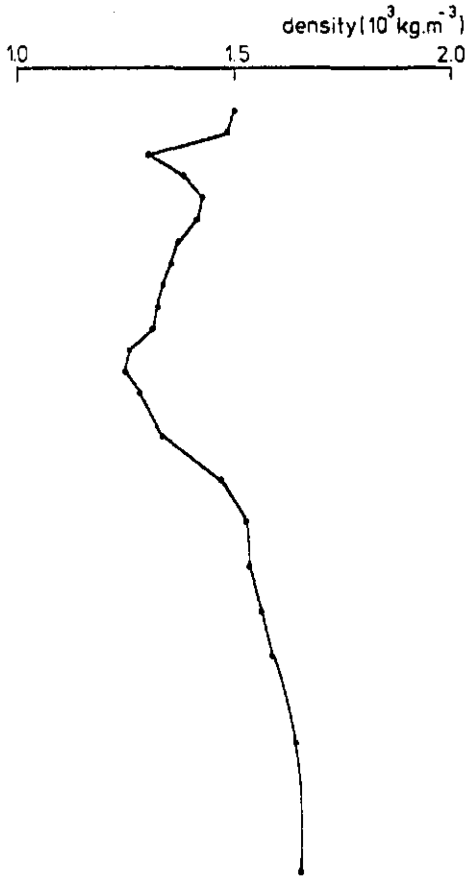

Fig. 4. Dry bulk density in 10^3 kg·m^{-3} of the soil on the experimental field

Table 2. Dry bulk density in $10^3\ kg \cdot m^{-3}$ of the soil on the field selected for the experiments

Horizon	100 cm^3 rings (this study)	300 cm^3 rings (Wösten, 1983)	standard values (Hoekstra, 1982)
A1an1	1.42	1.45	-
A1an2	1.31	1.30	1.28 (σ = 0.08)
B2	1.46	-	1.47 (σ = 0.10)
C11g	1.58	1.58	1.62 (σ = 0.09)
C12g	1.65	1.66	

For determination of the soil water content soil samples have been taken in Kopecky-rings with a content of 100 cm^3. These samples were also used for determination of the dry bulk density of the soil. Fig. 4 gives the course of the dry bulk density with depth. The calculated standard deviations remain for the major part below 3% of the density values.

At 15-20 cm depth the density is relatively low. This is seen as a consequence of ploughing of the old grassland before seeding of the present grass. Just below this layer the dry bulk density is about $1.42 \cdot 10^3\ kg \cdot m^{-3}$, corresponding with a porosity of about 45 percents. In the underlying part of the humous cover the density decreases with depth. This is normal for 'enk' earth soils (HOEKSTRA and POELMAN, 1982).

The density values given by WÖSTEN (1983) and those given as standard values for the concerning soil by HOEKSTRA and POELMAN (1982, p. 15-17) agree very well with the results presented in Fig. 4 (Table 2).

5. EXPERIMENTAL SET-UP

5.1. First year

The first year of the field study was meant for gaining experience with measuring methods. Spatially seen, the several parts of the research program were performed separately in the first year. As shown by Fig. 5, there were distinguished 168 plots, subdivided into three groups.

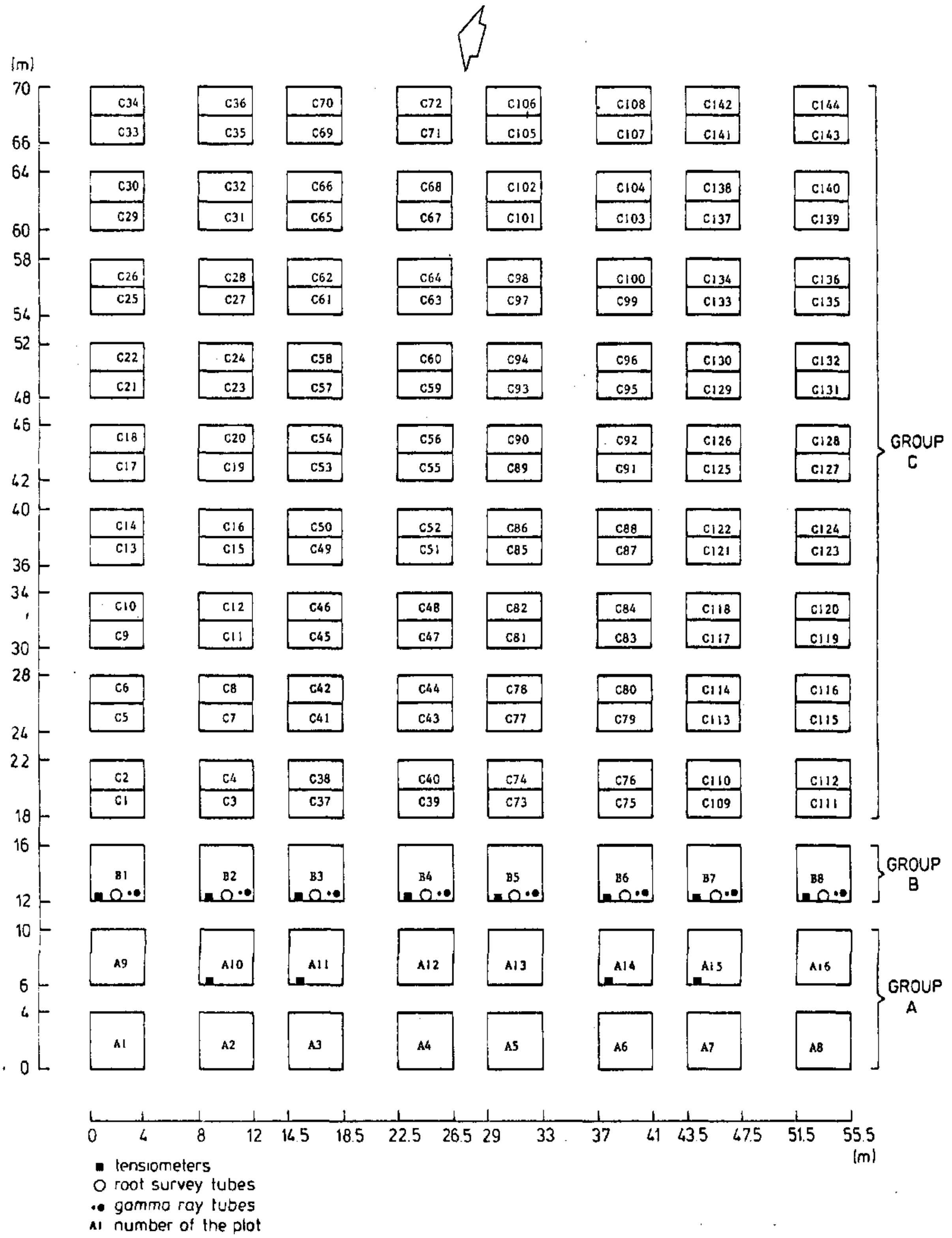

Fig. 5. Experimental set-up in the first year

- Group A. This group of sixteen 4 x 4 m^2 plots (A1 - A16 in Fig. 5) was used for the study of the effect of sprinkling on nitrogen leaching. Nitrogen application levels of 0, 300, 480 and 660 kg $N \cdot ha^{-1} \cdot year^{-1}$ were created. Half of each plot was used for measuring the herbage growth, the other half for measuring the loss of nitrogen towards the subsoil.
- Group B. The eight plots of group B were used for studying the effect of sprinkling on soil water flow and water uptake by the grass. The actual measurements were performed on half the plots, together with the measurements focussed on the root development. The other half of the plots was again used for measurements of the herbage growth. No difference in fertilisation occurred, each plot got 480 kg $N \cdot ha^{-1} \cdot year^{-1}$.
- Group C. These 144 plots of 2 x 4 m^2 were only used for studying the effect of sprinkling on herbage growth. Nitrogen was applied at a rate of 480 $kg \cdot ha^{-1} \cdot year^{-1}$.

For each plot the amounts of nitrogen applied to the different swards are given in Table 3. On the plots of groups B and C every sward got the same amount. On the plots of group A the gifts decreased with the progress of the growing season.

Table 3 also gives information about the sprinkling. A square around a number for the nitrogen dressing indicates that during the growing period of the corresponding sward sprinkling was carried out. A lack of a square means a growing period without sprinkling. Because of sufficient natural water supply, sprinkling of the first sward was excluded.

On some plots all swards except the first were sprinkled, on others only a limited number of swards. In this way the possibility was created to study the effect of sprinkling of a few swards on the growth of the next swards.

Sprinkling took place when the soil water pressure at 30 cm below surface was lower than -50 kPa (pF = 2.7). The gifts were equal to the soil water deficit on the plots with a nitrogen application of 480 $kg \cdot ha^{-1} \cdot year^{-1}$. Apart from these regular gifts the plots being considered for sprinkling obtained at least 8 mm directly after nitrogen application.

In the first year the grass on all plots was cut six times, except

Table 3. Rate of nitrogen application in $kg \cdot ha^{-1}$ on the plots used in the first experimental year.

A square means that during the growing period of the corresponding sward sprinkling was applied on the concerning plots

Plot group	Plot number				Sward 1	2	3	4	5	6	Total
A	7	15			0	0	0	0	0	0	0
A	8	16			70	60	60	40	40	30	300
A	4	12			100	90	90	70	70	60	480
A	3	11			130	120	120	100	100	90	660
A	2	10			0	$\boxed{0}$	$\boxed{0}$	$\boxed{0}$	$\boxed{0}$	$\boxed{0}$	0
A	1	9			70	$\boxed{60}$	$\boxed{60}$	$\boxed{40}$	$\boxed{40}$	$\boxed{30}$	300
A	5	13			100	$\boxed{90}$	$\boxed{90}$	$\boxed{70}$	$\boxed{70}$	$\boxed{60}$	480
A	6	14			130	$\boxed{120}$	$\boxed{120}$	$\boxed{100}$	$\boxed{100}$	$\boxed{90}$	660
B	7	8			80	80	80	80	80	80	480
B	5	6			80	80	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	480
B	3	4			80	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	480
B	1	2			80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	480
C	36	48	99	111	80	80					
C	33	46	98	110	80	80					
C	34	45	100	109	80	80					
C	35	47	97	112	80	80					
C	25	50	96	116	80	80	80				
C	28	49	94	113	80	80	80				
C	27	52	93	114	80	80	80				
C	26	51	95	115	80	80	80				
C	19	38	84	142	80	80	80	80			
C	20	39	81	143	80	80	80	80			
C	18	40	82	141	80	80	80	80	80	80	480
C	17	37	83	144	80	80	80	80			

Plot group	Plot number				Sward 1	2	3	4	5	6	Total
C	29	41	106	120	80	$\boxed{80}$					
C	31	44	105	118	80	$\boxed{80}$					
C	32	43	108	117	80	$\boxed{80}$	80	80	80	80	480
C	30	42	107	119	80	$\boxed{80}$					
C	6	68	87	132	80	80	$\boxed{80}$				
C	5	65	88	131	80	80	$\boxed{80}$				
C	8	66	86	130	80	80	$\boxed{80}$	80	80	80	480
C	7	67	85	129	80	80	$\boxed{80}$				
C	16	63	80	125	80	80	80	$\boxed{80}$			
C	14	61	77	128	80	80	80	$\boxed{80}$			
C	15	64	78	126	80	80	80	$\boxed{80}$	80	80	480
C	13	62	79	127	80	80	80	$\boxed{80}$			
C	1	58	104	122	80	$\boxed{80}$	$\boxed{80}$				
C	4	59	101	124	80	$\boxed{80}$	$\boxed{80}$				
C	3	60	103	123	80	$\boxed{80}$	$\boxed{80}$	80	80	80	480
C	2	57	102	121	80	$\boxed{80}$	$\boxed{80}$				
C	21	53	73	139	80	80	$\boxed{80}$	$\boxed{80}$			
C	23	55	75	138	80	80	$\boxed{80}$	$\boxed{80}$			
C	22	56	74	140	80	80	$\boxed{80}$	$\boxed{80}$	80	80	480
C	24	54	76	137	80	80	$\boxed{80}$	$\boxed{80}$			
C	9	69	90	134	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$			
C	12	71	92	135	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$			
C	11	72	89	133	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$	480
C	10	70	91	136	80	$\boxed{80}$	$\boxed{80}$	$\boxed{80}$			

Table 4. Depths of the tensiometers placed on the experimental field

Plot	Nitrogen gift ($kg \cdot ha^{-1} \cdot year^{-1}$)	Application c.q. level of sprinkling	Gamma ray tubes	Tensiometer at depth (cm -surface)																			
				5	10	15	20	25	30	40	50	60	70	80	90	110	130	150	180	210	240	270	30
First experimental year																							
A10	0	+			+		+		+		+												
A15	0				+		+		+		+												
A11	660	+			+		+		+		+												
A14	660				+		+		+		+												
B1	480	+	+	+	+	+	+	+	+	+	+				+								
B2	480	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
B3	480	+	+	+	+	+	+	+	+	+	+				+								
B4	480	+	+	+	+	+	+	+	+	+	+				+			+					
B5	480	+	+	+	+	+	+	+	+	+	+				+			+					
B6	480	+	+	+	+	+	+	+	+	+	+				+								
B7	480		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
B8	480		+	+	+	+	+	+	+	+	+				+								
Subsequent experimental years																							
41	0	W0	+		+		+		+	+	+		+		+		+						
42	220	W0	+		+		+		+	+	+		+		+		+						
17	440	W0		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
25	440	W0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
26	660	W0	+		+		+		+	+	+		+		+		+						
7	440	W1		+	+	+	+	+	+	+	+	+	+	+	+	+	+						
38	440	W1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
13	660	W1	+		+		+		+	+	+		+		+		+						
46	0	W2	+		+		+		+	+	+		+		+		+						
23	220	W2	+		+		+		+	+	+		+		+		+						
24	440	W2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
29	440	W2		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
21	660	W2	+		+		+		+	+	+		+		+		+						
30	660	W2			+		+		+	+	+		+		+		+						

on a number of plots in group C that was used to follow in detail the herbage accumulation. Therefor, during the growing period of the second, third and fourth sward everytime some plots were cut two weeks, some others three weeks and a third group six weeks after starting the regrowth, instead of the regular four weeks. These plots were not further used in the regular experiments.

For measuring the soil water pressure tensiometers were placed on all B plots and four of the A plots (Fig. 5). The depths of the tensiometers are given in Table 4. Furthermore, for measuring the soil water content by the gamma ray technique cupper pipes reaching a depth of 140 cm below surface were installed on each B plot, besides transparant perspex tubes for surveying the root development in the layer 0-60 cm below surface.

5.2. Subsequent years

After the first year all parts of the research program were integrated. In order to prevent a too laborious set-up the effect of sprinkling during only part of the growing season on the later herbage growth was left out, just like the cutting of the herbage at irregular times.

Fig. 6 shows the experimental set-up which was finally chosen. The field consisted of 48 plots, each 5 x 6 m^2. It was of a split plot design with four replicate blocks. There were differences in water supply (levels W0, W1 and W2) between the main plots and differences in nitrogen application (levels N0, N1, N2 and N3) between the sub-plots. On each (sub-)plot a 1 x 5 m^2 strip bordering directly to the neighbouring plot was used for soil water and root development measurements, an adjacent strip of 2 x 5 m^2 for herbage growth measurements and the remaining area of 3 x 5 m^2 for sampling of the soil as far as required for determination of the nitrogen loose to the subsoil.

The amounts of nitrogen applied to the different swards have been noted in Table 5. On a seasonal basis the gifts varied between 0 and 660 kg $N \cdot ha^{-1} \cdot year^{-1}$. With regard to the water supply the following treatments were distinguished:

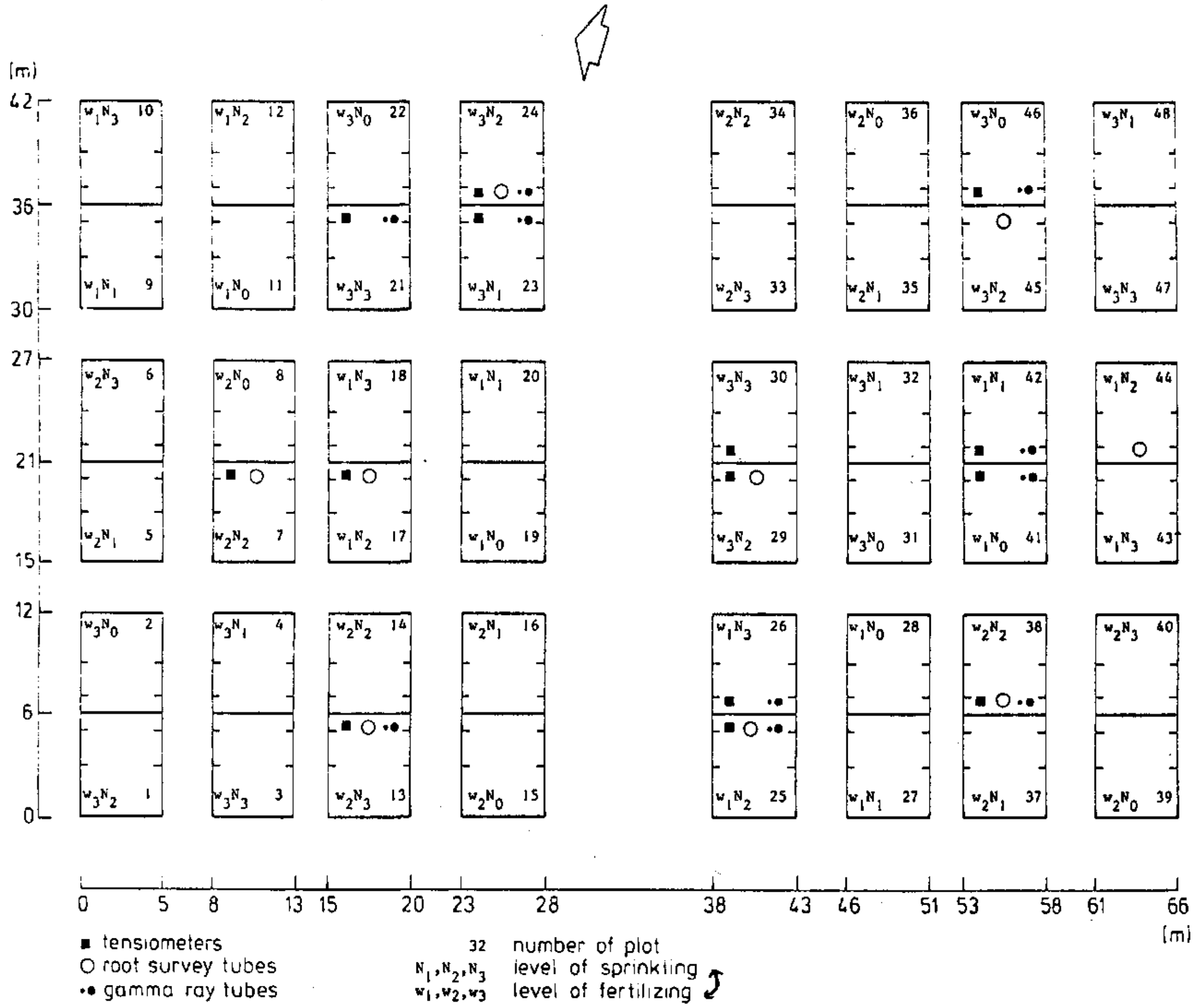

Fig. 6. Experimental set-up chosen after the first year

Table 5. Rate of nitrogen application in kg·ha^{-1} on the plots used after the first year

Fertilisation level	Sward						Total
	1	2	3	4	5	6	
N0	0	0	0	0	0	0	0
N1	60	40	40	30	30	20	220
N2	120	80	80	60	60	40	440
N3	180	120	120	90	90	60	660

- no sprinkling (level W0);
- moderate sprinkling (level W1): sprinkling when on the plots with a nitrogen gift of 480 kg·ha^{-1}·year^{-1} (N2) the soil water pressure at

25 cm below surface became lower than -50 kPa (pF = 2.7). The gift was set equal to the soil water deficit in the layer 0-25 cm below surface on the plots W1N2, e.g. the depth of water required to return the concerning layer to field capacity;

- frequent sprinkling (level W2): sprinkling when on the plots with nitrogen level N2 the soil water pressure at 25 cm below surface became lower than -20 kPa (pF = 2.3). The gift was set equal to the need of the W2N2 plots.

The places where tensiometers, gamma ray tubes and root survey tubes were placed, have been marked in Fig. 6. Table 4 gives the depths of the tensiometers.

Application of sprinkling lead to a faster growth, and a faster reaching of a full sward. To some degree this phenomenon has been accounted for in the cutting program. The cutting time for all plots with the same water supply level was based on the grass production occurring on the plots with a nitrogen application of 480 $kg \cdot ha^{-1} \cdot year^{-1}$ in case of 6 $swards \cdot year^{-1}$. Therefor the sprinkled plots were cut more times than the unsprinkled and automatically got more nitrogen.

6. GRASS SPECIES

The grassland used for the field experiments was seeded in September 1979 with a BG-3 mixture, existing for 100% of perennial rye-grass types (Lolium perenne). One half of the mixture formed late heading types, the other half middle-early heading types.

Heavy frost during the winter preceding the start of the second experimental year (winter 1981/1982) lead to dying-off of many perennial rye-grass plants. Therefor, the following spring by machinery BG-3 seed was put into the soil without destroying the remained plants (sod-seeding). Due to that measure perennial rye-grass could stay very dominant in the herbage. Presence of clover was of no importance, even not on the plots without nitrogen fertilisation.

7. SUMMARY

In order to get data for predicting the effect of sprinkling on the water use and the growth of a herbage a research program including field experiments has been set up.

In the note a description has been given of the organisation concerning the field experiments and the location of these experiments, viz. an enk earth soil, a type of plaggen soil, on the experimental farm Aver-Heino in the province Overijssel.

There has been pointed out that the grassland used for the experiments was splitted up in plots with different levels of water and nitrogen supply by sprinkling and fertilizing, respectively. Some plots were sprinkled when the soil water pressure at 25-30 cm depth was lower than -50 kPa (pF = 2.7), others when the soil water pressure was lower than -20 kPa (pF = 2.3) and a third group was not sprinkled. The nitrogen gift varied from 0 tot 660 kg·ha^{-1}·year^{-1}.

In het herbage perennial rye-grass was very dominant.

LITERATURE

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Mechanical composition of soil samples from the experimental field, determined in the laboratory (partly after Wösten, 1983). *particles >50 μm

Depth (cm -surface)		5-25	40-60	45-65	85-95	85-95	120-140	125-145	165-185
Horizon		Alan1	Alan2	Alan2	B2	B2	C11g	C11g	C12g
pH-KCl		4.7	3.8	3.9	4.3	4.3	4.7	4.8	4.8
		weight percents of air-dry soil							
Organic matter		4.8	6.3	6.1	1.6	2.6	0.4	0.1	0.2
Particles	0- 2 μm	3.5	-	4.4	-	-	-	2.7	2.4
Particles	0- 16 μm	6.7	5.6	6.1	3.1	3.0	1.9	3.5	3.2
Particles	16-2000 μm	88.5	88.1	87.8	95.3	94.4	97.7	96.4	96.6
		weight percents of the mineral fraction							
Particles	0- 2 μm	3.6	2.0	4.7	2.0	2.1	1.0	2.7	2.4
Particles	2- 16 μm	3.5	3.8	1.9	1.1	1.0	1.0	0.7	0.8
Particles	16- 50 μm	3.2	3.4	2.0	1.8	1.0	0.4	0.1	2.4
Particles	50- 75 μm	4.1	2.8	3.2	0.7	0.6	0.2	0.3	6.2
Particles	75- 105 μm	9.1	8.9	9.7	5.0	6.8	4.8	3.6	17.1
Particles	105- 150 μm	27.6	21.4	27.2	34.1	37.7	28.9	21.5	28.0
Particles	150- 210 μm	31.4	30.9	32.3	39.8	38.1	42.3	44.3	26.5
Particles	210-2100 μm	17.5	26.7	19.0	15.5	12.7	21.6	26.8	16.6
Median of sand fraction*(μm)		155	175	160	160	155	170	180	145