Data Concerning the Influence of Climate and Human Activity on the Dynamics of Salts in the Region East of the River Tisza

by

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Adatok a klíma és az emberi tevékenység befolyásáról a talajok sódinamikájára a Tiszántúlon. Az emberi tevékenység és a talajok sódinamikája közötti kapcsolat vizsgálatát tiszántúli kötött szikes talajokon természetes (öntözés nélküli) viszonyok között folytattuk.

A mintegy 2000 talajminta analízise alapján a következőket állapítottuk meg:

1. A talajokban történő sóvándorlást a csapadék, a párolgás és a talajvízszint a talaj mechanikai és kémiai összetételétől, valamint a mélységtől függően egymással összhangban irányítják.

2. A „kritikus mélység" körüli talajvízállásnál a mélyművelés, a 60 cm mélységre történő talajlazítás sómobilizáló befolyása nagyobb, mint a sekély talajművelés, a 15 cm-es szántás sómozgató képessége.

3. Hatásban az előbbieket a kémiai és fizikai (műanyaghab) javítás követi. Ezek befolyása elsősorban arra a talajrétegre szorítkozik, amelynek megjavítására szolgált.

4. A kémiai és fizikai javítás a befolyásuk alatt levő talajrétegekben a sók mozgását struktúra javító hatásuk következtében fokozzák, míg a javítatlan talaj csökkenti.

5. A fizikai javító anyagok, a poli-stirol, a poli-uretán habok a kémiai javító-anyagok hatását még növelik.

6. A "kritikus mélység„ feletti zónában levő talajvízszint a feltalaj sómozgását helyzetének megfelelően — a csapadékkal és a párolgással összhangban — irányítja. Magas talajvízállásnál a sómaximum feljebb, alacsony talajvízállásnál pedig lejjebb található.

7. A szikes talajok tulajdonságától függően javításukat talajlazításnak kell megelőznie. Az oldható sók kilúgozása ezáltal fokozódik, s ez a *talaj javulását nagy mértékben segíti.*

Angaben zum Einfluss des Klimas und der menschlichen Tätigkeit auf die Salzdynamik der Böden in dem Gebiet östlich von der Theiss. Von den Verfassern wurde eine Untersuchung bezüglich des Zusammenhanges zwischen der menschlichen Tätigkeit und der Salzdynamik der Böden durchgeführt, undzwar in der Region jenseits des Flusses Tisza in sodahaltigen Böden unter natürlichen (unberieselt) Umständen.

Auf Grund der Analyse der etwa 3000 Bodenproben kann folgendes festgestellt werden:

1. Die in den Böden vor sich gehende Salzmigration wird vom Niederschlag, Verdunstung und Grundwasserniveau, in Abhängigkeit von der mechanischen und chemischen Zusammensetzung des Bodens, sowie von der Tiefe im Zusammenhang miteinander determiniert.

2. Bei einem um die „kritische Tiefe" liegenden Grundwasserstand ist der salzmobilisierende Effekt der tiefen Bodenbearbeitung, die bis zur Tiefe von 60 cm hinabreichende Bodenauflockerung grösser als die salzbewegende Fähigkeit der seichten (bis zu 15 cm reichenden) Pflugarbeit.

3. Bezüglich der Effektivität folgt nach den obigen die chemische und physikalische (Kunststoffschaum) Amelioration. Ihr Einfluss beschränkt sich vor allem auf die zur Amelioration vorgesehene Grundschicht.

4. Von der chemischen und physikalischen Amelioration wird in den von ihnen beeinflussten Grundhschichten die Salzbewegung, infolge ihrer Strukturverbessernden Auswirkungen gesteigert, während sie vom nicht ameliorierten Boden wegen dem Mangel der obenerwähnten Einflüsse vermindert wird.

5. Von den physikalischen Ameliorationsmaterien — Poly-Stirol- und Poly-Uretanschaum — wird die Wirkung der chemischen Mittel noch gesteigert.

6. Das sich in der über „kritischen Tiefe„ liegenden Zone befindliche Grundwasserniveau determiniert gemäss seiner Lage und im Einklang mit dem Niederschlage und Verdunstung die

Salzmigration des Obergrundes. Bei einem höheren Grundwasserstand liegt das Maximum höher, bei einem niedrigen niedriger.

7. Bei natronhaltigen Böden muss, in Abhängigkeit von ihrer Beschaffenheit, bevor ihrer Amelioration eine Bodenlockerung vorgenommen werden. Die Auslaugung der löslichen Salze wird hierdurch gesteigert, was zu Amelioration des Bodens sehr bedeutend beiträgt.

In the regions beyond the river Tisza investigations were carried out on connections between human activity and the salt dynamics of unirrigated alkali soils.

On the basis of the analysis of about 2000 soil samples the following could be stated:

1. The salt migration in the soils are determined by the precipitation, evaporation and groundwater level in concordance with each other and depending on the mechanical and chemical composition of the soil and also on the depth.

2. With a groundwater level about the „critical depth" the salt mobilizing effect of deep tillage, the subsoiling to the depth of 60 cm is more intensive than salt mobilizing effect of shallow tilling, the ploughing to 15 cm depth.

3. As to the effectivity the above factors are followed by chemical and physical amelioration (plastic foam). Their influence is restricted mainly on the layer envisaged to be ameliorated.

4. Chemical and physical amelioration increase the salt migration in the respective soil layer (on account of their structure-ameliorating effect) while the unameliorated soil will, in want of such effects exert a decreasing influence.

5. The physical ameliorating material — poly-stirol and poly uretan foams — will even contribute to the effect of the chemical factors.

6. The salt migration of the surface soil is determined — in accordance with its position — by the groundwater level situated in the zone above the „critical level" (in conformity with the precipitation and evaporation). With a high groundwater level the salt maximum is to be found higher and with a lower one lower.

7. Depending on the qualities of alkali soils their ameliorations is to be begun with subsoil work. The leaching of soulbe salt will be thus increased which greatly contribute to the amelioration of the soil.

The accumulation of water-soluble salts in the soil results in crop failure. The main cause of the decrease of crop is the excessive amount of sodium ions in the soil solutions and chemical bond. This is, unfortunately a rather frequent phenomenon in this country, owing to its basin-character and other conditions. Alkali soil amounts to about 1/2 million hectares in Hungary and this is why steps must be taken against the alkalisation of additional territories and ameliorations have to be undertaken in the existing soils.

Under average climatic conditions the migration of soil salts takes place periodically also in this country. In winter the soil salts are washed out from the soil profile while in summer they will accumulate there.

The dynamics of soil salts are determined, under unirrigated conditions — by three factors:

1. precipitation,
2. evaporation,
3. ground water level.

With the progress of civilization the soil dynamics is more and more influenced by man as a soil forming factor. Such human activity is e.g.:

a) the cultivation of soil,
b) chemical and physical soil amelioration.

Introduction

In the formation of alkali soils of the region beyond the river Tisza the main role, from among the soil forming factors was played by the climate and geological factors. The first one includes the amount and distribution of precipitation, the water vapour content of the air, wind conditions and temperature. To the second group belong the conditions of the soil, its mechanical texture, the salt conditions and hydrological conditions.

Thus from the aspect of salt migration and alkalisation the groundwater level is a criterion.

Groundwater tables under 4 metres are practically of no effect whatever on the upper soil layer.

On the other hand, — depending on the texture of soil and the salt content of the groundwater the surface evaporation may already be nourished by the capillarity zone lying at a water-level of about 1—3,5 m. Thus in this case the soil may be alkalinisated by the concentration of dissolved salts and an accumulation of salt may arise [9, 15, 8].

The depth from which the water soluble salts may get to the surface or near to the surface by capillary rising is called "critical ground water level".

The salt dynamics of the soil has been in detail investigated by *Darab* [4] and *Szabolcs* [12] concerning the region beyond the river Tisza, while that of the region between the rivers Danube and Tisza by *Várallyay* [14].

Methodics

Determination of the total salt percentage of soil samples taken by 10 centimetres from parallelly drilled profiles of soil. Statistical evaluation of them according to natural factors, — precipitation, ground water level, and also according to human intervention, — soil-amelioration, subsoiling [5].

Investigating of connections between the fluctuations of water table and the migration of soil, on the basis of reading of (by 14 days) the groundwater registrating wells.

The percentage of total salt has been determined on the basis of the electric conductivity of soil paste. The investigations were carried on in heavy sodic soil in parcels of 50—60 m^2 in the region beyond Tisza.

In our observation series of 180 years no precedent has been found to the repetition of the value of any climatic element in any one of the years. However, certain laws can be found if comparing their connections with each other and the factors forming the climate.

In the course of the past decades a considerable development has been achieved in climatology through the scientific results in the field of singularity, macrosynoptic processes, statistics made on the basis of the air-masses' calendars and the isoplethe representation of the annual fluctuations of the different elements. [3, 10, 2, 1].

In the present short work the authors do not intend to deal in detail with the individual climatological elements since that would lead to a deviation from their task, so that only precipitation and evaporation are investigated being factors of the first order from the aspect of salt migration in the soil.

In this country — like in many other ones the climatic elements are generally satisfactory for the requirements of plant cultivation. It is proved by many years' experience that the production results of agriculture is decided mainly by the conditions of precipitation. However, for getting a complete survey of precipitation conditions the conditions of the other climatic elements too, must be clearly seen, and, in addition, also the connection between these climatic elements and the precipitation. The evaluation and application of the results to be found in older references is not undertaken here.

1. Charts representing the territorial distribution of precipitation, both for the whole year and for the summer half year, are generally known. From them one may read off the distribution of precipitation — as determined from observations up to the present. On the basis of the measurements of the stations it has been found that the dryest part of Hungary (with a precipitation amount of less than 500 mm) is Hortobágy, further a region of the length of about 50 km and the width of 20 km extending from Szolnok to Szarvas, and also the environment of Kunszentmárton. In the rest of the country the precipitation amount is more favourable. At the borders of plains a rise of the precipitation amount is to be observed and so the isohyethe can be found mainly along the bordering lines of the lowland and the mountains or hilly regions respectively. In the Great Hungarian Lowland, along the upper reach of the river Tisza and eastwards from there amounts of more than yearly 600 mm are to be found, obviously as an effect of the proximity of the Carpathian Mountains. In the regions of the mountains Börzsöny, Mátra, Bükk and Zemplén the annual amount is exceeding 700 mm. A similar situation is to be found in the south counties of Transdanubia with even more than annual 800—900 mm in some places like Farkasgyepű, Bakonybél, Borzavár, Sopron and Kőszeg.

The air-lifting effect of the hills and mountains results in an increase of the precipitation amount at the higher level since the horizontal air currents are forced into the height. Ascending air masses cool down at a rate of 1 ° per 100 m and so, depending also on other circumstances, the condensation process will take place more rapidly, the cloud formation will increase and so of course the precipitation. Similar conditions do not occur in lowlands. The configuration of the terrain is of such an importance that in some territories the precipitation conditions will be generally a function of the height above sea level. The connection between precipitation and the height above sea level has been proved, on the basis of 50 years' average by Hajósy (Table 1.)

Table 1

Connection of the annual amount of precipitation with the height above sea level (after Hajósy)

Height m	*100*	*150*	*200*	*300*	*400*
Great Hungarian Plain	545	560	—	—	—
Kisalföld	580	620	—	—	—
Transdanubia	650	670	690	700	720
Northern Mountains	545	575	590	650	700
	560	600	650	680	710

The difference may be explained by the different properties of the air of the individual regions and by the special variations of the air masses streaming there. The interaction of the local and arriving air masses varies from region to region. In the eastern territories continentality is prevailing.

The seasonal variations, the yearly tendency of precipitation, storms and hails, the daily march of precipitation and also the evaluation of snow-falls and passages of front have been neglected.

The number of days with precipitation — the averages of many decades — area, as a result of the work of Hajósy, at our disposal concerning the whole territory of the country and thus the frequencies of daily precipitation amounts attaining and going beyond 1 mm, 5 mm, 10 mm and 20 mm are also known. On the basis of the data concerning the frequencies of days with precipitation it can be established, according to 50 years' average that in the course of a year 120—160 days with precipitation can be expected. The most days with precipitation occur in December and the least in July to September. Generally at the end of winter a second minimum and in spring a second maximum can be observed while the autumn maximum appears sometimes only in December. When analysing the singular precipitation tendency of the calendar days it may be seen that the precipitation-probability of the individual days shows values in the beginning of summer (June) rivalling those of December. In the group of precipitation up to 1 mm in the spring maximum even that forges ahead; the frequency distribution of days with abundant precipitation shows yearly one important wave with a May—August maximum and a January—February minimum, which follows from the smaller vapour capacity of the cold air and partly also from the development of summer and winter monsoons.

As to the variation of the conditions of soil surface only some commentaries are given. Dry soil surface can be expected in yearly averages in 180 days, wet in 100—110 days and surface covered with snow and ice in 50—60 days. Dry surface occurs the most frequently in the second half of summer, wet one in autumn and those with snow and ice in January. The autumn frequency of wet surface indicates that the energy of insolation and the snow stored in the soil are not sufficient for the evaporation of the moisture of the surface while in summer even more than the disponible amount could be evaporated from the surface.

2. Within the theme of evaporation the circumstances and factors are to be shortly analysed causing a decrease (in mm/time unit) of the level of a water layer with a free surface.

The instruments of *Wild* and *Piche*, used up to the present in climatology are not suitable for determining the water amount actually evaporated from the surface: the values obtained by the instruments express the evaporating disposition of the existing atmospheric conditions and atmospheric processes respectively.

The evaporation, if considered as an amount, is of microclimatological character because it depends on several circumstances the complex of which show differences almost at every cm^2 of the surface of the soil. Influencing factors in the evaporation are: water temperature, air temperature, humidity, radiation and wind. In addition to the above, there is one more factor in the actual evaporation: the presence or absence of the evaporating water, thus giving a proof of its microclimatological character. The actual evaporation is measured with lysemeters but its determination, climatological evaluation, is more complicated than that of evaporation. Thus instead of measurements, attempts were undertaken to determine the actual evaporation by the aid of calculations and estimates.

Measurements of the evaporation are carried on in this country since 1875, by using *Wild's* evaporimeter. However, on account of the different microclimates of the meteorological stations the series of measurements are not homogeneous and thus unsuitable to give a general survey for the country. The analysis of such series enable us only to investigate the annual march (Table 2).

From the data of evaporation doubtless air temperature and relative air humidity are the influencing factors.

When comparing the effect of wind and humidity it can be seen that the evapotranspiration of April is almost the double of that of October although the mean temperatures of those two months are almost identical. From this it appears that the devia-

Table 2
Evaporation amounts in mm-s in the average of 16 years (1929—1944).

	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII	Year
Kecskemét	11	19	48	70	86	95	103	82	61	41	23	14	653
Túrkeve	11	15	35	55	67	71	83	70	51	34	15	14	521
Debrecen	11	17	37	65	81	83	90	77	54	38	21	14	588

tion of the evaporation capacity may be caused by the difference of air humidity and wind.

Considerable efforts have been made to determine the evaporation by means of computations. So we have the equations of *Bacsó* and *Ubel* but they are valid only for a given place and for the given instrument. For another places and instruments empirical constants are required.

A most simple and practical method for the measurement of the actual evapo transpiration and for the determination of the water amount of the soil has been elaborated by *Dunai, Posza,* and *Varga.*

The factors influencing evaporation are: the disponible water (w), the porperties of the evaporating surface (water, soil, plant) (F) and the evaporation capacity of the air (E_0).

$$E = f(w, F, E_0)$$

Under conditions when two of the above three factors do not change, the third one can be determined. Thus E_A the evaporation of the pan "*A*":

$$E_A = f(E_0)$$

In measurements the evaporation pans type "A" are used all over the world so that comparisons can be made between the results obtained by different countries.

In the course of the investigations carried out in Szarvas the authors have shown that the evaporation values of pan "*A*" can be computed on the basis of air temperature and saturation deficit.

The air temperature has been substituted by the saturation vapour pressure (E) and the saturation deficit ($E-e$) expressed as follows:

$$E_A = \frac{E(E-e)}{E+(E-e)} \text{ mm/day}$$

Thus the evaporation capacity may be computed:

$$E = \frac{1-f}{2-f} t$$

$f = \frac{e}{E}$ ("e" is the actual -, "E" the saturation vapour pressure)

E_0 evaporation capacity of the air,
E_A quantity of the evaporated water
E evaporation value

All of the above three factors are practically of the same value. Having at our disposal the percentile values of relative humidity and the values of mean temperature the evaporation can be determined in the form of mm/day.

3. With a view to evaluate the investigations concerning salt-dynamics wells have been built for the registration of ground water level. These wells can be divided into two groups. The first three ones (No-s 1, 4 and 7) are situated at a distance of about 500, resp. 850 metres from an artificial fish pond. The other two wells (No-s 12 and 13) are at a distance of 50, resp. 100 m from the abovementioned pond.

The water-level variations of these belonging to the first groups are more equal, they show less oscillations. At the time of the observations they were about 2 metres. The variations of the water level were directly not influenced by the pond.

In the case of the nearer registration wells the case is different. The mean water level of them was about 1/2 m higher and that was to be ascribed to the presence of the fish pond (*Fig. 1*).

The water level of the well being nearest to the pond (See *Fig. 1.* No. 12, within 50 m); line marked with triangles) depends on the water level of the fish pond. That manifested itself in an increase of the water level of the registration well after filling up the artificial pond with water of after abundant rains (*Fig. 1*).

In contrast to well No. 12 the water level variations of No. 13 (situated somewhat farther: within 100 m) were influenced first of all and more considerably by precipitations above 10 mm. This may be seen in *Fig. 1* (line marked with circles) where the sudden rise of the precipitation diagram is exactly followed by the rise of the groundwater level.

In the oscillations of the registrating wells No. 1, 4 and 7 the effect of the abovementioned large rains too, can be observed, apart from the seasonal variations determined by their position. Of course in a smaller measure than in wells with a high water level.

The seasonal water level oscillations are more characteristic in the wells situated farther from the pond (No-s 1, 4 and 7). In this case the phenomenon could not have been disturbed by the water in the pond and the precipitation [7].

The somewhat differring water level of wells No. 1, 4 and 7 comes from the different mechanical composition of the respective soil layers.

In order to examine the effect of the abovementioned human activity the investigations of salt dynamics in alcalic soil were divided into two parts:

Observations A) *concerning the groundwater level about the "critical depth"*;
Observation B) *observation of salt migration in depthshigher than the critical one.*

A. Analyses with groundwater levels near the critical depth

The salt migration examinations (shown in *Fig. 2*) were carried out in the surroundings of wells No. 4 and 7. Between their water level oscillations and the salt migration taking place in the soil profile the following connections could be found:

The salt amount of the soil samples (taken to the depth of 60 cm), i.e. the salt migration taking place in the soil profile, far from the fish pond was influenced above all by the soil cultivation. By the loosening of the soil executed every 4 years to the depth of 60 cm a better desalinization was achieved (*Fig. 2.* See graph-series below) than by the shallow loosening, the annual ploughing of 15 cm (*Fig. 2.* See: graph series above).

After the soil amelioration the next important factor of salt mobilization (from among the three main factors of salt migration, i.e. precipitation, evaporation, groundwater) was the precipitation. This statement is corroborated by the situation to be read out jointly from *Fig.-s 1* and *2*) 19 July 1973. Because of the season (summer) the salt maximum should have been nearer to the soil surface. Its situation is however, nearly identical with the conditions of 15 March 1974 (*Fig. 2.* Comparison of the drillings No.-s 130—134 and 190—194). The equality of salt content was brought about in this case by the leaching effect of the large precipitation amount (14—18 mm, and 130 mm in all) fallen during the previous 11/2 years on seven occasions (*Fig. 1.*). Thus the precipitation had in the case of the situation of 19 July 1973 a different role which may be separated from the groundwater of about 2 metres and from the soil amelioration to be discussed later.

In the investigated period the role of the groundwater level came only after those of the abovementioned factors from the aspect of the formation of salt profiles.

When comparing the salt-curves of the samples taken at the same time (See: *Fig. 2*) it becomes clear that the profiles of the soil ploughed yearly (to 15 cm) contain, apart from chemical amelioration, generally more water soluble salts than the soil loosened to the depth of 60 cm, resp. the soil having been ameliorated by plastering even at the bottom of the furrow. Thus the chemical amelioration had on the soil layer investigated to 60 cm a smaller effect, from the aspect of salt migration, than the deep tillage, the soil-loosening to the depth of 60 cm. As to effectivity it comes only after the latter. In the further investigations it will become even clearer that the desalinizating effect of the chemical soil amelioration is limited only to the upper layer of 20 cm and to the bottom of the furrow respectively, i.e. mainly to the layer obtaining the most part of the chemical materials. This is proved also by the analyses of exchangeable sodium.

The demonstrated salt-migration investigations are not significant, they show only tendencies, because the heterogeneity of the soil, the statistical deviation of the analyses is larger than the difference of the deviations between the treatments. This is a consequence of, a deficiency in the method of taking the samples, since the samples were not taken at the starting of the experiment but only 10 years later.

However the data of salt migration taking place as an effect of soil cultivation, their trends are nevertheless considered as reliable since the analyses corroborate the following statement of Sigmond [11]: "If by some reason, and if even temporarily a decrease of the groundwater level is observed (or the surface salt water is drained) a strong leaching process will take place, the first phase of which is a decrease of the amount of water soluble salts (below 0,10—0,15%) while the soil absorption complex will not yet loose from its Na content.

The abovementioned leaching process may be even promoted by loosening the soil. In this case we open the way to, and accelerate the process of leaching, the removal of the soluble salts from the upper soil layer.

When carrying out chemical soil amelioration the first step is (depending on the characteristics of the soil) the subsoiling of the alcalic soil opening the way in this way to the disappearance of the salt. On the basis of the law of mass-effect the amelioration is better and more effective in this case.

The chemical causes of this phenomenon have been analysed in our previous paper [6].

On the basis of the above the authors of the present paper are in disagreement with the principle followed by *Herke* [13] in determining the exchangeable ammonium carbonate Na, and approve the method of *Mados*. In our opinion the latter does not involve any "overdosing" of amendment given to the respective soil layer.

Fig. 1

Depth of water in groundwater tablecontrolling wells and rainfall

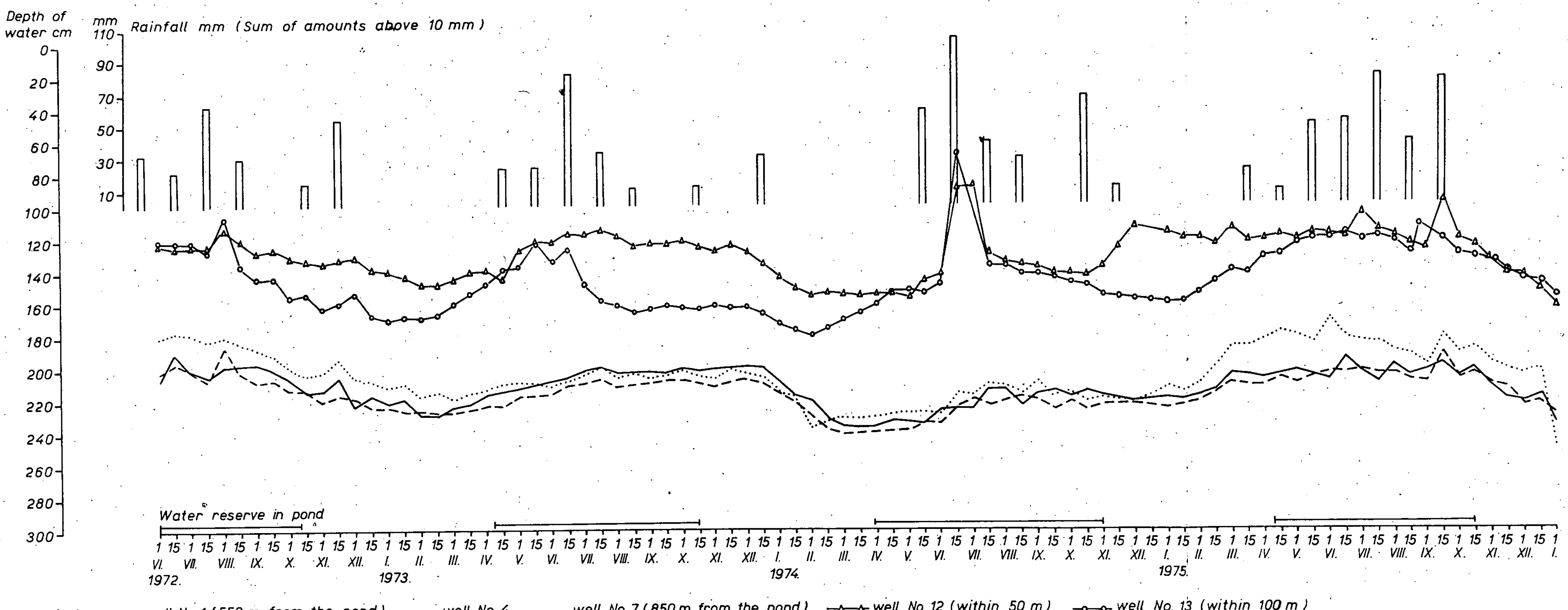
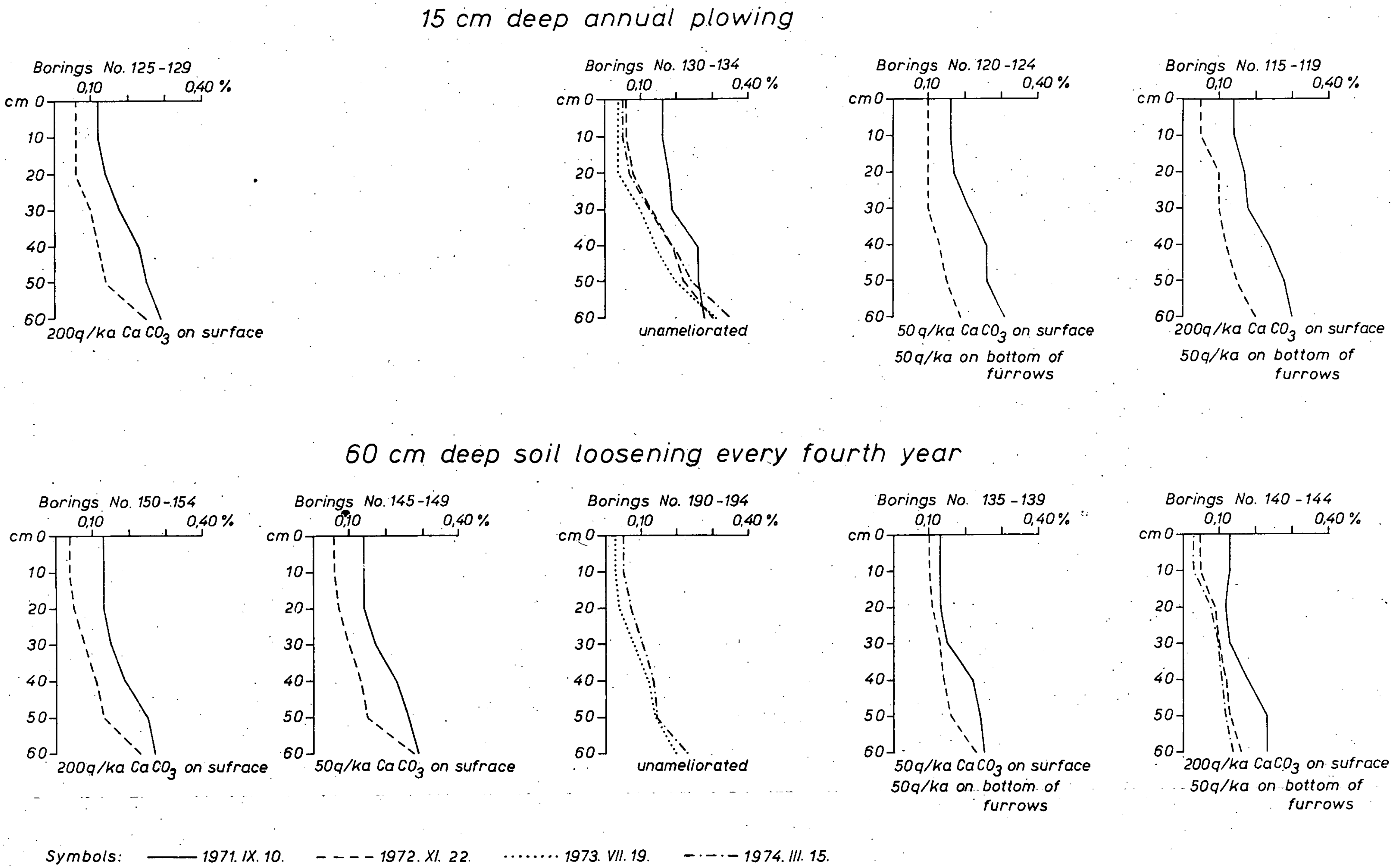


Fig. 2 Variation of the total percentage of the agricultural experiment



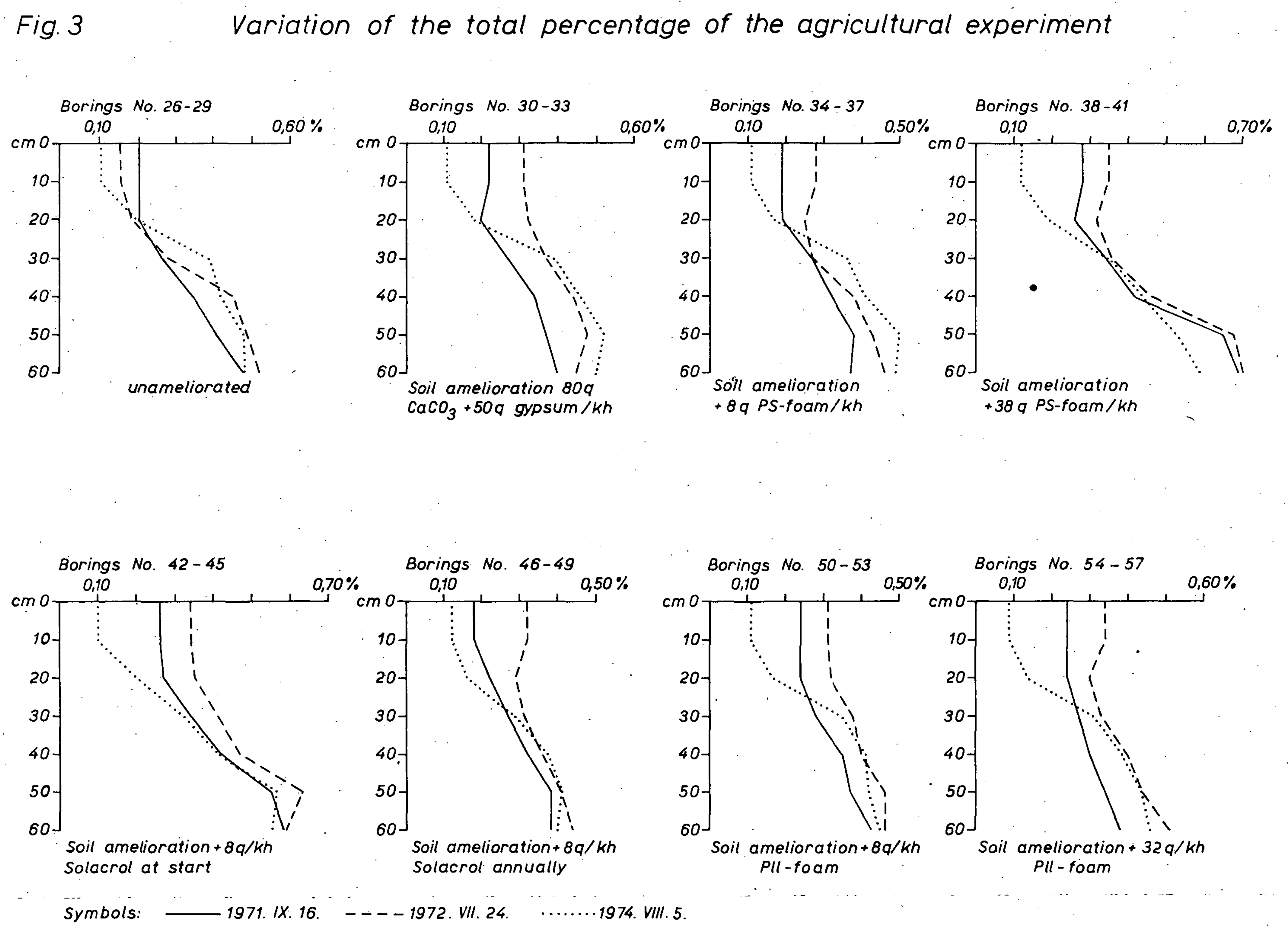


Fig. 3 Variation of the total percentage of the agricultural experiment
Borings No. 26-29
0,10
0,60 %
cm 0
10
20
30
40
50
60
unameliorated
Borings No. 30-33
0,60%
Soil amelioration 80q
CaCO3 +50q gypsum/kh
Borings No. 34-37
0,50%
Soil amelioration
+8q PS-foam/kh
Borings No. 38-41
0,70%
Soil amelioration
+38q PS-foam/kh
Borings No. 42-45
0,70%
Soil amelioration+8q/kh
Solacrol at start
Borings No. 46-49
0,50%
Soil amelioration+8q/kh
Solacrol annually
Borings No. 50-53
0,50%
Soil amelioration+8q/kh
PII-foam
Borings No. 54-57
0,60%
Soil amelioration+32q/kh
PII-foam
Symbols: 1971. IX. 16. 1972. VII. 24. 1974. VIII. 5.

B. Examination of salt dynamics analysed under circumstances of a groundwater level above the „critical depth"

The examined soil amelioration experiment was carried out between the fish pond and the registration well No. 13.

From *Fig. 3* and the data contained therein the following determinations can be made:

The obvious difference between the ameliorated soil (drillings No. 30—57) and the non-ameliorated one is that in the ameliorated soil the movement of the water-soluble salts, their quantitative variation, is much more important than in the original unameliorated one. This difference is characteristic mainly for the layers between 0—10 and 10—28 cm. Thus it can be stated that in unameliorated soil the increase of total salt and its decrease respectively, is 0,1% while in the ameliorated one 0,17—0,25%. Between the two ways of tillage the difference is significant.

The cause of this phenomenon is the fact that the ameliorated soil structure furthers the movement of the water (and the salt in it) much better than the unfavourable structure of the untilled alkalic soil.

This is corroborated also by the significant difference of salt percentages to be found between cases of tillage where 8 quintals of poly-stirol (PS) or poly-uretan (PU) and 32 quintals of the same materials were applied (*Fig. 3*).

It can be stated also that this intensive salt movement extended in the unameliorated soil mainly over the layer of 0—10 cm while in the ameliorated one over the layer of 0—20 cm.

The investigated material was collected from the soil-profile of 0—60 cm. The movement of water soluble salts was influenced, in addition to the above, most considerably also by the precipitation (evaporation) and by the groundwater level: by the latter one for the simple reason that it is no rare case to find the groundwater at a depth of about 1 m (*Fig. 1*). In such a case the salt migration is, in contrast to the water level of the registration well No. 13, determined rather by the groundwater level than by precipitation. The correctness of this observation is proved by the larger salt content of the soil samples taken on 24 July 1972 (*Fig. 3*, broken line, and Fig. 1, water level of 105 cm) and the significantly smaller salt content of the samples collected on 5 August 1974 (*Fig. 3*, dotted line, and *Fig. 1*, water level of 138 cm).

In the investigated two cases considerable precipitation fell at that time on the territory: in the first case 65 mm and in the second one by 25 mm more than the quantity of 104 mm of the previous month (*Fig. 1*). In spite of that the salt content of the soil profiles is rather a proof of the influence of the groundwater level than of the leaching effect of the large rains. The salt content of the soil profiles is larger with a higher groundwater level (*Fig. 1*, on 24 July 1972) (See *Fig. 3*, broken line) and smaller with a lower water level (*Fig. 1*, 5 August 1974 and *Fig. 3*, dotted line). Obviously in the latter case the leaching effect too, will manifest itself as it can be readily seen on the upper stages of the salt curves.

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