THE WATER REQUIREMENTS OF RED PEPPER (PAPRIKA) ESPECIALLY AS RELATED TO THE IRRIGATION OF THE RED PEPPER GROWN IN THE SZEGED DISTRICT

By

I. PÉNZES

Introduction

When examining the characteristic features of the natural conditions (climate, soil etc.) of the red pepper growing district of Szeged it was established that the yield of this crop depends among other factors on the amount and distribution of precipitation. The conditions of precipitation in the district are generally favourable for the growing of red pepper, although according to experiences and to the precipitation values of many years there are years or months respectively when supplementing is necessary.

The present paper deals, on the basis of natural conditions and examination of the plant's requirements, with the problems of growing red pepper with irrigation. Supplementary water is necessary from time to time to increase mean crop yields and to maintain them year to year on a nearly identical level. When supplementing water, due consideration must be given also to the properties of the soil.

I.

The geological and geomorphological conditions of the red pepper district of Szeged

In this district three sharply distinct parent rocks constitute the basis of the soil:

1. Early Holocene, Late Holocene and Pleistocene sand,
2. Pleistocene Loess or Infusion Loess and
3. Early and Late Holocene Alluvium.

Among the surface formations the areas of greatest extension are occupied by the Pleistocene Loess variations which are general to the east of the river Tisza and have a smaller surface on the west-side. The homogenous Loess-ridge was torn up by the rivers Tisza, Körös and Maros and divided into four separate unities.

1. The greatest homogenous loess panel is situated to the east of the Tisza—Körös line or to the north of the river Maros respectively. This area is covered by infusion loess, typical loess, argillaceous loess, heavy humic Pleistocene sand and red clay. Smaller spots of Holocene formations (meadow clay, alluvial silt, drift sand and clayey alkaline loess) are wedged into this area. The height above sea-level of the loess-ridge varies between 82—102 m; the south-eastern part rises above 100 m, but the greatest part is situated at a 82—90 m level. The relative difference between the higher and lower horizons is 2—3 or in some cases 5 m.

2. The main formation of limited extension of the Szőreg loess ridge is infusion loess, clayey loess and typical loess. This loess panel is torn up, composed of four bigger and some smaller blocks. Holocene meadow clay and alluvial silt areas are wedged in between the units. The height of the loess panel is nearly at the same level (80—82 m above sea level) with its surroundings.

3. The loess panel Szeged—Röszke—Szentmihálytelek—Fehértó forms one unit. Its main formation is infusion loess and clayey loess. Alluvial silt and meadow clay spots are wedged into the area. As related to red-pepper growing, the typical loess spots of the panel Öthalom, Ráczok-kertje etc. are of great importance. The loess-terrain both in the East and in the West as well as in the North and in the South merges into the ridge between Danube and Tisza and into the alluvial terrain of the river Tisza. The separation or contact respectively is gradual, and can be hardly denoted with a difference of 1 m. Higher horizons within the loess panel (2—5) are formed by the typical loess spots, lower horizons (—2 m) by the Fehértó and its surroundings to the North as well as by the Maty-ér (rill).

4. The main formations of the loess-panel Csánytelek—Gátér—Pálmonostor—Kiskunfélegyháza consist of infusion-loess and aeolian sand. The panel is becoming narrower to the North-East; ;its unity is split up by Pleistocene and Holocene drift sand, variegated with low-lying caustic sludge spots. Typical loess and clayey loess spots are also found in the loesspanel. The area becomes lower from NW to SE and gradually merges into the alluvial horizon of the Tisza. Its height above sea-level varies between 84 and 120 m. The relative differences of level are around — 3—5, + 3 m.

The Holocene formations on different parent rocks border on one another at the Szatymaz—Sövényháza line. The two independent but contiguous areas are to be considered as separate on account of their different parent rocks, divergent height above sea-level and differences in the process of soil formation.

The Holocene sandy area to the West of the Kiskundorozsma—Szatymaz—Sövényháza—Kiskunfélegyháza line is an integral part of the sand-ridge between Duna and Tisza. The sand-ridge is overlaid by drift, sand, cover-sand and cledgy sand, variegated with caustic sludge depressions directed from NW to SE. Its area is situated in the 129—95 (86—84) m horizon above sea level, with a slope towards East. The region merges in eastern and western direction alike almost unnoticed into the surroundings; natural limits are denoted merely towards E. by areas with different parent rocks (loess, alluvium). Its western limits are purely administrative and identical with the limits of the outer red-pepper district of Szeged which were determined by the state in 1934. Within the region level-differences are around —1—2 or +3—4 m respectively.

A smaller unit of the Holocene areas, forming also an integral part of the sand-ridge between Duna and Tisza is found to the NW of Csongrád or Kiskunfélegyháza respectively, divided into an eastern and a western part by Pleistocene formations. The area is for the most part covered by drift sand, variegated with loess or meadow-limestone areas in smaller spots. The western part is situated at a height of 122—113 m above sea level, with a diminishing value in the direction N to SW or SE. The relative level-differences can be expressed in the terms of 1—2 m. The eastern part again has a NW-SE slope and the difference in height between the two extreme wings is 24 m.

Another part of the Holocene formations consisting in a distinct unity, is the immediate environment of the rivers Tisza, Körös and Maros. Among its formations meadow clay and alluvial silt are represented in an approximately identical ratio. This part of the red-pepper district of Szeged is the lowest; its height above sea-level varies between 77 and 83 m. The area is twofold, including both the present floodplain and the previous ones. The height above sea level of the present flood-plain varies between 77 and 81 m, while the former flood-plain is situated at a 80—83 m level. The latter is attained by the flood in exceptional cases only and is therefore a very important area of agricultural production and particularly of red-pepper growing (Fig. 1.).

The general slope of the red-pepper district of Szeged is directed from NW towards Szeged, progressing from the W-E direction towards the line of the Tisza. The rate of the slope is rather considerable: from the W-E direction 30—50 m, from the E-W direction 15—20 m. (The differences in height of the red-pepper growing district of Szeged are presented in Fig. 2.)

II.

Soil conditions in the red-pepper growing district of Szeged

In this district the parent rocks of soil formation are: loess (typical, infusion, clayey and sandy loess), sand (Pleistocene and Holocene drift sand, cover-sand and caustic sludge sand) and alluvial deposits (alluvial silt and meadow clay). On lower levels the movement of material was very frequent (effect of water and wind), therefore soil formation is slower, humification still progresses at a low rate. The soil of the flood-plain and of the depressions attained periodically by the flood has the character of a skeleton soil developing in the direction of the chernozem variety.

Grassland soils, meadow clay variations, alluvial skeleton-soils, indistinctive drift sand and alkali soils are found in this district. The grassland soil areas formed on various parent rocks have many common features, but it is nearly impossible to recognize the identical among so many similar soils. The differences that may be observed in the properties of grassland soil areas are of small dimensions, not causing therefore substantial changes in red-pepper growing as regards quantity and quality.

The grassland soil of the loess areas is medium heavy loam with an excellent crumbling quality and crumble structure; its top soil (humus) has a depth of 60—90 cm. Its reaction is alkalescent (pH = 7,6—8,0); the soil is well provided with humus and nutrients, has an excellent water storing capacity and is easy to work.

The grassland soil of the sandy terrain is a brown or dark greyish-brown soil with a rich humus content. The top soil is 50—90 cm deep and is well provided with nutrients. The structure of the soil is heavy sand with a rather high water absorbing capacity. The working of the soil is in consequence of the loose structure easy and less costly.

The grassland soil of the alluvial area is heavier than medium, with a good crumble structure. The top soil is 70—90 cm deep, with a rich humus content, well provided with nutrients; its water storing capacity is satisfactory. The working of the soil is, in consequence of its being heavier, more costly and difficult.

The grassland soils developed on various parent rocks are very adapted for red-pepper growing and provide best crops both as regards quality and quantity.

The meadow clay varieties are compact soils difficult to work, easy to form clods and crust and therefore not adapted for red-pepper growing. They are generally low lying areas with a poor permeability and water raising capacity. They are well provided with nutrients and may therefore, when thoroughly cultivated, give good quantitative yields, but the quality of the crop is always poorer than e. g. on loam soils, particularly the colouring matter content will be low.

III.

Precipitation conditions of the red-pepper growing district of Szeged analysed for pentads

The yearly and monthly values of precipitation in this district are sometimes favourable, however, as a consequence of the continental climate, years deficient in precipitation often occur and generally it can be stated, that in Szeged and its surroundings every second year is deficient in precipitation, at least in the months of the year important for red-pepper growing. Years with an excess of precipitation constitute a rare exception, and in a significant percentage of the years the quantities of precipitation during the vegetation period need to be supplemented. Red-pepper very favourable responds to water available in a good distribution and in a satisfactory quantity; therefore in most years it is necessary to supplement or to replace precipitation in case it is entirely missing.

In the month of May the quantity of precipitation (64,8 mm in the average of the years 1890—1944) is sufficient, but at the same time some sections of the month are deficient in precipitation, particularly the period between May 10. and 20. In this period watering of the seedlings is certainly desirable. Irrigation is not needed in this month as the winter moisture is still considerable anough.

In the month of Juin the value of precipitation is in the average of 55 years 67,3 mm. The water requirements of red-pepper amount in average to 13,3 mm or 16,6 % pro pentad. The plants obtain this quantity of moisture only in the third pentad of Juin. The second and fourth (driest) pentad receives less precipitation than required; in these pentads therefore supplementation becomes an absolute necessity.

The month of July, with a precipitation of 51,9 mm belongs to the water-deficient months. Red-pepper receives only 86,5 % or 43,25 % respectively of its optimal water requirement of 60—120 mm. Of the 6 pentads of the month in 2 red-pepper receives not even its minimal water requirements. More than half of the years was deficient in water which had to be supplemented. According to calculations in the month of Juin red-pepper must be given at least 30—40 mm of water beside precipitation.

August is the initial maturing period of the red-pepper crop, when water requirements of the plant are already diminishing, but at the same time the want for sunshine and heat increases. Szeged has in the month of August comparatively ample precipitation, 49,7 mm in average. The water requirements of red-pepper fall below this limit, thus precipitation in the average surpasses the quantity needed and therefore in this month, apart from possible exceptions, irrigation is no more desirable (Fig. 3.).

IV.

Surface waters and groundwater conditions in the red-pepper growing district of Szeged

The hydrographic conditions of the district are favourable for the extension of red-pepper growing with irrigation. The main river is the Tisza dividing the area in a length of about 100 km into an eastern and western part. As the most significant red-pepper yielding areas are situated to the E. and W. of the Tisza, this river is most important for the water supply. Its water is at the lowest in the end of summer or beginning of autumn, while it is the highest in spring. Its water discharge ranges between 100 and 2500 m^3.

The other two rivers of the area are Maros and Körös which broadly speaking follow an East-West direction. As these rivers are situated to the North or to the East respectively of the main red-pepper growing areas they are of a minor importance.

In the irrigation of the areas beyond the river Tisza beside the rivers a significant role must be attributed to the brooklets or rills (»ér«) serving for the periodical drainage (the Kurca with the Korogy and

Veker, the Szárazér) and to the constructed channels (main channel of Kopáncs etc.). The rills serving for the water drainage between Danube and Tisza (Dongér, Matyér) and the channels (main channels of Majsa, Fehértó, Domaszék, Széksóstó etc.) are in consequence of their low situation and alkaline subsoil of less importance. An independent well and irrigation channel system would represent a definitive and reassuring solution of the red-pepper irrigation problem in this district. Hydrological conditions are shown in Fig. 4.

During the vegetation period the ground water can be found on a considerable part of the sandy territories at a mean depth of 2—3 m, excepting the lower levels and their immediate surroudings where the water table ranges between 1 and 2 m.

In the loess areas the mean depth of the ground water is 3—5 m, the low lying plain spots constituting again an exception because there the depth of the ground water may reach occasionally 2 m.

On the alluvial area of the rivers Tisza, Körös and Maros the ground water table is situated at a depth of 2—4 m. In plain spots lying deeper the ground water is very near to the surface — in some cases it even rises to the surface — and in certain years causes serious damages as »vadvíz« (underground water rising and spreading over low grounds) as e. g. in Szeged 1942. The mean depth of the underground water in this district is shown in Fig. 5.

V.

Relations between natural conditions and irrigation of red-pepper

The substratum of various soils of the district is generally a good water reservoir but in most cases its water raising capacity is not sufficient to enable red-pepper to make use of the ground water. The use of the ground water is only possible, where water in the course of capillary water raising reaches a height of 1,2—1,5 m. The 100 hours capillary water raising capacity of the parent rock is represented in Fig. 6.

In irrigation some other soil properties than water raising capacity are also of great importance, such as water absorption, heaviness, crumbling, quality and grain diameter. The permeability of soil expressed in mm modifies the amount of irrigation water since various soils have a different water absorption capacity and there are even differences between the absorption capacity of various sand loess or alluvial varieties. The loess area beyond the Tisza is more clayey and compact, therefore its water absorption capacity is lower; the Csánytelek—Gátér—Pálmonostor—Kiskunfélegyháza area on the other hand is looser, more sandy and as a consequence its water absorption capacity is higher. The loessridge of Szőreg owing to this feature stands nearer to the territories beyond the Tisza, while the loesspanel Szeged—Röszke—Szentmihálytelek—Fehértó is more similar to the Kiskunfélegyháza area.

The 5 hours water absorption capacity of the loess panel beyond the Tisza ranges between 80 and 320 mm. The greatest part of this territory has a water absorption capacity of 200—300 mm which is adequate to the requirements of red-pepper. The soils with a poor permeability are alkaline in this region and therefore not advantageous for red-pepper growing.

The loess-panel Szeged—Röszke—Szentmihálytelek—Fehértó has a higher water absorption capacity; most soils on this territory can absorb 260—360 mm of water during 5 hours. Here a difference of 140 mm appears between the permeability of the different areas, while the loess-panel beyond the Tisza shows a difference of 220 mm only.

The loess-panel of Szőreg stands nearest to the conditions of the territories beyond the river Tisza, the 5 hours water absorption capacity varying between 160 and 320 mm.

The Csánytelek—Gátér—Pálmonostor—Kiskunfélegyháza panel is surrounded by sandy areas. The loess is sandy, thus having a similar permeability as the sandy territories. Its five-hours permeability ranges between 200 and 420 mm.

The sandy territories are characterized by the greatest permeability, which surpasses at certain parts 500 mm for 5 hours. In this area most soils have a water absorption capacity of 280—460 mm. The territories of very low permeability are alkaline or with lime sludge.

On the alluvial territories permeability is different, depending on the parent rock being meadow clay or alluvial silt. The 5 hours water absorption ranges between 0 and 180 mm.

The high permeability might be advantageous and disadvantageous too. It is advantageous since it promotes rapid infiltration of rainfall. It is also advantageous when the layers between 2 and 3 m are impermeable, because in this case much water is stored near the surface and this enables the plant to cover ist water requirements by water raising. It is advantageous too, when the ground water is near (at a 1,5—2,5 m distance) to the surface and there is no impermeable stratum between the ground water and the surface layers. It is disadvantageous on the other hand in all cases, when the ground water is at a depth of 3—4 m, when there is an impermeable layer between ground water and the surface strata etc. Fig. 7. presents the permeability of various soils and the quantity of water required for one irrigation of red-pepper in mm.

The quantity of water which fulfils the water requirements of red-pepper on areas with different parent rocks is as follows:

		Loess	Alluvium	Sand	
During the vegetation period:					
	Total	220—270	170—200	400—540	mm
May		45—60	40—45	90—120	mm
Juin		65—80	50—60	120—160	mm
July		50—60	40—45	90—120	mm
August		30—35	20—25	50—70	mm
September		30—35	20—25	50—70	mm

The data thus determined are only of an informatory character for the regional units with different parent rocks. Further examinations are necessay to obtain exact answers. According to the experiences and examinations up to now whenever the value of the precipitation is lower than the given quantity, the red-pepper already suffers from lack of water. The lack of water affects differently the development of the plant in each month and even in each pentad but in the final result is detrimental to the quantity and quality of the crop and this of course diminishes the disposition of the farmers to grow red-pepper.

The first and second pentad of the month of May (1—10. May) is the most important and most desirable period to plant the seedlings. This requires water and when the weather is somewhat dry, watering of the seedlings is absolutely justified. Watering of the seedlings can be only omitted, when in the last pentad of April there was plenty of precipitation. In the period between May 10—20. (third and fourth pentad) water is also very important for the seedlings to set root and become stronger; also in the case when they are planted at a later period. In this case 20 mm of precipitation is needed, and when this fails to come about, this quantity of water must be supplied. Only those years can form an exception, in which the first and second pentads are rainy, or the precipitation in the second and third pentad surpasses 20 mm. In this part of the month of May the soil seldom receives that quantity of water, so in most years watering is necessary. Also otherwise this period of May is the driest. The fifth and sixth pentad of May is the time for the development of the seedlings or their late planting respectively. For development or growth water is also indispensable; at least 30 mm precipitation is needed. In most years this period of May is rainy and the necessity of watering arises under exceptional conditions only.

The pentad between the 1. and 5. of Juin is the time of the growing of the plant or of the very belated planting of the seedlings and of their replacement; water requirements are about 10 mm and irrigation becomes necessary in exceptional cases in very dry years only.

The second pentad of Juin is the period immediately preceding to the flowering of red-pepper, when the value of precipitation must attain at least 10 mm, for the full development of the plant. This pentad of Juin is deficient in precipitation and in most cases the lack of water must be supplied by irrigation.

The third and fourth pentad of Juin is the right time for the first flowering of red-pepper, when water is indispensable. In the third pentad irrigation becomes seldom necessary as the value of precipitation is about equal to the quantity of water used by the plant in 5 days. The fourth pentad on the other hand is deficient in precipitation and in this period a water supply must be provided for in order to promote abundant setting of fruits.

The fifth and sixth pentads aree already rainier. In most years red-pepper obtains the quantity of water required and irrigation must be arranged only in years exceptionelly deficient in precipitation.

In July the second, fourth and sixth pentads are poorer in precipitation as compared to requirements. This month is the main time for the second flowering and the further setting of fruits: Lack of water in this period invariably causes a poorer crop yield; therefore a quantity of water of 30 or 40 mm must be given at least twice in July.

August is the period when the fruits already set are growing, a belated flowering and early maturing takes place. Water requirements are reduced and irrigation is not desirable in spite of the drier period, as this could delay maturing of the crop.

On the basis of experiments and of the biological properties of the plant the dates for the irrigation of red-pepper were fixed for the periods between May 20. and 30., Juin 5—15., July 10—20. and August 5—15. Taking into consideration the soil moisture, the practical experiences and the specific requirements of the plant, irrigation in the month of May seems not to be justified. In Juin it is desirable to irrigate between 5. and 10., 20 and 25 of Juin, i. e. twice, in July between 5. and 10., 15. and 20., 25. and 31. i. e. three times; in August, on account of the procedure of ripening, irrigation is no more recommended.

When fixing the rate of irrigation it was established, that this value depends mainly on the quantity of precipitation, its distribution, the moisture content of the soil or the length of the dry periods. Taking all these into consideration in one year on aeolian soils 160 mm of water must be given to supply for precipitation; on alluvial soils about 140 mm, on sands 260 mm.

This quantity of water is equal to 922 m^3/cad. hold on loess, 606 m^3 on alluvium and 1500 m^3 on sand. In a considerable part of the aeolian and alluvial areas the problem of water necessary for irrigation can be solved by making use of the rivers Tisza, Körös and Maros, on sand soils however wells only con be employed.

VI.

Territories of the red-pepper growing district of Szeged that are already under irrigation and those that might be included in the irrigation system

The water of the Tisza was used up to now for the irrigation of red-pepper in the outskirts of the village Gyálarét (20—25 cad. holds) and along the Kopáncsi channel of Hódmezővásárhely (30 cad. holds). Smaller irrigated areas can be found also in the neighbourhood of Artesian wells, e. g. in Röszke, in the »Lenin« cooperative farm (about 5 cad. holds), in the outskirts of the village Tápé in the »Ady« cooperative farm (also 5 cad. holds), in the cooperative farm of Hódmezővásárhely (1—2 cad. holds) etc. Red-pepper areas irrigated at present are shown in Fig. 8. Making use of the given possibilities (Tisza, backwater of the Tisza, stagnant waters, channels, Artesian wells etc.) almost without any investment about 466 cadastral holds can be included in the red-pepper irrigation system. Of this territory 35 cad. holds are administered by state-farms, 90 cad. holds belong to cooperative farms and 341 cad. holds to farms of other description.

It was established on the basis of measurements that on the sand-terrain a large scale irrigation is only possible by the means of Artesian wells. The water discharge of these is important enough to pay for the sums invested, in other words irrigation is profitable. Wells to be built and an adequate network of channels would make the irrigation of about 1500 cad. holds possible. This quantity of water could be provided for from 15—18 well placed wells with an abundant water discharge (1000 lit/min.); for each well a reservoir of 18—20.000 m^3 should be constructed. On the aeolian or alluvial soils the large scale red-pepper irrigation can be realized with the least cost by using the water of the Tisza and Maros rivers, making the irrigation of a further 1500 cad. holds possible, with comparatively low costs.

According to their water supply the territories may be divided into 4 large groups:

1. Areas which could be provided with a healthy surface water within a short time,
2. with surface water within 1 or two years time,
3. with surface water within a longer period (2—6 years)
4. with water from the depth.

The areas thus divided can be seen on Fig. 9.

VII.

Modalities and operating types of irrigation

In the practice the method of spray irrigation or furrow irrigation is employed in the irrigation of red-pepper. On the basis of experimental and practical experiences for the irrigation of red-pepper a well arranged furrow method is preferable because the response of the plant on this treatment is very favourable. Before the furrow irrigation in every second row 15—18 cm deep and 35—45 cm wide furrows are drawn which after the watering or the water being sucked up are filled up with earth. After the irrigation carried out this way it is recommended to give a hoe when the earth is drying up after irrigation, to reestablish the aeration of the soil.

Irrigation of red-pepper can be divided — according to the water supply — in two main groups:

1. irrigation of large plots with surface water and
2. irrigation of limited areas with artesian water.

In the first case, by using the water of the Tisza, Maros and Körös rivers, the water is available in practically uncontrolled quantities at a low cost, while in the second case water is expensive and its quantity is limited. In large scale irrigation costs of preparing the furrows and covering them with earth after the irrigation, hoeing etc. is rather high as related to the cost of the water used while in the small-scale irrigation with Artesian wells the quantity of water used is more expensive (on account of the costs connected with the establishment of the wells), the digging out and subsequent covering of the furrows on the other hand represents a minor cost.

As a consequence in the firts case a lower number of irrigations while in the latter case a more frequent irrigation is more profitable.

Therefore in large scale irrigation it is advisable to replace the missing precipitation with 2—4 dosages and in small scale irrigation based on wells, with 8—9 water feeds.

In the Szeged district red-pepper growing is still done on 1—2 cad. holds plots, with the exception of a few cooperative farms, such as the »Új Élet« (40 cad. holds), »Táncsics« (15 cad. holds) and »Szabad Tisza« (60 cad. holds) cooperative farms. For the extension of irrigation this breaking up of the land means serious difficulties.

In large scale farms in the zone of extensive irrigation systems beside the furrow irrigation of red-pepper other crops may be irrigated too. Profitableness also exacts a certain cooperation of the growers. The irrigation of red-pepper is necessary only in some intervals and with comparatively small quantities of water. The exploitation of the establishments requires however the continous utilization of the water available. On the other hand crop rotations of 4,8, and still more years are necessary to preserve soil fertility; therefore areas must be chosen for the operation of irrigation in an arrangement which warrants full utilization of water.

VIII.

Advantages and disadvantages of red-pepper irrigation

The results of red-pepper irrigation-experiments and surplus yields obtained by many farmers with irrigation clearly prove, that reliable good crops of red-pepper and profitableness of growing can be only assured with irrigation. In years with insufficient quantities and unfavourable distribution of precipitation the supply of the missing water warrants an increase of the yield by 5—600 per cents or stabilizes the mean crops of favourable years with a very slight deterioration of quality. Consequently in all territories where water of a good quality is available at a comparatively low cost, it is worth while and absolutely advisable to make suitable arrangements for irrigation. The effect of irrigation soon appears in a more powerful growth, in a more abundant foliage, richer setting of fruit etc.

The weight increase of the average berry is remarkable, similarly to the increase in the number of berries. If e. g. the mean raw berry weight of nonirrigated red-pepper is taken for 100, then on territories with moderate irrigation the berry weight will be 117,6 and on territories with abundant irrigation 205,5. As a consequence of abundant irrigation both the length of the berry as the diameter of the basis increase by about 33 %. The inclination of the fruits to curve also diminishes. As to water dosage it seems to be most advantageous to provide in very dry years with a single irrigation for a water dosage equal to 30—40 mm of precipitation, not to let the water overflow in the furrows but to reach only 2/3—3/4 height of these, not only because water flown out of the furrow and staying at its base is detrimental to the plant, but because the furrow soaked to its upper edge causes the formation of a crust which deprives the plant of the necessary aeration of the roots.

A late irrigation (after the middle of August) is not advisable, because this would certainly delay the maturing of the fruit. On the other hand when irrigation is performed very soon, immediately after planting, the development of red-pepper will be more rapid, and in consequence flowering, setting of the fruit and maturation will all be sooner. This is particularly important for the diminishing of the danger of frosts in early autumn.

According to the experiences gained in the experiments the replacement of a quantity of water equal to 140—260 mm of precipitation is the most advantageous, as this treatment produces very good results without any qualitative deterioration. Too frequent irrigation produces a further increase in weight but with manifest qualitative deterioration and with costs out of proportion.

When comparing the mean yields of red-pepper irrigated and non irrigated it appears that the relation between these is determined by the precipitation values of the years. In the extraordinary drought of the year 1950 crop yield was determined by irrigation; similarly in the year of drought 1952. In 1952 hot red-pepper varieties gave with a moderate irrigation a crop yield surpassing that of the non irrigated hot red-pepper by 271,7 %. In the case of average and frequent irrigation the corresponding figures were 445 and 697,2 per cents respectively. Crop yields for non hot red-pepper were still more considerable. In the wet years of 1951 and 1953 irrigation resulted in a surplus of 53 % only. The number of irrigation was 2, 4 or 8—9 respectively when irrigation was moderate, average or frequent; expressed in precipitation this is equal to 60, 150 or 330—340 mm. The pooled quantity of precipitation and irrigation represented 247,1 335 or 521,1—531,1 mm of water respectively, when the irrigation was moderate, average or frequent. The quality of red-pepper grown with this method somewhat deteriorates, particularly the content of colouring matters and capsaicin is lower. This qualitative deterioration is outweighed however by the higher yield and reliability of production.

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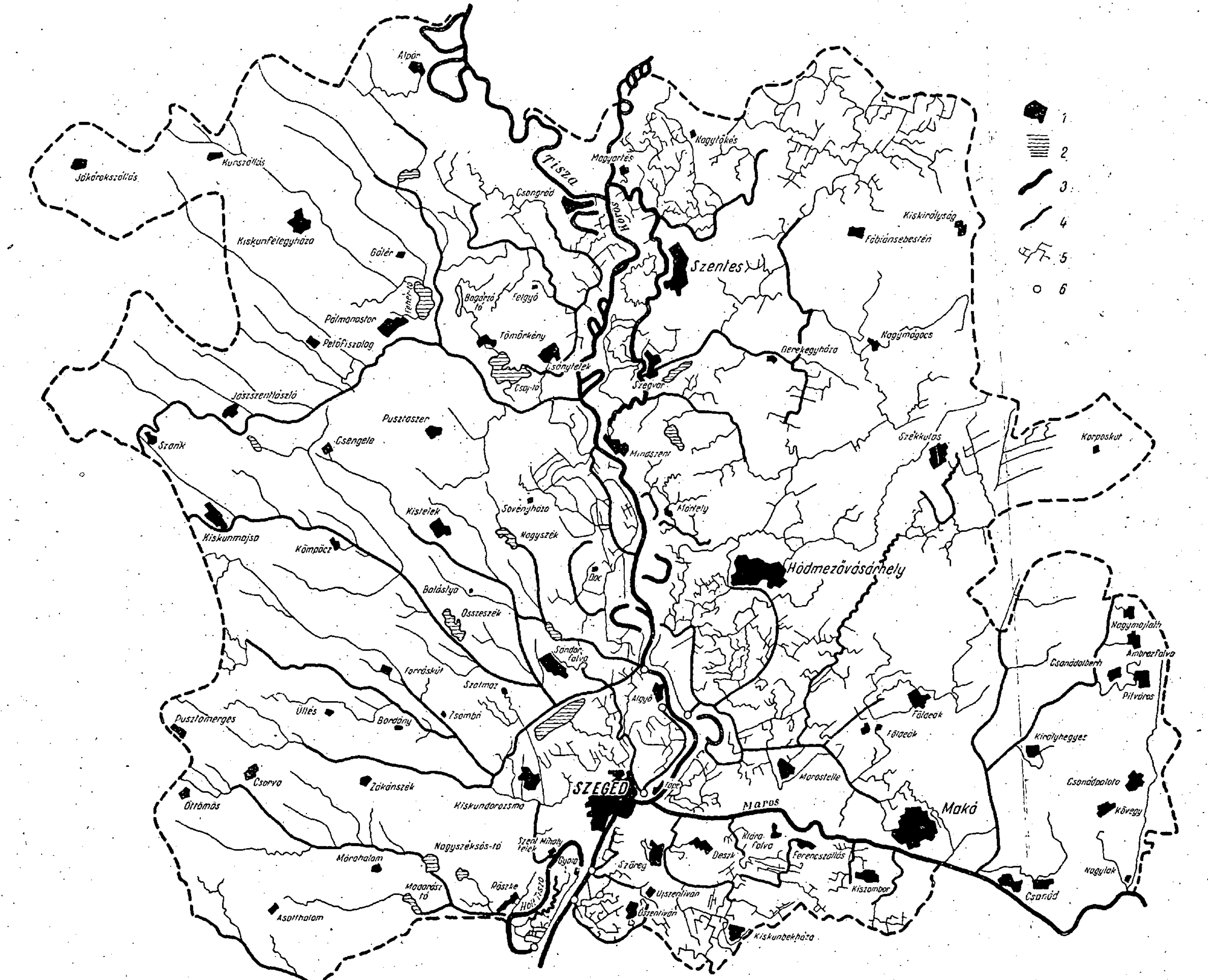


Figure No. 4. Hydrological conditions of the red-pepper grown in the Szeged district.

1. Settlements
2. Lakes, swams
3. Rivers, marshes etc.
4. Canals
5. Lateral drains
6. Pumping plants

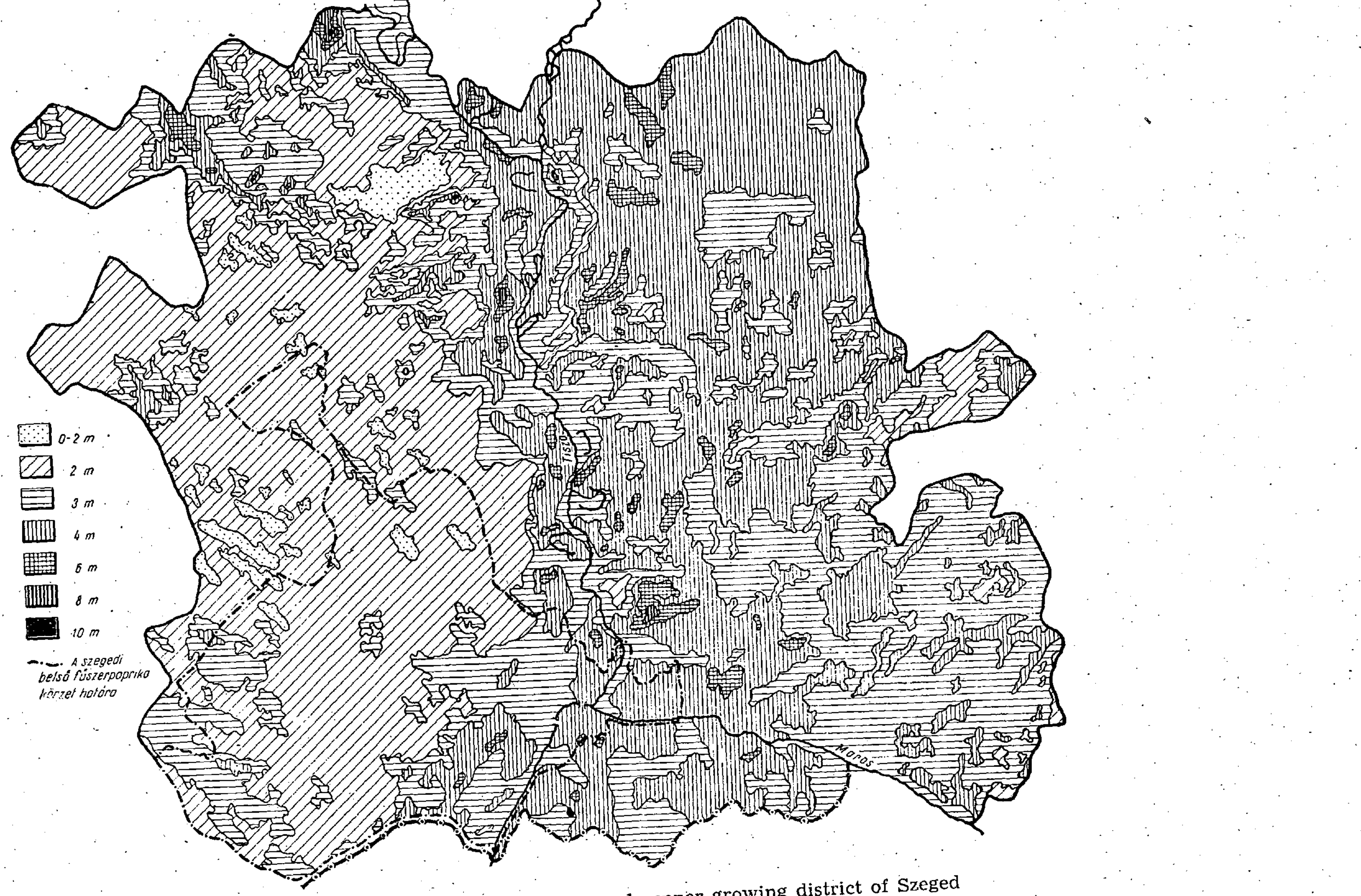


Figure No. 5. Average water table depth of the red-pepper growing district of Szeged

1. Between 0—2 m
2. „ 2 m
3. „ 3 m
4. „ 4 m
5. Between 6 m
6. „ 8 m
7. „ 10 m
8. border of the Szeged inner red-pepper growing district

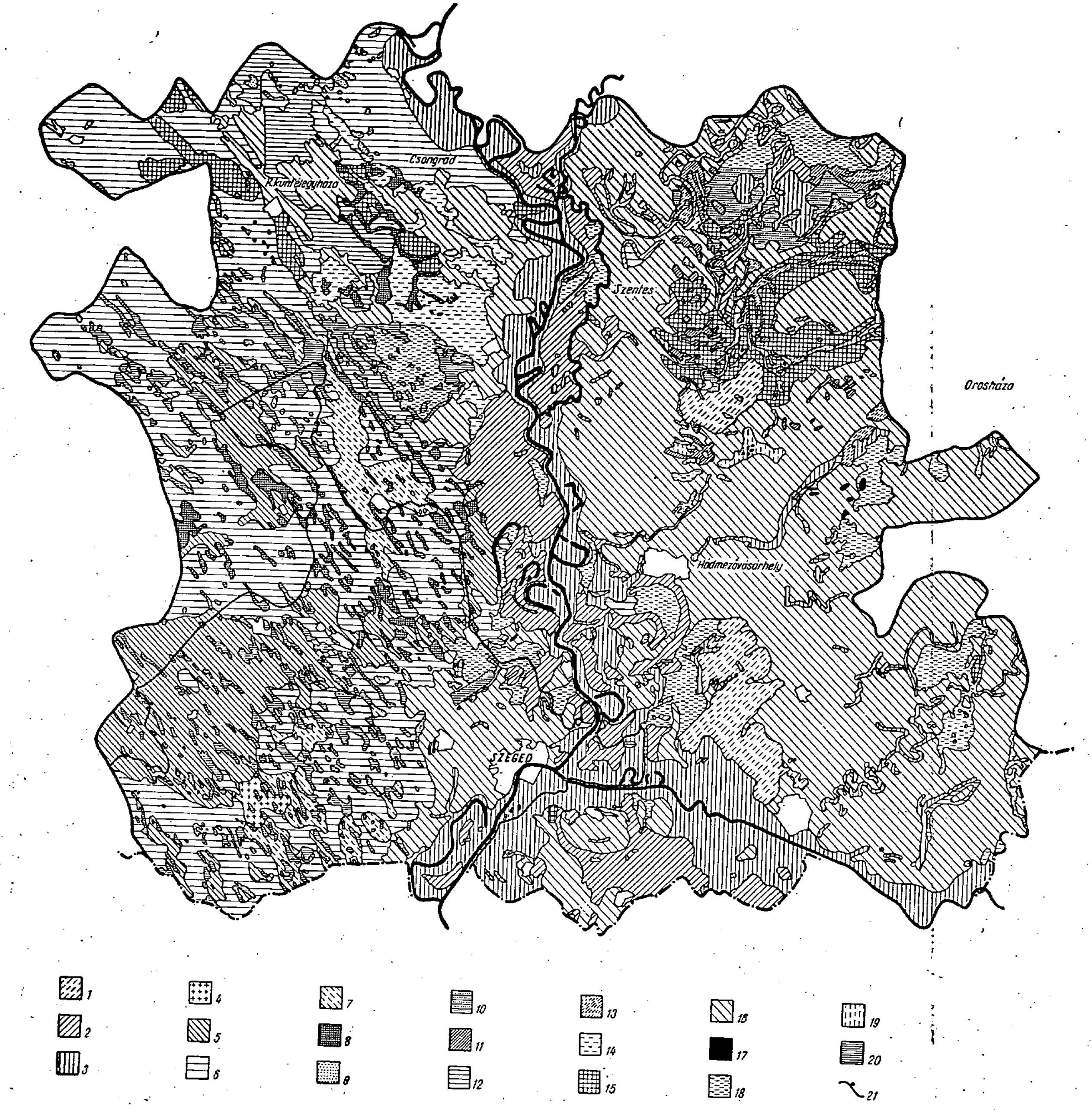


Figure No. 1. Geological diagram of the Szeged ıed-pepper growing district.

I. Holocene

1. marsh clay
2. meadow clay
3. flood mud
4. fixed sand
5. veil sand
6. driftsand
7. lime silt sand
8. lime silt
9. meadow limestone
10. clay alkali loess
11. loess deposit

II. Pleistocene

12. driftsand
13. humus-like fixed sand, fixed san
14. loess sand
15. type loess
16. infusion loess
17. sand loess
18. clay loess
19. red clay
20. lakes, rivers
21. border of the inner red-pepper growing district of Szeged

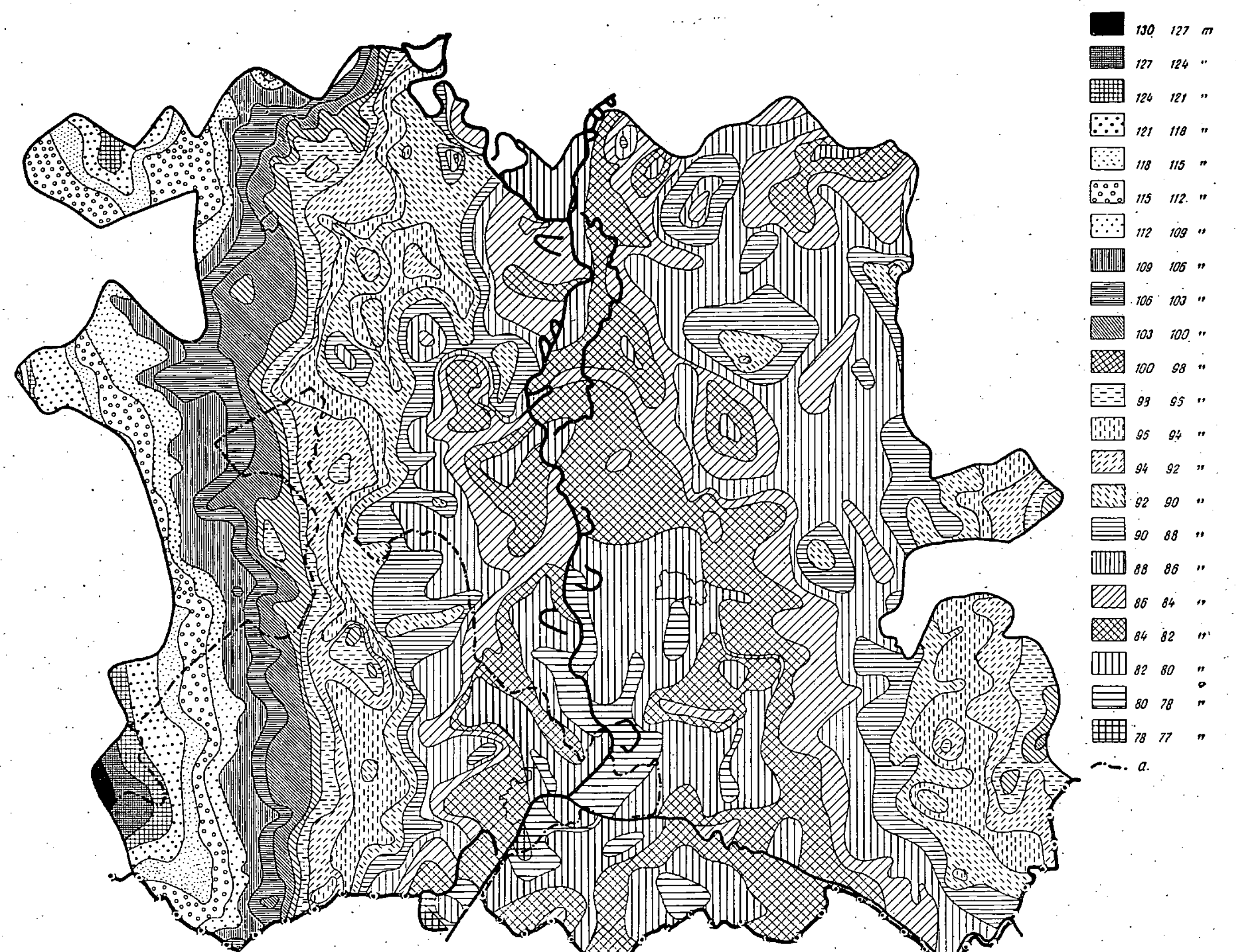
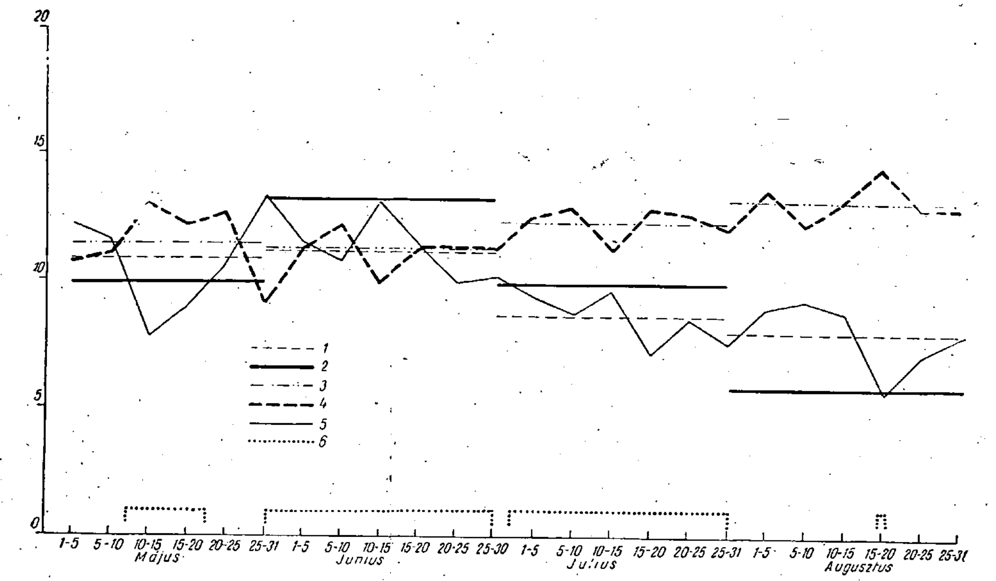


Figure No. 2. Level line map of the Szeged red-pepper growing district

1. 130—127 m
2. 127—124 m
3. 124—121 m
4. 121—118 m
5. 118—115 m
6. 115—112 m
7. 112—109 m
8. 109—106 m
9. 106—103 m
10. 103—100 m
11. 100— 98 m
12. 98— 96 m
13. 96— 94 m
14. 94— 92 m
15. 92— 90 m
16. 90— 88 m
17. 88—86 m
18. 86—84 m
19. 84—82 m
20. 82—80 m
21. 80—78 m
22. 78—77 m
23. border of the Szeged red-pepper growing district



May June July August

Figure No. 3. Formation of the precipitation values and years deficient in precipitation pro pentad between 1890—1944.

1. Mean number of precipitation averages pri pentad.
2. Mean number of the water requirements of red-pepper pro pentad.
3. Average of years deficient in precipitation pro pentad (The values indicated on the diagram are to be multiplied by three.)
4. Number of years deficient in precipitation pro pentad. The value of precipitation remained under 10 mm in these years. The values indicated on the diagram are to be multiplied by three.)
5. Average of the precipitation in mm pro pentad.
6. The precipitation does not meet the water requirements of red-pepper at these periods.

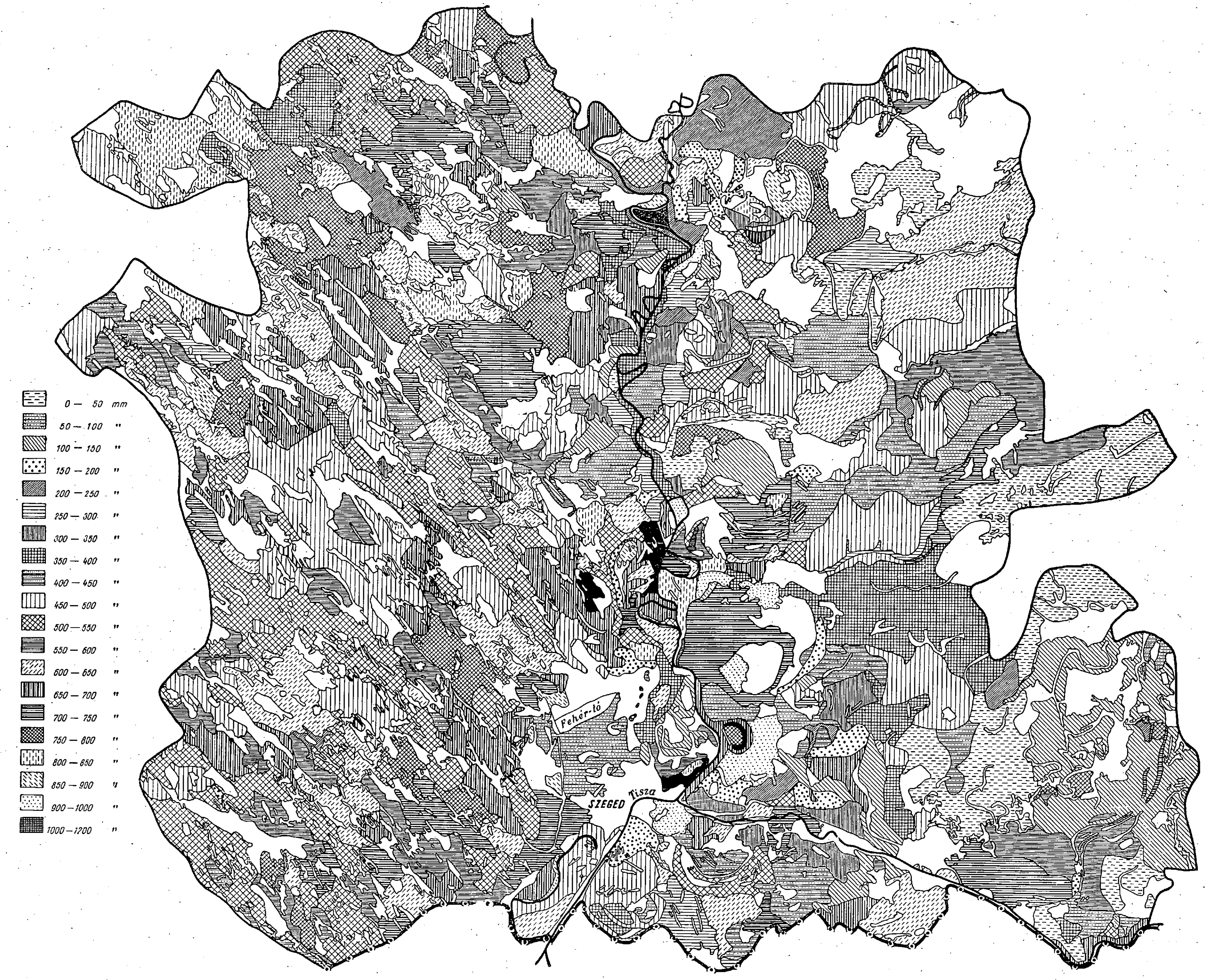


Figure No. 6. Capillary water lifting capacity of subsoil per 100 hours.

1. from 0— to 50 mm
2. „ 50— „ 100 mm
3. „ 100— „ 150 mm
4. „ 150— „ 200 mm
5. „ 200— „ 250 mm
6. „ 250— „ 300 mm
7. „ 300— „ 350 mm
8. from 350— to 400 mm
9. „ 400— „ 450 mm
10. „ 450— „ 500 mm
11. „ 500— „ 550 mm
12. „ 550— „ 600 mm
13. „ 600— „ 650 mm
14. „ 650— „ 700 mm
15. from 700— to 750 mm
16. „ 750— „ 800 mm
17. „ 800— „ 850 mm
18. „ 850— „ 900 mm
19. „ 900— „ 1000 mm
20. „ 1000— „ 2000 mm

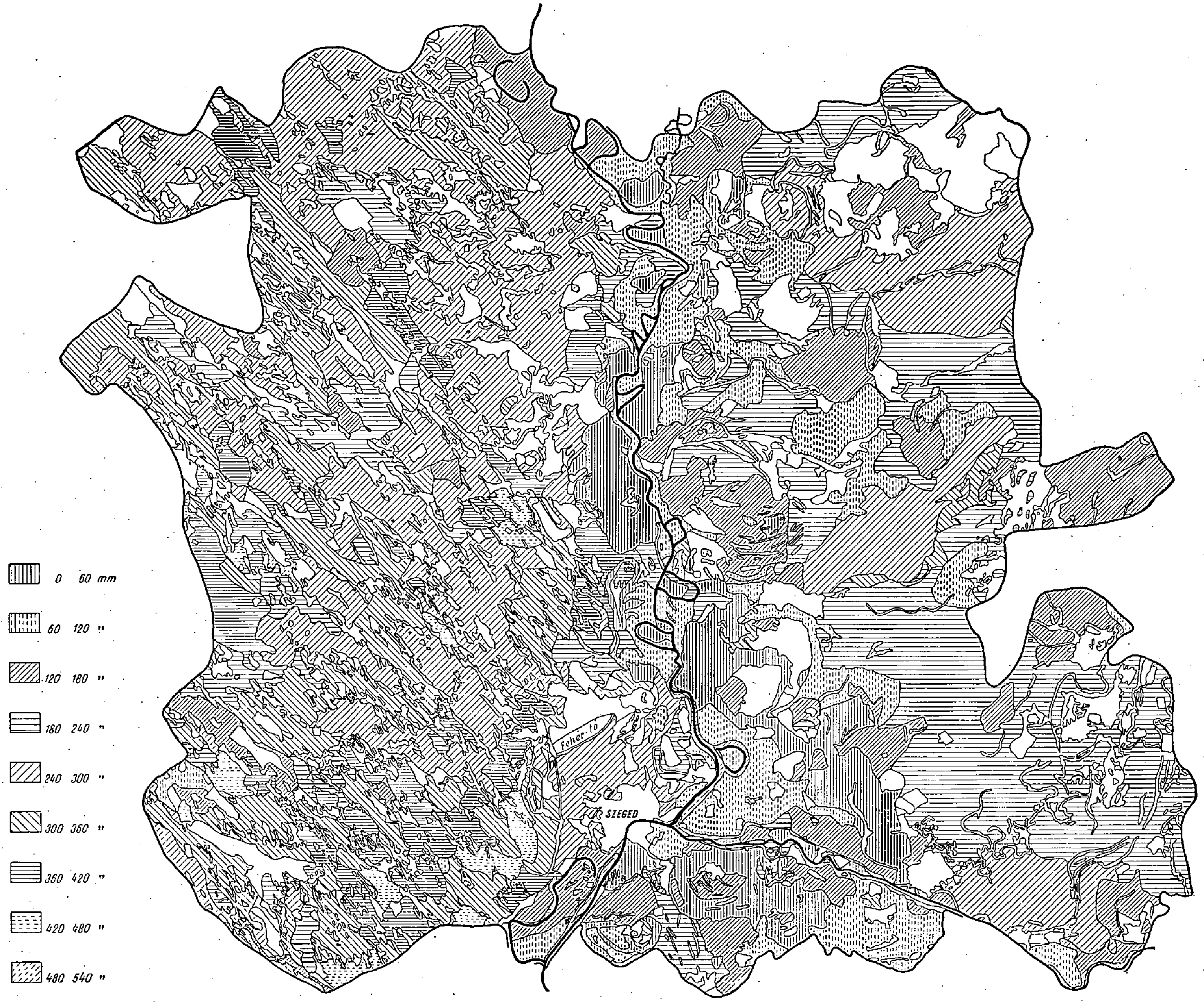


Figure No. 7. Water permeability of the soil per 5 hours on »A« level.

Water permeability of level »A« in mm.	Degree of irrigation of soils Wit different water permeability in mm, at single irrigation
1. from 0— to 60 mm	15 mm
2. „ 60— „ 120 mm	20 mm
3. „ 120— „ 180 mm	25 mm
4. „ 180— „ 240 mm	30 mm
5. „ 240— „ 300 mm	35 mm
6. „ 300— „ 360 mm	40 mm
7. „ 360— „ 420 mm	45 mm
8. „ 420— „ 480 mm	50 mm
9. „ 480— „ 540 mm	55 mm
10. „ 540— „ 560 mm	60 mm

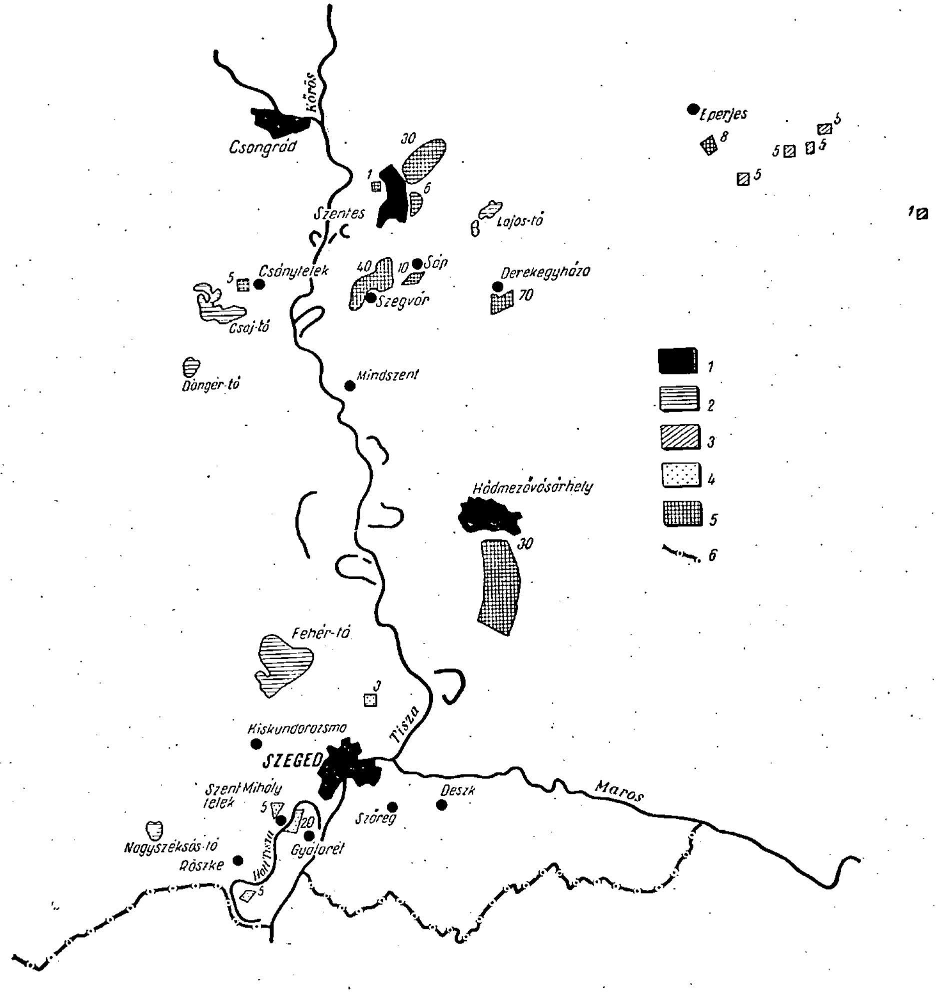


Figure No. 8. Iirrigated red-pepper areas in the Szeged district in 1956.

1. Settlements
Lakes, rivers
3. Irrigated areas outside the Szeged red-pepper growing district
4. Irrigated areas in the Szeged inner red-pepper growing district
5. Irrigated areas in the outer Szeged red-pepper growing district
6. Frontier
7. Quantity of irrigated ereas in cadastral yoke

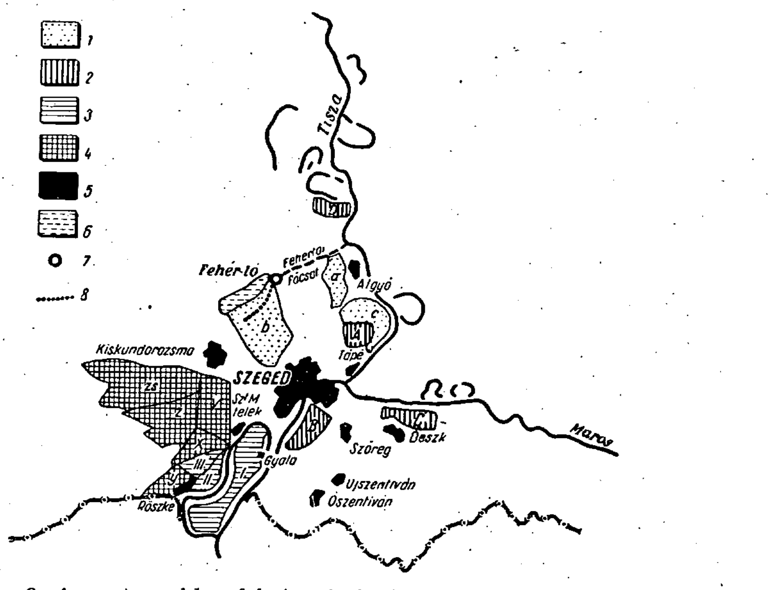


Figure No. 9. Areas capable of being irrigated lucratively of the Szeged red-pepper growing district.

1. Group of areas which can be supplied with sound water before soon.
2. Group of areas which can be supplied with water in one or two years.
4. Group of areas which can be supplied with water of depth.
5. Settlements
6. Lakes, rivers, canals
7. Water extrasting work, main channel to be built