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The Influence of Soil Aggregation on Its Water Retention

Określenie wpływu agregacji gleby na jej retencję wodną

Определение влияния агрегатов почвы на ее ретенцию воды

INTRODUCTION

The circulation of water in biosphere is conditioned by the soil which performs a role of its distributor. The soil receipts and retains rain-water, transmits the water into deeper layers supplying underground water as well as it releases water to atmosphere by way of evaporation and transpiration. The role of soil in the formation of water balance is mainly conditioned by its two properties, i.e. by water capacity and water permeability. Therefore, the knowledge of these properties and of the influence of different factors on their formation as well as method of their regulation allow us to control the processes of water circulation in biosphere. That is particularly important in agricultural productive areas, where the amount and the state of water in the soil has a fundamental effect upon the growth and development of plants. Moreover, there is a possibility of changing of soil capacity and permeability by means of the agrotechnical measures (Bavel, Burst, Stirk 1968, Hillel 1971, Kozlovsky 1968, Lvovic 1966, Philip 1972, Rose 1961, Rose, Stern 1967, Walczak, Zawadzki 1978, Wilgat 1974).

Many studies have pointed out that the agrotechnical measures cause dilatational and non-dilatational strains of soil. Soil structure, defined as a geometry of solid phase, appeared to be the most variable soil feature while those agrotechnical measures were carried out (Dechnik, Lipiec 1975, Dobrzański, Michałowska, Walczak 1973, Turski, Domżał, Słowińska, Hodara 1977). Complex studies

Tab. 1. The basic properties of chernozem developed from loess
Podstawowe właściwości czarnoziemu wytworzonego z lessu

Organic matter content (%)	Specific soil density (g cm^{-3})	Specific surface area (m^2 g^{-1})		Percentage of soil particles and aggregates acc. to diameter (in mm)										
		H_2O	N_2	1—0,1	0,1—0,05	0,05—0,02	0,02—0,002	0,002>	<0,25	0,25—0,5	0,5—1	1—3	3—5	5—10
2.11	2.5385	49	15	3,5	6,5	47,5	28,5	14	15	8	19	29	7	22

on soil cultivation have shown a significant influence of soil structure on the formation of optimum water-air relations, however, they did not answer the following question: which of the structural constituents are responsible for the occurrence of a definite type of the physical properties of soil? Thus they do not point out which of the soil structure creates the complex physical properties of soil that is responsible for optimum water-air conditions in the soil.

Scarce attempts to determine the influence of the size and mutual arrangement of different soil aggregates on water and air properties of soils were undertaken by Abrol and Palta (1970), Amemiya (1965), Sokołowska (1966, 1967), Tamboli et al. (1965), and Trzecki (1973). The results of those studies have shown the effect of aggregate size of different soils on density of soil, its porosity, and pore size distribution as well as water conductivity. However, due to varied techniques of sample preparation and measurements applied by the authors mentioned above, the results obtained are uncomparable and they make the drowing of general conclusions impossible. Simultaneously it should be stressed that the knowledge of the relation between the size of aggregates and the soil water-air characteristics is the way to increase plant production to a maximum, since it enables obtaining the instructions concerning the possibilities of regulation of the components of the soil water balance as well as the growth and development of plants by changing of soil structure by means of a proper application of the agrotechnical measures.

The purpose of this study was to determine the influence of soil aggregation, understood as a differentiated aggregate composition of soil, on its water retention.

METHODS

The studies on the influence of soil aggregation on the water retention of soil were carried out on chernozem derived from loess (Werbkowice). Soil samples were taken from the arable layer (0—30 cm) since this layer is particularly submitted to the action of the agrotechnical measures which change its physical properties. This layer simultaneously determines water distribution in a soil profile. The soil samples were collected at moisture content W=25 (%kgkg^{-1}) in the form of horizontal monoliths. Then they were dried out in the laboratory in a temperature of about 20°C to air-dry state equal to 2.5—3 (%kgkg^{-1}) and fractionated by sieving them through a set of sieves into the following fractions: below 0.25, 0.25—0.5, 0.5—1, 1—3, 3—5, and 5—10 mm in diameter. To characterize the material studied the basic analysis were performed and the results are presented in Table 1.

The soil aggregate fractions separated were poured into the Kopecky' cylinders by using a vibrator which allow us to obtain a uniform density of soil samples. Thus prepared soil aggregate samples were submitted to successive wetting-drying cycles; after that the aggregate composition was stabilized and the soil samples showed invariable properties during further studies (Walczak, Witkowska-Walczak 1980).

Water retention of the soil aggregate samples being studied was determined by calculation of the soil water potential-moisture characteristics. In order to obtain such characteristics, for potentials within the range 98.1 Jm^{-3} (pF 0) — 49.033 Jm^{-3} (pF 2.7), a kaolinite block was used, while for potentials ranging from 98.066 Jm^{-3} (pF 3) to 1.471.000 Jm^{-3} (pF 4.2) pressure chambers were applied (Walczak 1977, Zawadzki, Michałowska 1974).

The determination of the soil water potential-moisture characteristics was carried out at a constant temperature 20°C. The succeeding points

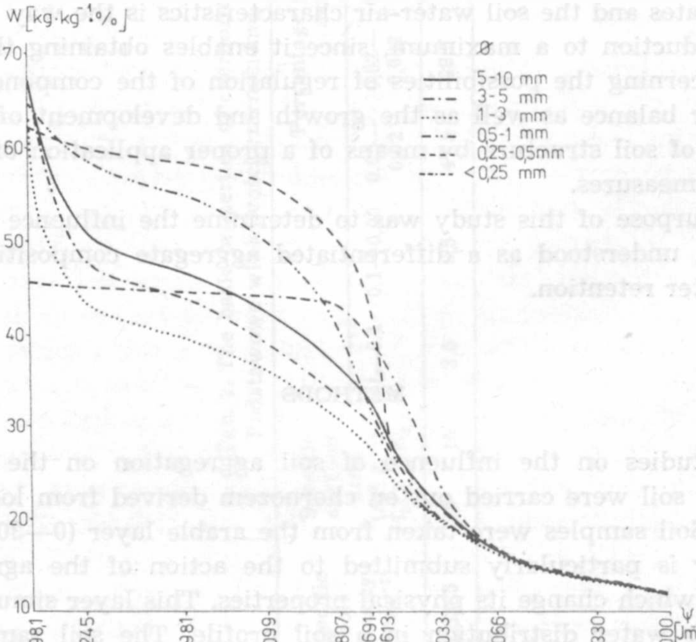

Fig. 1. Soil water potential-moisture characteristics (kgkg^{-1}%) for different soil aggregate fractions

Charakterystyki: potencjał wody glebowej—wilgotność (kgkg^{-1}%) dla różnych frakcji agregatów glebowych of the characteristics were obtained by cyclic repeating of the process from the moment of full saturation of samples with the water up to establishing of desired value of the soil water potential. While calculating useful and productive water retention, on the basis of the soil water potential-moisture characteristics, the soil water potential equal to 15.691 Jm^{-3} (pF 2.2) was considered as equivalent to field water capacity, and the potential 49.033 Jm^{-3} (corresponding to pF 2.7) as a starting point of the plant growth inhibition. That was based on the considerations given by D o m ż a ł (1977).

THE INFLUENCE OF SOIL AGGREGATE SIZE ON THE WATER RETENTION ABILITY

THE SOIL WATER POTENTIAL-MOISTURE CHARACTERISTICS OF DIFFERENT FRACTIONS OF SOIL AGGREGATES

Water retention ability of the soil aggregate samples was determined by calculating their water potential-moisture characteristics during the process of drying. The results of study are presented in two versions because characteristics have shown different courses in both cases. That was caused by the fact that in the case of expressing of moisture in mass units (%$kgkg^{-1}$), the amount of water retained by soil mass unit at a definite "suction" force is determined. The amount of water in this case depends only on the changes in the volume of pores and their distribution. Whereas in the case of expressing of moisture in volume units (%m^3m^{-3}) the change in the water amount in a unit volume in relation to soil density is also considered.

The soil water potential-moisture characteristics expressed in (%$kgkg^{-1}$) are presented in Fig. 1. The courses of the curves show the changes in the amount of water bound with different forces in a unit of soil mass. The courses of the characteristics, as can be seen from the figure, are clearly determined by the size of soil aggregates. The changes of moisture in relation to the aggregate size are the greatest for low soil water potentials. The range of the influence of aggregate size on the course of characteristics for low values of the soil water potentials can be reflected by the amount of water retained at a potential, for example 245 Jm^{-3} (pF 0.4). The values for the following fractions of aggregates: below 0.25, 0.25—0.5, 0.5—1, 1—3, 3—5, and 5—10 mm in diameter reached respectively: 45, 60, 59, 43.8, 51, and 48% ($kgkg^{-1}$).

Each soil water potential-moisture curve can be divided into certain characteristic intervals, in which the shape of its course is different. The soil moisture within the potentials from 245 Jm^{-3} (pF 0.4) to

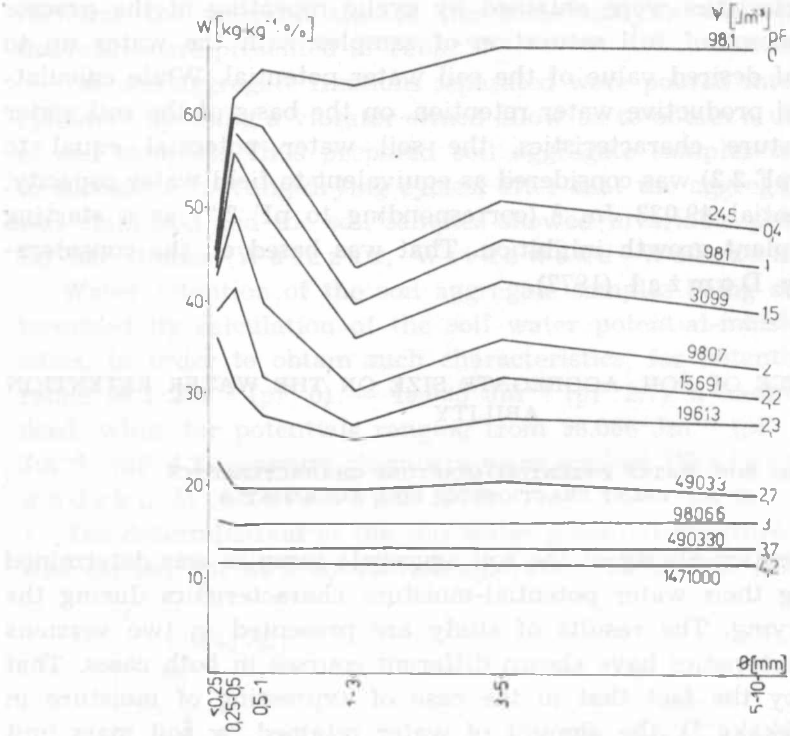

Fig. 2. Relationship between the size of soil aggregates and the amount of water contained in soil at various potentials

Zależność pomiędzy wielkością agregatów a ilością wody o różnym potencjale zawartej w glebie

9.807 Jm^{-3} (pF 2) changes only to a slight degree. As the potential exceeded the value of 9.807 Jm^{-3} (pF 2) a sharp decrease of moisture was recorded (an intensive drying process occurred), till the moment where the soil water potential reached the value of 98.070 Jm^{-3} (pF 3). After exceeding this value of the potential the change of moisture concomitant with the potential variation were again very slight.

Fig. 2 presents the relationship between the size of soil aggregates and the amount of water contained there with different potentials. As it results from the course of curves the size of aggregates influences the amount of water contained in a unit of soil mass at potentials lower than 19.613 Jm^{-3} (pF 2.3), whereas it practically does not effect the amount of water at higher potentials. The greatest amount of water of low potentials are bound by aggregates of 0.25—0.5 and 0.5—1 mm in diameter, while the lowest one by the aggregates smaller than 0.25 and 1—3 mm in diameter. Starting from the soil water potential value equal to 49.035 Jm^{-3} (pF 2.7) the amount of water in a unit of soil mass for all the soil fractions studied is similar, except for the aggregate fraction of diameter below 0.25 mm, where it is slightly higher.

The results of study presented in Figs. 1 and 2 allow us to state that the size of aggregates markedly determines the amount of water of lower potentials than 49.035 Jm^{-3} (pF 2.7) contained in a unit of soil mass, while it practically does not influence the amount of water bound by the soil with the potentials higher than 49.033 Jm^{-3} (pF 2.7). That is undoubtedly connected with the fact that water of low potentials occurs in the interaggregate pores, while water of a high potential is considerably bound by soil in the intraaggregate pores the number of which, as the studies have shown, depends on the aggregate size to a slight degree (Fig. 6).

The relationship between the soil water potential and the amount of water, expressed in m^3m^{-3}, for different soil aggregate fractions is presented in Fig. 3. Knowledge about the amount of water bound with different forces contained in a unit soil mass is particularly useful from the agricultural point of view, since the possibilities of water uptake by

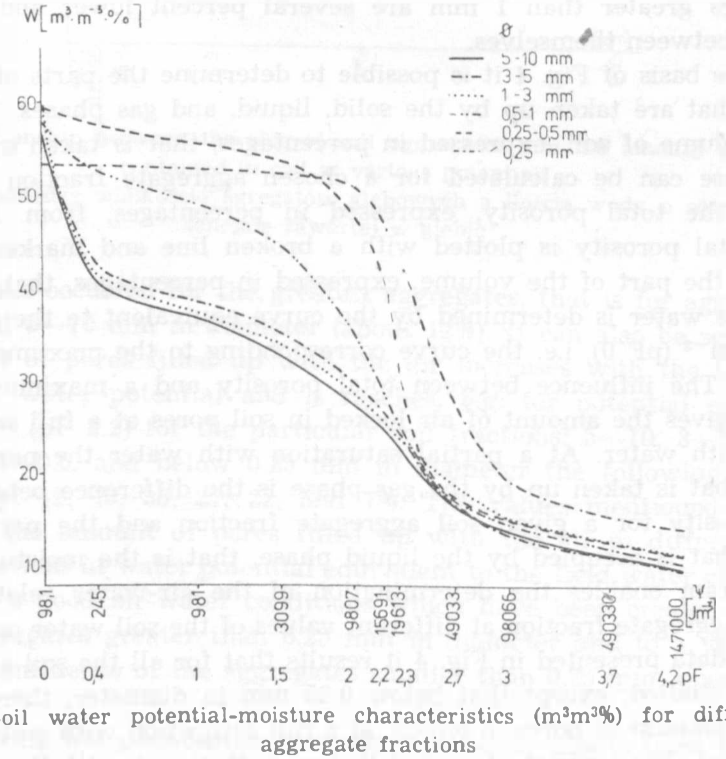

Fig. 3. Soil water potential-moisture characteristics (m^3m^3%) for different soil aggregate fractions

Charakterystyki: potencjał wody glebowej—wilgotność (m^3m^3%) dla różnych frakcji agregatów glebowych a plant are determined by the water quantity and binding force in the volume of soil embraced by the root system. Moreover, the knowledge of a such relationship enables to do the balancing of water in different layers of soil.

From the course of curves in Fig. 3 it appears that the amount of water bound with low forces (potential values to 19.613 Jm^{-3} — pF 2.3). contained in a volume soil unit, depends on the size of aggregates, while the amount of water of high potentials depends on the size of aggregates only to a slight degree. Starting from the potential equal to 49.033 Jm^{-3} (pF 2.7), maximum differences between the amount of water bound by different soil aggregate fractions do not exceed 2—3%, except a fraction of diameter below 0.25 mm, which binds higher amount of water.

Fig. 4 presents the relationship between the moisture and the size of soil aggregates for different values of the soil water potentials. It results that the highest amount of water at different potentials in soil volume unit is bound by aggregates of diameter 0.25—0.5 and below 0.25 mm. A considerably lower amount of water at different potentials is bound by aggregates of 0.5—1 mm in diameter while those bound by aggregates greater than 1 mm are several percent lower and slightly differed between themselves.

On the basis of Fig. 4 it is possible to determine the parts of the soil volume that are taken up by the solid, liquid, and gas phases. The part of the volume of soil, expressed in percentages, that is taken up by the solid phase can be calculated for a chosen aggregate fraction by subtracting the total porosity, expressed in percentages, from 100% (in Fig. 4 total porosity is plotted with a broken line and marked as P_0). Whereas the part of the volume, expressed in percentages, that is taken up by the water is determined by the curve equivalent to the potential of 98.1 Jm^{-3} (pF 0), i.e. the curve corresponding to the maximum water capacity. The influence between total porosity and a maximum water capacity gives the amount of air locked in soil pores at a full saturation of soil with water. At a partial saturation with water the part of the volume that is taken up by the gas phase is the difference between the total porosity for a given soil aggregate fraction and the part of the volume that is occupied by the liquid phase, that is the moisture. Thus this diagram enables the determination of the air-water relations for any soil aggregate fraction at different values of the soil water potentials.

From data presented in Fig. 4 it results that for all the soil aggregate fractions studied, except that below 0.25 mm in diameter, there occurs a certain amount of pores in which, at a full saturation with water, air is still present. The amount of pores filled up with the air at full saturation of soil with water depends on the size of aggregates. The highest values

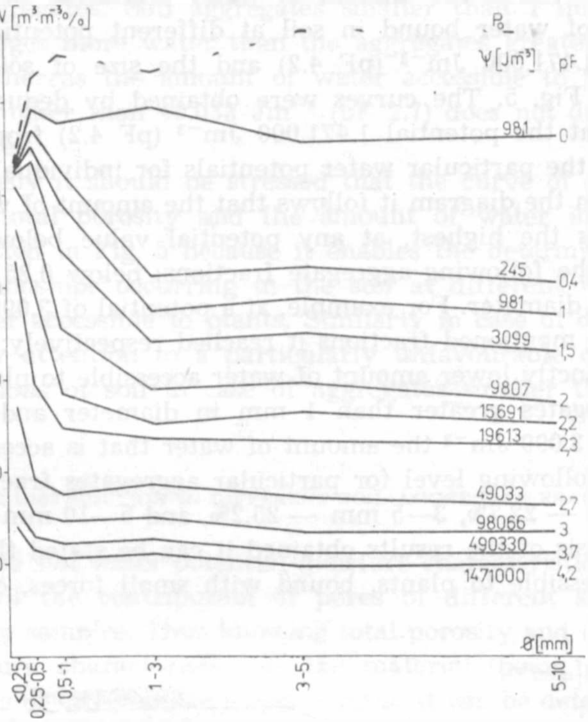

Fig. 4. Relationship between the size of soil aggregates and the amount of water contained in soil at various potentials

Zależność pomiędzy wielkością agregatów glebowych a ilością wody o różnym potencjale zawartej w glebie

of such pores occurred for the greatest aggregates, that is for aggregates of 3—5 and 5—10 mm in diameter (about 12%). It can also be seen that the amount of pores filled up with the air increases with the increase of the soil water potential and it reaches, e.g. for potential equal to 15.691 Jm^{-3} (pF 2.2) for the particular soil fractions: 5—10, 3—5, 1—3, 0.5—1, 0.25—0.5, and below 0.25 mm in diameter the following values respectively: 42, 40, 38, 27, 22, and 7%. The values mentioned above, describing the amount of pores filled up with the air in different aggregate fractions at water potential equivalent to the field water capacity, betoken to a good air-water conditions which have been created in soil by the aggregates greater than 0.25 mm in diameter and to a very unfavourable influence of the aggregates smaller than 0.25 mm, upon these conditions.

Considering the possibilities of water uptake by plants from the soil the most interesting thing is the information concerning the amount of water contained in a unit volume of soil that is accessible to plants. The relationship between the amount of water accessible to plants, that is the amount of water bound in soil at different potentials with forces lower than 1.471.000 Jm^{-3} (pF 4.2) and the size of soil aggregates is presented in Fig. 5. The curves were obtained by deducting the value of moisture at the potential 1.471.000 Jm^{-3} (pF 4.2) from the value of moisture for the particular water potentials for individual soil aggregate fraction. From the diagram it follows that the amount of water accessible to plants was the highest, at any potential value below 49.033 Jm^{-3} (pF 2.7) for the following aggregate fractions: below 0.25, 0.25—0.5, and 0.5—1 mm in diameter. For example, at a potential of 3.099 Jm^{-3} (pF 1.5) for the above mentioned fractions it reached respectively: 42.5, 37.8, and 34.4%. A distinctly lower amount of water accessible to plants was bound by the aggregates greater than 1 mm in diameter and for the same potential, i.e. 3.099 Jm^{-3} the amount of water that is accessible to plants reached the following level for particular aggregates fractions: for fraction 1—3 mm — 22.7%, 3—5 mm — 25.2%, and 5—10 mm — 22.6%.

On the basis of the results obtained it can be stated that the amount of water accessible to plants, bound with small forces, depends on the

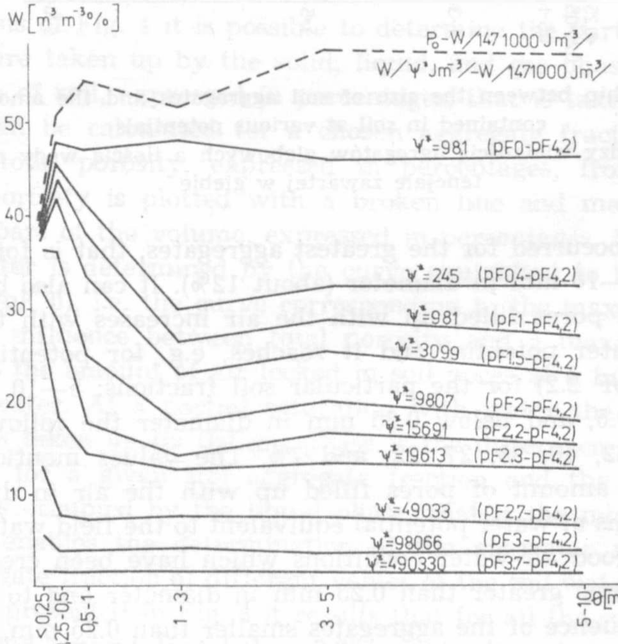

Fig. 5. Relationship between the amount of water accessible to plants at different potential and the size of soil aggregates

Zależność pomiędzy ilością wody o różnym potencjale dostępnej dla roślin a wielkością agregatów glebowych size of soil aggregates. Soil aggregates smaller than 1 mm bind from 10—20 percentages more water than the aggregates greater than 1 mm in diameter. Whereas the amount of water accessible to plants at potential values higher than 49.033 Jm^{-3} (pF 2.7) does not depend on the size of aggregates.

Simultaneously it should be stressed that the curve of course of the differences of total porosity and the amount of water inaccessible to plants was plotted in Fig. 5 because it enables the determination of the air-water relationships occurring in the soil at different values of potentials of water accessible to plants. Similarly in case of data in Fig. 4 one should pay attention to a particularly unfavourable course of the aeration conditions of soil in case of aggregates smaller than 0.25 mm in diameter.

PORE SIZE DISTRIBUTION IN DIFFERENT SOIL AGGREGATE FRACTIONS

The described soil water potential-moisture characteristics also enable determination of the contribution of pores of different size occurring in soil aggregate samples. Thus knowing total porosity and the soil water potential-moisture characteristics of the material being studied, the amount of pores of different sizes occurring in it can be determined.

Fig. 6 presents the amount of pores of different sizes occurring in the soil aggregate fractions studied. Three groups of pores were distinguished as follows:

1) pores of a diameter greater than 18.5×10^{-6} m, in which water is bound with an energy lower than 15.691 Jm^{-3} (pF 2.2), so-called large pores;

2) pores of a diameter smaller than 18.5×10^{-6} m and greater than 0.2×10^{-6} m, in which water is bound with an energy higher than 15.691 Jm^{-3} (pF 2.2) and lower than 1.471.000 Jm^{-3} (pF 4.2), medium pores;

3) pores of a diameter smaller than 0.2×10^{-6} m, which retain water with potential higher than 1.471.000 Jm^{-3} (pF 4.2), small pores, (Sokołowska 1966, Trzecki 1973).

The interdependence between the amount of the above distinguished pores conditions the air-water relations in soil. Thus small pores decide upon the amount of water inaccessible to plants, medium pores decide upon the water relations in soil, and large pores determine air relations in it. From Fig. 6 it follows that the size of the aggregate fractions studied does not affect the amount of pores of a diameter smaller than 0.2×10^{-6} m (the highest difference of their amount in relation to aggregate size reaches about 4%). Whereas the increase in the soil aggregate size

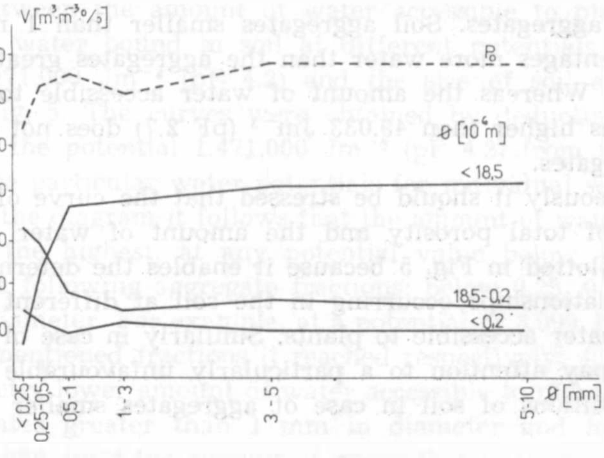

Fig. 6. The amount of pores of different size in the soil aggregate fractions studied
Ilość porów różnych wielkości w badanych frakcjach agregatów glebowych

(to 1 mm in diameter) increases the amount of large pores as follows: 7.2% for fraction below 0.25 mm in diameter and 36.6% for those of 0.5 mm in diameter, and diminishes the amount of medium pores, i.e. 32,1% for aggregates smaller than 0.25 mm, and 17.7% for the fraction of 0.5—1 mm in diameter. Further increase in the soil aggregate size from 1 to 10 mm is accompanied by a slight increase in the amount of large pores (about 5%). While the amount of medium pores does not practically change and it reaches the following values: for aggregate fraction of 1—3 mm in diameter — 14%, 3—5 mm — 16.7%, and 5—10 mm — 15.1%.

To sum up one may say that the amount of small pores does not depend on the aggregate size. That seems to be obvious considering the fact that majority of small pores exist as intraaggregate pores the number of which does not depend on the size of aggregates. This conclusion is in accordance with the results of studies carried out by Sokołowska (1966) and Trzecki (1973). A higher amount of small pores in the aggregates of a diameter smaller than 0.25 mm can be explained by the fact that part of them exist there as interaggregate pores and their magnitude is conditioned by small sizes of soil particles and thus by their closer mutual arrangement. In the case of medium and large pores, one may observe that the contribution of large pores increases with the increase of aggregates' diameter, with simultaneous decrease in the amount of medium pores, to a certain bounder (aggregate diameter — 1 mm). While exceeding that bounder further changes are not observed. Such character of the relationship is undoubtedly connected with the mutual arrangement of aggregates of different sizes in the differentiated, in respect to the aggregate composition, soil material, where greater aggregates form large pores completely or partially filled up with smaller aggregates and an increase in the aggregate diameter causes an increase of the size of pore diameter.

At the same time the possibilities of filling pores with fine aggregates are higher for smaller aggregates than for greater ones. Therefore at inconsiderable differences between the densities of samples of aggregates greater than 1 mm in diameter the relation between the amount of large and medium pores was approximated. These results can be confirmed by analysing the aggregate composition of the samples studied after multiple moistening-drying cycles, while at the beginning of the experiments the mono-aggregate samples were taken (Walczak, Witkowska-Walczak 1980).

THE USEFUL AND PRODUCTIVE WATER RETENTION OF DIFFERENT SOIL AGGREGATE FRACTIONS

Knowledge of the soil water potential-moisture characteristics enables not only the determination of the amount of water accessible to plants that is contained in the soil, but also the determination of the magnitude of useful and productive water retention which, in turn, conditions optimal water supply for growth and development of plants.

In the soil material studied the useful water retention was calculated as a difference of the amount of water contained between the field water capacity (soil water potential equal to 15.691 Jm^{-3} — pF 2.2) and the permanent wilting point of a plant (soil water potential equal to 1.471.000 Jm^{-3}, pF 4.2). The productive water retention was calculated as a difference of the amount of water contained between field water capacity and the point of a complete inhibition of plant growth (soil water potential equal to 490.033 Jm^{-3}, pF 3.7). Moreover, the point corresponding to the beginning inhibition of plant growth (soil water potential equal to 49.033 Jm^{-3}, pF 2.7) was considered as a bounder between the useful and the productive water easily and with difficulty accesible to plants (Domżał 1977). The results obtained are presented in Fig. 7.

From Fig. 7 it follows that the highest amount of water accessible to plants was retained by aggregates smaller than 0.25 mm, i.e. 32.7%, slightly lower by aggregate fraction of a 0.25—0.5 mm — 28.5%, and the lowest by aggregates of a diameter 1—3 mm — 14%. All the remaining fractions of aggregates are able to retain useful water in amount from 15.1 to 17.7%. The amount of the easily accessible useful water was also retained, to the highest degree, by the same aggregate fractions and it ranged from 20.8% for fraction 0.25—0.5 mm to 6.5% for fraction of

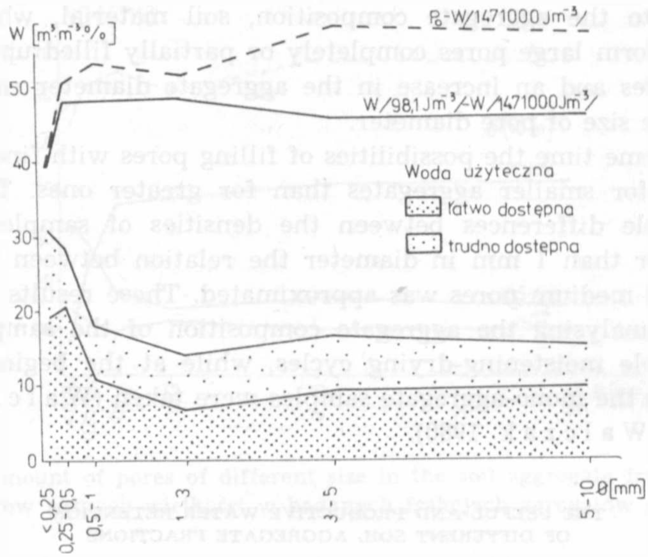

Fig. 7. The magnitude of the useful water retention for different soil aggregate fractions

Wielkość wodnej retencji użytecznej dla różnych frakcji agregatów glebowych

1—3 mm in diameter. Whereas the amount of water accessible to plants with difficulty was retained by all the aggregate fractions studied in approximately the same range (6.2—7.7%), except the smallest fraction of aggregates in which the retention was the highest (13%).

Fig. 7 also presents the values of differences between total porosity (P_0) and maximum water capacity (soil water potential equal to 98.1 Jm^{-3}, pF 0) and the amount of water inaccessible to plants (soil water potential equal to 1.471.000 Jm^{-3}, pF 4.2). The comparison of the courses of these differences with the values of the useful water retention enables the determination of the air-water conditions existing in the soil as well as the determination of the relations between the amount of water accessible to plants and the amount of useful and productive water. A particular attention should be paid to the interdependence between the total porosity and the maximum water capacity and the amount of useful water for aggregates smaller than 0.25 mm in diameter. From Fig. 7 it results that the smallest aggregates, despite binding the highest amount of water accessible to plants, are characterized by a decidedly unfavourable water-air relations because of their low air porosity (the amount of pores occupied by air reached less than 10% at the field water capacity). The most favourable water-air conditions were created by aggregates of 0.25—0.5 mm in diameter. They bound the highest amount of useful water easily accessible to plants and the amount of pores that were taken up by the air ranged from 10—20%. The other aggregate fractions bound slightly less amount of useful water (15—18%). That also ensures good air-water relations in the soil, since the amount of pores that are taken up by the air can reach even up to 35%.

The soil aggregate fractions studied retain the productive water in a similar way as the useful one, at the same time the amount of productive water is .lower about 2—4% in comparison to the useful one.

Recapitulating it can be stressed that the highest amount of useful and productive water is retained by aggregates smaller than 0.5 mm in diameter (32.1—27.1%), while the other fractions retained it in a considerably lower level (17.7—12.4%). In the aggregates smaller than 0.5 mm in diameter the amount of useful and productive water easily accessible to plants was twice as large as for the aggregates greater than 0.5 mm in diameter and reached respectively 19.1—20.8% and 6.5—10.6%. Whereas the amount of useful and productive water accessible to plants with difficulty was simillar for all the fractions studied (i.e. 6.1—7.7% and 4.6—6.3%, respectively), except the smallest fraction which retained its twice as much as the other ones (i.e. 13.0—9.6%).

It should be stressed that the most favourable water-air conditions for plants' growth in the soil are ensured by the aggregates of a 0.25—0.5 mm in diameter, while the aggregate fraction smaller than 0.25 mm creates unfavourable water-air relations, in spite of their highest ability to retain useful and productive water. That is due to the fact that they contain an insignificant amount of air.

CONCLUSIONS

The results of the studies carried out to determine the influence of soil aggregate size on its water retention ability allow us to draw the following detailed conclusions:

1. The size of aggregates influences the amount of water bound in a unit mass of soil within the range of soil water potentials from 98.1 to 19.613 Jm^{-3} (pF 0 — pF 2.3). The highest amount of water, retained in a unit mass, contains aggregates of 0.25—0.5 and 0.5—1 mm, slightly less the aggregates of 1—3 mm, and the least those below 0.25 mm in diameter.

2. The size of aggregates influences the amount of water bound in a volume unit of soil within the range of soil water potentials from 98.1—19.613 Jm^{-3} (pF 0 — pF 2.3). The highest amount of water retains the aggregates of the following fractions: 0.25—0.5 mm, below 0.25 mm, and 0.5—1 mm in diameter, and slightly lower those of diameter 1—3 mm.

3. The size of aggregates practically does not influence the amount of water contained in a volume and mass unit of soil at the potential higher than 49.033 Jm^{-3} (pF 2.7).

4. The size of aggregates influences the amount of water of different potentials that is accessible to plants within the range of soil water potentials from 98.1—19.613 Jm^{-3} (pF 0 — pF 2.3). The highest amount of water accessible to plants at different potentials are retained by the following aggregate fractions: 0.25—0.5 mm, 0.5—1 mm, and below 0.25 mm in diameter, while the least amount by those of 1—3 mm in diameter.

5. The size of aggregates determines the amount of pores in the soil as well as their distribution in such a way that the increase in aggregate diameter increases the number of large pores and simultaneously decreases the number of medium pores, while the amount of small pores does not depend on the aggregate size.

6. The size of aggregates influences the amount of useful and productive water. The highest amount of them are retained by the following aggregate fractions: 0.5—0.25 mm, below 0.25, and 0.5—1 mm in diameter, while the lowest one by the aggregate fraction of 1—3 mm in diameter.

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STRESZCZENIE

W pracy przedstawiono wyniki badań dotyczących wpływu agregacji gleby na wielkość retencji wodnej. Badania przeprowadzono dla agregatów czarnoziemu wytworzonego z lessu wyodrębnionych z warstwy ornej. Wyznaczono charakterystyki: potencjał wody glebowej—wilgotność dla różnych frakcji agregatów: <0,25 mm, 0,25—0,5 mm, 0,5—1 mm, 1—3 mm, 3—5 mm i 5—10 mm. Określono ilości porów różnych wielkości w badanych próbkach glebowych, ilości wody dostępnej, użytecznej i produkcyjnej. Stwierdzono istotne zależności pomiędzy wielkością agregatów budujących glebę a wszystkimi badanymi charakterystykami hydrofizycznymi.

РЕЗЮМЕ

В статьи показано результаты исследований касающихся определения влияния величины агрегатов почвы на способность ретенции воды. Исследования велись для агрегатов чернозема с пахотного слоя почвы. Определено характеристики потенциала почвенной воды — влажность для разных фракции агрегатов, количество пор разных диаметров в исследованных почвенных образцах, количество доступной, пользовательной и производственной воды. Замечено основные зависимости между размером почвенных агрегатов и вышеуказанными гидрофизическими характеристиками.