Netherlands Journal of agricultural Science
VOL. 3 No 1 FEBRUARY 1955

EXAMINATION OF SOILS AND CROPS AFTER THE INUNDATIONS OF 1st FEBRUARY, 1953 [1])

II THE INFLUENCE OF SALT ON THE CHIEF VEGETABLE CROPS

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SUMMARY

Inundation with salt water increases the common salt concentration in the ground water (C index), which, on the one hand, exerts a toxic effect on plant life, and, on the other hand, causes the structure of the soil to deteriorate.

The toxic effect finds expression in retardation of germination and growth, and in the death of part or all of the plant. Keeping qualities and, in some cases, taste, are also adversely affected.

The deterioration in the structure of the top layer of soil hinders the come-up of seed, especially as regards fine-seeded crops. Certain diseases are more virulent in salt soil than in normal soil.

Both in salt and in normal soils, the quality of the ground, preceding crop, tillage, etc., are reflected in the yields.

In the case of a certain C index the weather during the growing season is of great importance for the development of the crops. Since it is impossible to forecast this accurately over long periods, the advice given regarding the prospects for the crops to be grown on salt ground cannot be more than general instructions.

1 INTRODUCTION

On 1st February, 1953, many polders in Zeeland and northwest Brabant, and on the islands of South Holland, were inundated with salt water. When the waters finally went down, and the polders became dry again, the soil was more or less impregnated with salt.

This impregnation with salt is fraught with many problems for the cultivation of field and horticultural crops. These problems, however, were not enterely new, owing to experience acquired in previous floods, and in particular as a result of the inundations of 1944–1945.

In 1945, 1946, 1947 and 1948, VAN DEN BERG (1) investigated the reaction of field crops to the salt content of the soil in numerous trial fields. The results obtained in the trial fields were also checked by reference to data from practical agriculture.

Owing to this, a great deal of information was available, and use could be made of it in giving advice in the present case.

An impression of the sensitivity to salt of vegetable crops was obtained from numerous observations carried out by NOBEL (8) in 1916, 1917 and 1918, and by DORSMAN and WATTEL (3) in 1945, 1946, 1947 and 1948.

In contrast to the position with regard to field crops, however, no yield data were available in respect of horticultural crops grown on soils with varying contents of salt.

In 1953, this gap in the information was appreciably felt; and it was therefore decided to investigate in trial fields the reactions of vegetables to the salt content of the soil. The trial fields concerned, eleven in all, were located in various polders on the islands of South Holland.

[1]) Received for publication August 10, 1954.

2 The trial fields

A *Procedure, and operations carried out*

Each of the eleven trial fields was laid down in duplicate, and covered an area of about 0.1 hectare.

The arrangement of all trial fields was the same. The following crops were grown in duplicate in all of them:

spinach
kale (planted)
cabbage lettuce (planted)
savoy cabbage
leek (planted)
strawberries
kale (sown in situ)
French beans (dwarf type)
beet
celeriac
early potatoes
cabbage lettuce (sown in situ)
endive (planted)
cauliflower (planted)
savoy cabbage (sown in situ)
red cabbage (planted)
runner beans
cauliflower (sown in situ)
Brussels sprouts (sown in situ)
leek (sown in situ)
radish
purslane
chicory
winter carrots
Brussels sprouts (planted)
red cabbage (sown in situ)

The area of the plots varied from 10 to 25 square metres.

When planting or sowing was carried out, soil samples were taken from the 0–5 cm and 5–20 cm layers in the plots concerned, for investigation of the A, B and C indexes. (The A and B indexes give the number of grams of water and NaCl respectively per 100 grams of air-dry soil, and the C index gives the number of grams of NaCl per litre of soil moisture (1953)). In order to ascertain the connection between the salt content of the soil and the growth or yield of a crop, it is preferable to take the C index of the 5–20 cm layer, just before sowing. The layer from 0 to 5 cm is left out of consideration, because very rapid and great changes in salt concentration may occur in it. The C index of this shallow layer, may, however, be of importance for the germination of the seed.

When the above-mentioned connection is known, it is possible, by taking a soil sample just before sowing or planting, to ascertain what crops can best be cultivated there by reference to the result of the salt examination.

In order to obtain an idea of the depths to which the soil had been salinized, the 20–40 cm, 40–60 cm, and 60–80 cm layers were also sampled in three plots in each trial field.

From the salt index figures for these layers it was found that the soil in the deeper layers was not so strongly impregnated with salt (Table 1).

Table 1. C indexes for some trial fields.

	Date sampled	0–5 cm	5–20 cm	20–40 cm	40–60 cm	60–80 cm
Het Buitenland van Rhoon	25-4-'53	6.0	6.1	5.4	2.5	1.4
Zuidpolder (Barendrecht)	25-4-'53	5.6	3.5	3.0	2.5	1.9
Numanspolder (Numansdorp)	22-4-'53	6.4	4.8	4.2	2.8	2.8

These low figures in the subsoil are due to the fact that the soils in question were only flooded for a comparatively short time (two months).

This deep sampling was also carried out in July and October, so that data were also obtained regarding the trend of the salt content of the soil during the growing season.

From each trial field, a soil sample was also taken of the 0–20 cm layer for examination for pH (KCl), humus content, $CaCO_3$ content, granular composition, P number, P (citric acid extraction number), and potassium content.

The various data from the trial fields are given in Table 2.

In order to combat deterioration in structure, 200 kg of gypsum were strewn in April over every salt trial field. In addition, every chicory plot (25 sq.m.) was given an extra 25 kg of gypsum after sowing.

In May, all trial fields received 30 kg of nitro-chalk, while in July and August the crops were given an additional dressing of this fertilizer, according to their stand. Fertilization with potash and phosphoric acid was omitted. Disease control measures were carried out whenever necessary.

The development of the various crops was closely followed. Scenes characteristic of damage due to salt were photographed. Yields were determined in respect of each crop.

B *The development of the crops in the trial fields in 1953*

The germination of the seed. Seed germinates slowly in salt ground. In fact, the seeds of some crops do not germinate at all in the presence of a high salt content (3, 4, 5, 7).

In the trial fields the come-up of spinach, leeks and carrots, sown at the end of April, was bad at first. A considerable proportion of the seed did not germinate until after the large amount of rain at the end of May and the beginning of June had caused the C index of the layer in which the seed lay to fall to such a degree as to allow the seed to assimilate moisture. A sufficiency of rain after sowing is an important condition for good and uniform come-up of seed in salt ground.

Moreover, the structure of the shallow top layer of the soil must be satisfactory to ensure a good come-up of the seed, especially in the case of fine-seeded crops. By strewing gypsum over the seed bed it is possible to combat deterioration in structure to the maximum extent.

Planting. In 1953 the plants took root without difficulty.

Retardation of growth. The crops grew more slowly, so that they were only ready for harvesting at a date later than would have been the case had they been grown on normal soil. This might result in products being brought to market at a time when prices are low. The leaves remained smaller than in plants grown on normal soil, and were stiff and sometimes lumpy. The longitudinal growth of Brussels sprouts and kale was less than on normal soil.

Bolting. The high salt content of the soil stimulated formation of a flowering stalk (cabbage lettuce, spinach).

Colour. The leaves were generally dark green in colour. In the case of cabbage and leek, there was a blue sheen on the leaves (wax formation), especially in warm and dry periods.

Table 2. Various data

Trial field proprietor	Polder	Sampling date	A 0–5	C 0–5	A 5–20	C 5–20	A 20–40
Proefboerderij Westmaas ..... (Westmaas Experimental Farm)	Westmaas Nieuwland				Normal		
C. Groenenboom, Ridderkerk ..	Woude				Inundated with		
L. Hensen, Heinenoord	Minsheerenland van Moerkerken	23/4	14.8	2.2	25.7	1.5	25.4
S. van Bergeyk, Barendrecht ..	Zuidpolder	25/4	24.3	5.6	34.8	3.5	33.0
C. de Klerk, Heinenoord	Zomerlanden	24/4	22.7	5.8	36.6	4.0	31.3
R. L. v. d. Berg, 's-Gravendeel .	Nieuw-Bonaventura	24/4	15.9	8.1	23.4	4.7	23.1
L. D. v. d. Waal, Numansdorp .	Numanspolder	22/4	22.6	6.4	31.1	4.8	29.1
G. v. d. Ven, Rhoon	Molenpolder	25/4	12.1	15.1	20.9	5.6	22.5
Idem	Het Buitenland van Rhoon ..	25/4	17.7	6.0	26.8	6.1	27.0
P. Speelman, Zuid-Beijerland ..	Eendrachtspolder	21/4	20.2	9.3	23.5	8.0	24.3
Idem	Idem	21/4	15.9	5.7	23.1	4.9	26.0

D y i n g o f f. In the case of lettuce, endives and savoy cabbage, the edges of the leaves often died off; in the case of leek, the tips of the leaves sometimes died.

Highly salt-sensitive plants such as beans, peas and strawberries died off when the C index was still quite low.

C *The connection between salt indexes in the 5–20 cm layer and yields*

The results obtained from a specific crop on salt soils are not purely a matter of quantitative yields. Account must also be taken of quality (external appearance and taste), and, as regards certain plants, keeping properties as well.

Moreover, the duration of the growing period (earliness) is sometimes important for the financial results.

In Fig. 1 the yields in kg in the trial fields from French beans (dwarf type), a highly salt-sensitive plant, have been plotted against the C indexes of the 5–20 cm layer. Through the points a curve has been drawn freehand, which shows the connection between the above-mentioned quantities. The variation in the points in the case of a certain C index is due to the other factors which, in addition to the C index, also influence yields.

from the trial fields.

C 20–40	A 40–60	C 40–60	A 60–80	C 60–80	pH KCl	Humus %	$CaCO_3$ %	Sand > 90 μ	Sand 90–16 μ	Silt and clay < 16 μ	P number	P (citric acid extraction no.)	Potassium %	
					7.1	6.7	4.3	3	43	43	1.5	37	0.020	agricultural soil
fresh water					7.6	3.0	10.7	3	41	42	1.0	35	0.015	,,
1.2	26.4	0.8	25.8	0.6	7.25	3.0	3.2	7	36	51	2.5	70	0.032	horticultural soil
3.0	32.6	2.5	30.5	1.9	7.25	6.0	6.6	4	36	47	1.5	53	0.019	agricultural soil
3.7	26.1	3.1	28.2	2.6	7.45	5.8	6.2	14	39	35	4.0	118	0.049	horticultural soil
3.3	25.3	2.2	27.8	1.8	7.75	2.4	9.7	18	45	25	1.0	35	0.025	agricultural soil
4.2	28.7	2.8	26.8	2.8	7.5	5.6	7.9	9	43	35	1.5	55	0.020	,,
5.7	25.2	5.8	29.9	4.9	7.75	2.0	9.0	12	44	33	1.5	42	0.018	,,
5.4	28.1	2.5	32.9	1.4	7.75	3.8	8.2	5	42	41	1.0	42	0.025	,,
8.0	26.6	9.1	25.9	9.2	7.55	5.7	10.1	8	40	36	2.0	54	0.041	horticultural soil
3.3	28.1	2.7	31.9	2.8	7.45	2.8	8.8	7	36	45	1.5	58	0.046	,,

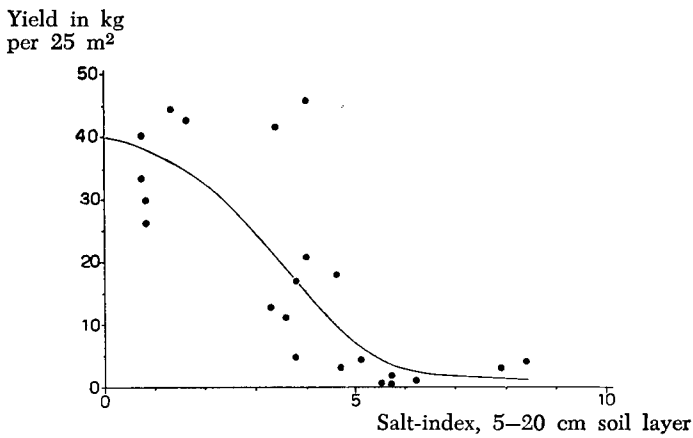

FIG. 1. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE YIELDS IN KG FROM FRENCH BEANS (DWARF TYPE), IN THE TRIAL FIELDS IN 1953.

A second example of the connection between salt index and yield is given in Fig. 2, where yields from a less salt-sensitive vegetable, savoy cabbage (planted), have been plotted against the salt indexes of the soil.

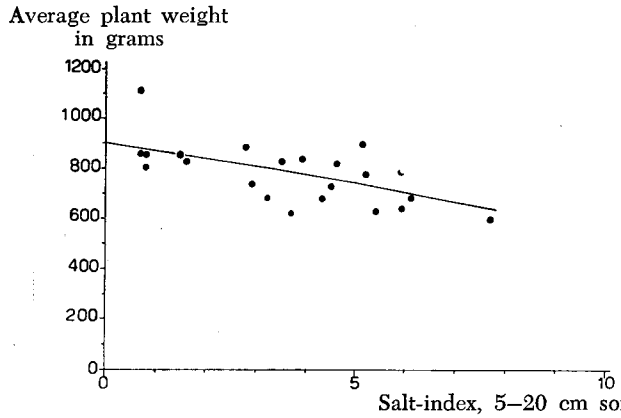

FIG. 2. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE AVERAGE WEIGHT PER HARVESTED HEAD OF SAVOY CABBAGE (PLANTED), IN THE TRIAL FIELDS IN 1953.

By allotting the nominal value of 100 to the average yields in kg of various crops on normal soil, it is possible to combine the yield curves in one collective graph, whereby it is also possible to compare the sensitivity to salt of the different crops.

In Figures 3, 4 and 5, this has been done for various vegetable crops from the trial fields.

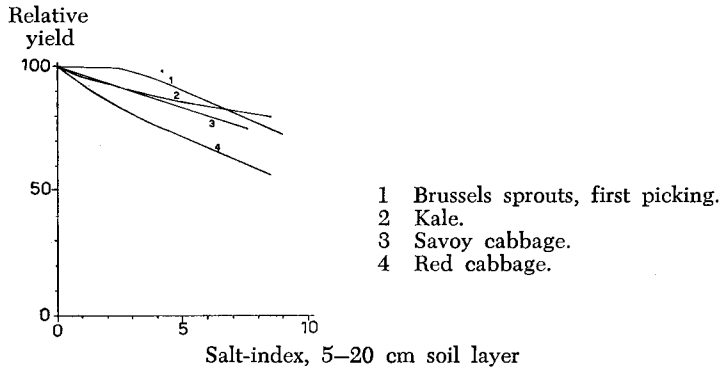

FIG. 3. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE RELATIVE YIELDS IN KG OF VARIOUS CROPS IN THE TRIAL FIELDS IN 1953.

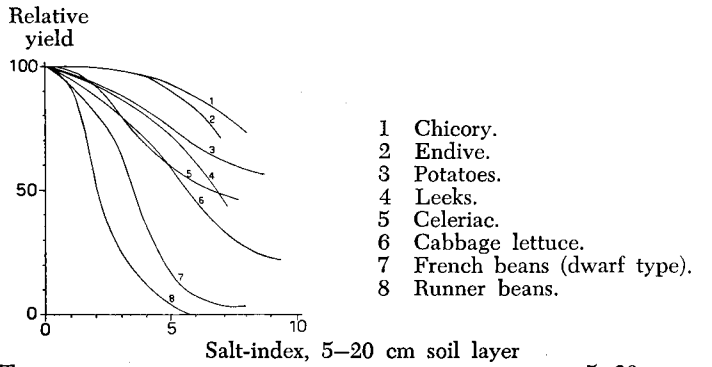

FIG. 4. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE RELATIVE YIELDS IN KG OF VARIOUS CROPS IN THE TRIAL FIELDS IN 1953.

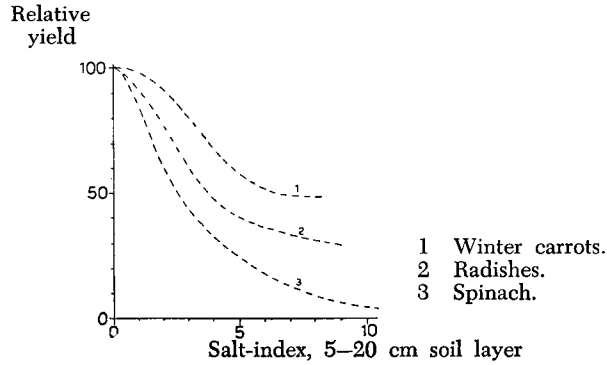

FIG. 5. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE RELATIVE YIELDS IN KG OF VARIOUS CROPS IN THE TRIAL FIELDS IN 1953.

In Figure 5 the yield curves are broken, to indicate that they do not purely represent the sensitivity to salt of the crops concerned. The low yields of these crops on soils with high C indexes are especially due to the poor come-up of the seed.

Results from planting leek, red cabbage, savoy cabbage, kale, Brussels sprout and cauliflower plants were compared in the trial fields with results from sowing seed directly on the spot (in situ). Only the results of planting are given in the collective graphs. Red cabbage is an exception to this, because the *planted* crop failed owing to attack by *Phoma lingam*. The cabbage in the control plots were also attacked, and consequently infection had probably taken place even before planting.

The difference in results between planting and sowing directly in situ was slight in the case of the cabbage varieties. The cabbage sown immediately in situ suffered an attack by flea beetle shortly after coming up. At harvest time, the percentage of loose sprouts was greater in the case of the Brussels sprouts sown immediately in situ than in the case of the planted ones. Brussels sprouts could only be picked once, as the trial fields had to be ploughed again in the autumn.

Owing to poor come-up, results from the leeks sown immediately in situ were inferior to those from the planted leeks. The leeks were harvested in November. If harvesting had taken place in the spring, the harvest depression would probably not have been so great, owing to the favourable effect of the autumn and winter rains.

The chicory roots in the trial fields were forced in the autumn of 1953 by heating the soil electrically. If the yield curve of chicory (Fig. 6) is compared with the yield curve of carrots (Fig. 4) the course of both curves will be seen to be approximately the same.

There is therefore little difference between the yields in kg of heads of chicory forced from roots which have grown in salt soil, and from roots growing in normal soil. This is also the case as regards the quality of the heads.

The cauliflower crop failed in the trial fields. Under practical agricultural conditions, spring cauliflower has produced reasonable results on soils with a C index of up to 4 when pot plants were used and planted early. In the case of the autumn crop, the selections from the Italiaanse Reuzen group were the most satisfactory. Spring cauliflower should not be used.

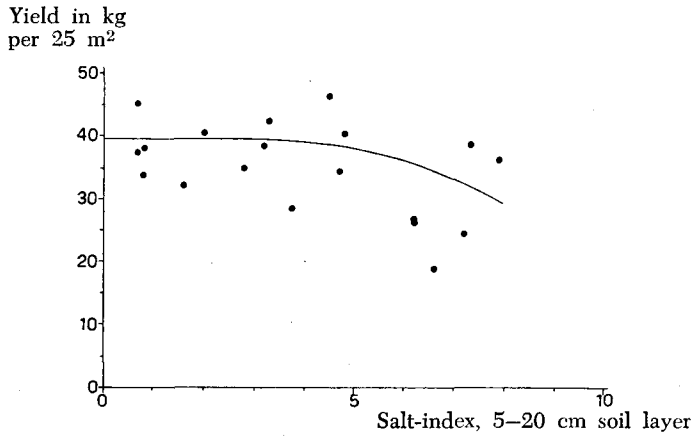

FIG. 6. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE YIELDS IN KG OF CHICORY (HEADS) FROM THE TRIAL FIELDS IN 1953.

In the trial fields, all strawberry plants planted in soils with a C index greater than 2 died.

It has already been said that, as regards vegetables, not only the quantitative yield, but also the quality, is of importance. Accordingly, some brief notes are made below about the quality of the products.

Lettuce, endive and, to a lesser degree, savoy cabbage, are susceptible to what is known in the Netherlands as "randen" (tipburn) – a brown discoloration of the borders of the leaves which often manifests itself in crops grown in areas that have been inundated by salt water.

In Figures 7, 8 and 9, the connection between tipburn and the C index of the above-named crops has been represented in the form of a graph.

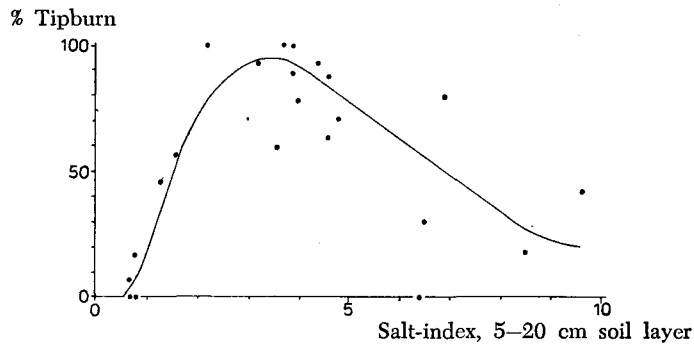

FIG. 7. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND TIPBURN IN CABBAGE LETTUCE, IN THE TRIAL FIELDS IN 1953.

In the presence of high C indexes tipburn in lettuce decreased again. With these C indexes the plants grew slowly, remained small, and developed, for the most part, a flowering stem without forming a head.

The quality (taste) of potatoes is adversely affected by salt. Cultivation of potatoes on soils with a C index higher than 3 must therefore be avoided.

Owing to their slow growth the products cannot be harvested until later

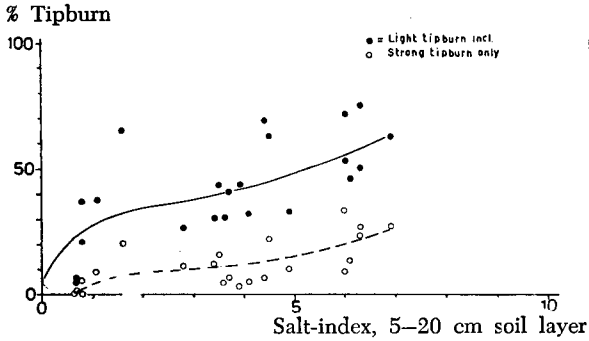

FIG. 8. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND TIPBURN IN ENDIVE, IN THE TRIAL FIELDS IN 1953.

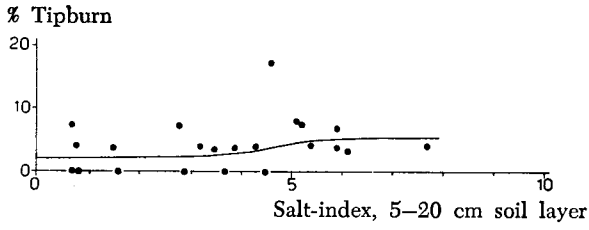

FIG. 9. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND TIPBURN IN SAVOY CABBAGE.

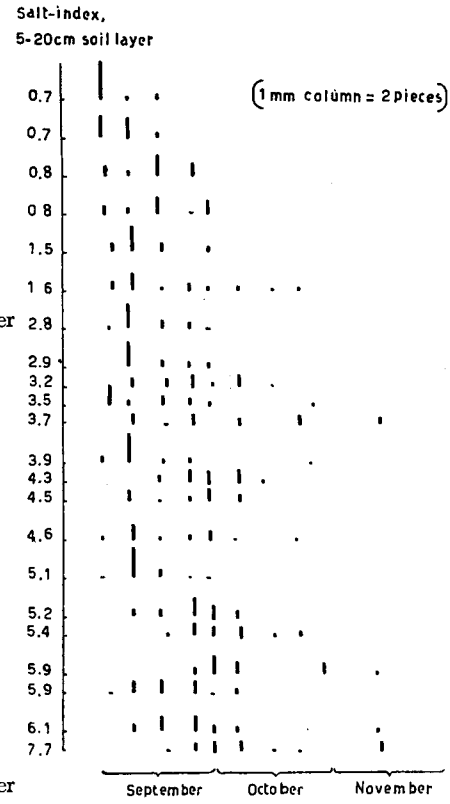

FIG. 10. THE CONNECTION BETWEEN THE SALT INDEXES OF THE 5–20 CM LAYER AND THE EARLINESS OF SAVOY CABBAGE, IN THE TRIAL FIELDS IN 1953.

than would have been the case on normal soils. In Fig. 10, the number of savoy cabbages harvested per plot is shown in respect of every harvesting date.

In the trial fields high A indexes from the 5–20 cm layer were favourable to the development of various crops, especially leafy crops. Fig. 11 shows the connection between A figures and the yield in kg of planted kale.

3 THE INFLUENCE OF SOME OTHER FACTORS ON THE RESULTS

The yield from a crop on salt soil is not determined solely by the salt content of the soil. There are various other factors which have an effect on yield. These factors are:

A *The weather.* In the reaction of crops on salt soil a great deal depends on the weather that follows sowing or planting. Owing to the fact that, in the summer months, evaporation exceeds precipitation, the C index of the 5–20 cm layer will generally rise in those months (9).

Under conditions of drought and high temperature crops are more sensitive to salt than under conditions of great precipitation and low temperature (1, 3, 4, 5, 7). This is probably connected with transpiration by the crop.

Results will therefore be better in summers with much precipitation than in dry summers.

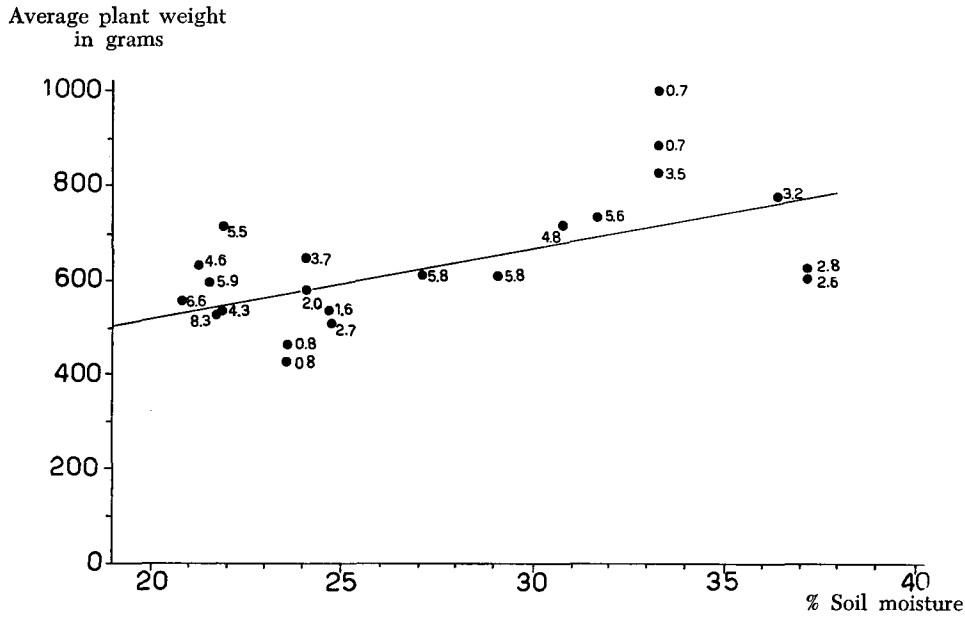

FIG. 11. THE CONNECTION BETWEEN THE MOISTURE FIGURES (A) OF THE 5–20 CM LAYER AND THE AVERAGE YIELD PER PLANTED KALE PLANT IN THE TRIAL FIELDS IN 1953. THE FIGURES BESIDE THE POINTS REPRESENT THE C INDEX OF THE 5–20 CM LAYER.

Comparison with the average for the whole of the Netherlands for the years 1911–1950 shows that, in 1953, precipitation was below normal in the spring and above normal in the months of June, July and (especially) August. The amount of precipitation in the autumn of that year was abnormally low.

The average daily temperatures differed only slightly from the averages for the country for the years 1911–1950.

The C indexes of the 5–20 cm layer not only did not rise in the summer of 1953, but even showed a decline (Table 3).

Table 3. C indexes for the 5–20 cm layer on various dates.

	April	July	October
Het Buitenland van Rhoon	6.1	6.1	2.6
Zuidpolder (Barendrecht)	3.5	2.7	1.6
Numanspolder (Numansdorp)	4.8	4.5	2.9

The trend of the C indexes for this layer (see Table 1) was influenced, not only by the rainfall, but also by the C indexes of the deeper layers.

B *The quality of the soil.* The quality of the soil has an important bearing on the results to be achieved in salt soils as well as in normal ones, especially when the crops concerned are not highly sensitive to salt anyway. Given the same C indexes, results in soil with a high A index were better, as a rule, than in soil with a low A index.

If the content of leachable particles is approximately the same in two or more soils, the difference in A index will be determined, in particular, by the humus content. In Fig. 12 the A indexes (5–20 cm) of the trial fields have been plotted against the humus content (0–20 cm).

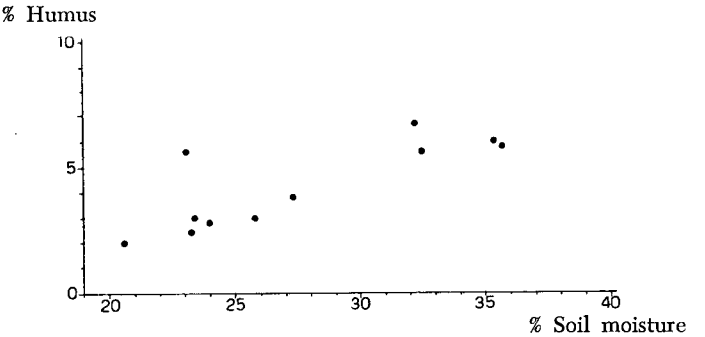

FIG. 12. THE CONNECTION BETWEEN THE HUMUS CONTENT AND THE MOISTURE CONTENT OF THE SOIL.

The greater the humus content of the soil the higher the A index will be, but, in addition, the less the soil will suffer from deterioration in structure. Accordingly, the superior development of crops on salt soils with a high A index should not be attributed only to the high water content; the structure of these soils is also good. Moreover, when the soil's structure is bad the come-up of the seed is often unsatisfactory – which, in itself, will seriously depress harvest results. Differences in nutritive condition, tillage, previous crop, profile, etc., will be reflected in yields from salt soils, just as they are reflected in yields from normal soils.

C *The varieties.* A difference in sensitivity to salt may exist between the varieties of one plant. DORSMAN and WATTEL (1951) recommend that only the variety Tussensoort should be used in autumn cultivation of cauliflower. As regards potatoes, VAN DEN BERG (1951) found that the variety Bintje was more sensitive to salt than Bevelander or Eigenheimer. A difference in reaction was also detected between barley varieties. American writers also report differences between varieties as regards sensitivity to salt (4, 5, 6).

No comparison of varieties was carried out in the trial fields during the present investigation.

D *Sowing and planting time.* In salt soil cauliflower has most chance of succeeding when grown as a spring or autumn crop. If planted early, it can be harvested before the salt rises to any great extent. When planted in the autumn, the crop can profit by the desalting effect of that season's rains. For the same reason endive on salt soil can only produce a reasonable yield in the autumn. Endive sown as a summer crop is very prone to develop "edges". Generally speaking, it can be said that the risk of damage by salt is greatest in the summer months.

E *Diseases.* Owing to the deterioration in the soil's structure some diseases occur to a greater extent in salt soil than in normal soil (3). In the salt trial fields cabbage crops suffered more than usual from black leg (*Phoma lingam*).

Beet sometimes exhibits a poor stand owing to Black Leg; spinach is more susceptible to Colletotrichum spinaciae, carrots to Alternaria radicina.

Good disinfection of seed is of great importance when planting in salt soils.

4 Conclusions

Figures 3, 4 and 5 will give an idea of the sensitivity to salt of the various crops, in which connection, however, their table quality (appearance and taste), conservability, and "earliness" must also be borne in mind.

It is difficult to state the limit (C index) at which cultivation on salt ground is still worth while.

As has already been said, the yield from a crop in salt soil is not determined only by the C index. For instance, the weather during the growing season is of great importance to the development of crops in such soil. This, however, cannot be predicted far in advance; and consequently yields may exceed or fall short of expectations.

As regards weather conditions during the growing season, 1953 was a fairly average year. This enhances the value of the trial field results, because advice given concerning cultivation in salt soil must be based on the assumption that the weather will be normal during the growing season.

With a certain C index, yields on good soil will be higher than on poor soil. Varieties may differ as regards sensitivity to salt.

The above-mentioned limit (C index) also depends on the price the product commands (e.g., duration o fthe growing period — earliness). This price may fluctuate considerably as regards certain vegetables. Accordingly, in giving an account of the prospects of crops to be grown in salt soil, normal conditions must be assumed as a basis.

If the results achieved by practical agriculture in growing crops on salt soil are also taken into consideration, the following critical C indexes for the 5–20 cm layer (during sowing or planting) may be used as a standard when dealing with the crops in question.

In giving these figures, the above remarks concerning the need for satisfying requirements as to quality, conservability, etc., have been, as far as possible, borne in mind. Furthermore, in the case of each crop, observations are added which are of value in connection with cultivation in salt soil.

Purslane, C 5–20: *10.* Good horticultural soil (good structure) is required.

Beets, C 5–20: *9.* In salt soil beets may develop well. To ensure a good come-up gypsum must be strewn over the seed bed, especially on soils of inferior structure. The development period, however, lasts a little longer, so that early beets have to be harvested rather later than usual.

In 1953 the yield from early beets was poor.

Autumn beets should not be sown too late. Winter beets from salt soil do not keep very well, for which reason cultivation of this crop is not considered advisable.

It is necessary to disinfect the seed, owing to the occurrence of black leg.

Radishes, C 5–20: *8.* When the salt index is fairly high, it is only possible to grow radishes on good horticultural ground. The foliage remains somewhat shorter than usual.

Kale, C 5–20: *8.* Kale may develop well in salt soil. The plant remains rather lower than usual.

Chicory, C 5–20 : *6.* Chicory is a fine-seeded plant. When the structure of the soil is poor, difficulties may be experienced with the come-up. On account of this, gypsum must be strewn over the seed bed. Early sowing is necessary, to ensure that there is a chance of sowing seed again in the event of failure. The soil must be well drained, in connection with the occurrence of violet root rot (*Rhizoctonia crocorum*).

Chicory roots from salt soil are often slightly weaker than roots from normal soil.

Spinach, C 5–20 : *6.* For the cultivation of spinach in ground with a high C index a good horticultural soil is required, especially with a view to a good come-up. Spinach develops more slowly in salt soil than under normal conditions.

Autumn cauliflower, C 5–20 : *6.* A selection from the Tussensoort group is recommended as autumn cauliflower. These selections are characterized by a longer period of development, and must therefore be planted early. In 1953, selections from the Alpha group were found to be much more sensitive to salt than those from Tussensoort.

Green savoy cabbage, C 5–20 : *6.* In growing green savoy cabbage account must be taken of the fact that autumn cabbage is more sensitive than the winter-hardy type "putjeskool", which is harvested later and benefits by the desalting effect of the autumn rains.

Brussels sprouts, C 5–20 : *6.* If Brussels sprouts are to be cultivated on salt soils the structure of the soil must be good. Brussels sprouts on salt soil are more susceptible to the fungus *Phoma lingam,* which causes black leg. Owing to the risk of infection by this fungus the plants must be put into the soil immediately after lifting for transplantation. The seed will have to be disinfected. The plants remain rather shorter on salt ground.

Leek, C 5–20 : *5.* On account of difficulties with the come-up of seed, it is advisable to sow the planting material in normal soil.

Carrots, C 5–20 : *5.* Cultivation of carrots is justified on the lighter soils. On the heavier soils the come-up of seed is greatly hampered by deterioration in the structure of the top layer. To ensure a good come-up on the lighter soil gypsum must be strewn over the seed bed.

Red cabbage ("weeuwen" *), C 5–20 : *4.* The cabbage remains rather smaller than usual. The crop is more susceptible to the *Phoma lingam* fungus which not only causes blackleg in red cabbage, but also what are known as "canker stalks" (see further under "Brussels sprouts").

Cauliflower ("weeuwen" *), as pot cauliflower, C 5–20 : *4.* In 1953 it was found that, when growing early cauliflower, the best results were obtained froom pot plants.

Celeriac, C 5–20 : *4.* This crop is not so easily damaged by salt. The root remains somewhat smaller than usual.

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*) Plants planted in the autumn, in sheltered spots or in boxes, where they pass the winter. This manner of planting enables them to develop early in the spring and be harvested early.

Endive, C 5–20 : *3*. Cultivation of summer endive in soil with this C index is not advisable, owing to the danger of "edges". Cultivation of autumn endive is practicable on good horticultural soil.

Early potatoes, C 5–20 : *3*. Cultivation of early potatoes on salt soil is certainly possible. In 1953, however, potatoes brought to auction from salt polders fetched a lower price owing to their inferior quality.

Cauliflower (spring), grown as "trapkool", C 5–20 : *2*. Cauliflower planted in the spring without a clod of earth from the pot round its roots yielded results in 1953 which were considerably less good than those from pot cauliflower.

Red cabbage (keeping), C 5–20 : *2*. The danger of blackleg and canker stalks has already been pointed out when dealing with red cabbage as a "weeuwen" crop. In addition, the possibility that the cabbage will be less easy to keep must also be taken into consideration.

Dwarf and runner beans, C 5–20 : *1.5*. Dwarf and runner beans are highly sensitive to salt in the soil and to inferior soil structure.

Strawberries, C 5–20 : *1.5*. When planting strawberries account must be taken of the fact that the young plants are highly sensitive to salt and to poor soil structure.

Cabbage lettuce, C 5–20 : *1*. Cabbage lettuce grown under normal conditions often exhibits defects (e.g., "edges"). The danger will be greater in soils which have been inundated with salt water.

These critical salt indexes are found to correspond fairly well with those of DORSMAN and WATTEL (1951). But the critical C indexes of the crops least sensitive to salt (which include kale), as found in the trial fields in 1953, are higher than those found by DORSMAN and WATTEL, so that a wider range of tolerances is obtained.

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