Plant Archives Vol. 20, Supplement 2, 2020 pp. 102-109 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF ORGANIC RESIDUES ON THE SOIL PORES SIZE DISTRIBUTION FOR DIFFERENT INCUBATION PERIODS

Hamza Kadhim Ebreesum and Ahmed Khalil Hassan AL-Sultani
College of Agriculture, Al-Qasim Green University, Iraq

Abstract

A field experiment was carried out in agricultural field silty clay loam soil, located 10 km from the center of the town of Hillah, (32° 28'24.178'N 44° 26'56.459'E), to evaluate the effect of added buffalo waste and wheat straw incubated for different periods In Distribution of soil pore size Data of water characteristic curve Includes drainable soil pores, water-filled pores and remaining pores. The experiment was conducted using the Randomized Complete Block Model (RCBD) with three replicates based on the split-plot model. The experiment included three levels of incubation after 30 (P_1), 60 (P_2) and 90 (P_3) days of mixing organic waste with soil in the main plot. While the second plot consisted of organic waste forms and rates, including buffalo and wheat straw residues with a rate of 1% and 2% depending on soil's dry weight. A total of 45 experimental units. Results of the study showed that the level of 2% of each type form of organic waste resulted in a significant reduction in the ratio of drained soil pores (0.338 to 0.287 and 0.291 cm^3 cm^{-3}) and a significant increase in the ratio of water-filled pores (0.291 to 0.299 and 0.309 cm^3 cm^{-3}) and the ratio of remaining pores (0.371 to 0.414 and 0.399 cm^3 cm^{-3}) for control and residues of buffalo and wheat respectively. Buffalo residues and wheat residues increased the ratio of remaining concurrently, while there were no significant differences in the water-filled ratio between the two types of wastes added at the same level. The results of the study also, the ratio of drained soil pores decreased significantly from 0.319 to 0.297 cm^3 cm^{-3}, besides the ratio of water-filled pores increased significantly from 0.298 to 0.300 cm^3 cm^{-3} and the remaining pores ratio improved from 0.383 to 0.403 cm^3 cm^{-3} for each P_1 and P_3 incubation period.

Keywords: Organic Residues, soil pores, Incubation Periods

Introduction

Because of their successful function in regulating and governing fluid movement and storage in the soil and providing a pore space that is essential for the biological and physiological process of the rhizosphere, pore size distribution of soil is of great importance in agricultural production (Eynard *et al*., 2004). The pore size distribution is more important than total porosity because of its close and complex relationship with other soil characteristics, especially with soil structure and stability of their aggregations and with the volumetric distribution of particales (Nimmo, 2004). The characteristic curve of soil moisture is closely associated with the distribution of soil pore size, which was the traditional method for determining and calculating the volumetric distribution of pore (Stingaciu *et al*., 2010). Nimmo (2004) has shown that the most widely used method of measuring pore size distribution is water holding curves that describe the action of a liquid substance in an unsaturated porous medium by following the concept of an efficient capillary volume that acquires or loses liquid from a given volume of pore sizes through a curve. The drying or wetting curve of the relationship between the moisture content (θ) and the moisture tension (Ψ) of the porous medium. To promote the analysis of volumetric soil pores distribution and use of pore space in two volumetric classes, namely: Large pores and known as air pores and accurate pores are capillary pores, and activities are influenced by the size distribution of pores, where capillary forces such as cohesion and adhesion and water retention in the micro porous system are a source of water and solute processing, whereas a large porous system is important for soil aeration (Eynard *et al*., 2004; Mujdeci *et al*., 2017). While Goncalvesa *et al*. (2010) described three volumetric classes of porous space based on the concept of active porosity, the remaining pores are Crypto pores, which are very fine pores of less than 0.2 μm, retaining water with great force resulting from the forces of molecular attraction and charge, and small pores The pores are between 0.2 and 50 micrometres in size where the capillary forces prevail. The wide pores are in excess of 50 micrometres. And that the internal soil drainage is caused by the effect of the attraction force of the earth. The stability of the pores associated to the stability of the soil structure, and an existence of organic matters in soil, especially in fine texture soil, has improved the structure soil significantly, this was reflected in a good volumetric porous distribution as the number, size and stability of soil pores' effective diameters increased (Eynard *et al*., 2004). Pagliai *et al*. (1985; 1998) found the time of addition to increase the pore size and change the soil pore system associated with increased soil cluster stability to be significant. Noufal (2005) clarified that adding organic matter decreases the density of the apparent soil and, depending on the type and amount of organic matter applied, increases the overall porosity and pores of water retention and micro capillary pores. Asghari et al. (2009) found that the introduction of cattle fat at 12.5 and 25 g kg^{-1} levels and 6 month incubation in sandy soils above the second level of cattle fat reduced the number of large pores (over 75 microns) and increased the number of small pores (under 30 microns). Ibrahim *et al*. (2015) suggested that the application of charcoal to soil with a mud ratio of 34.18 percent had a significant effect on the distribution of pore volumes and that fast-pore, slow-pore, and water-saving pores were the most important categories of pores. These three pores types are the main parts of soil porosity and are very important for soil fertility and plant growth. The number of fast-pore pores was 21.36, 30.69 and 25.96 %, while slow-pore pores were 14.54, 24.00 and 21.99 % and water conservation pores were 25.38 and 26.85 and 35.75 % respectively for levels 0, 5, 10 g kg^{-1}. Zhang *et al*. (2005) showed that adding organic matter to the soil increases small pores and reduces the size of large pores, thereby increasing the retention of soil water. Mujdeci et al. (2017) suggested that the application of 35 tons of green manure and green manure using traditional 0-0.1m tillage in clay soils increased large pores from 0.22 to 0.24 and 0.23, as well as small pores from 0.32 to 0.37 and 0.36 respectively Comparative treatment, field manure and green manure. The goal of this study is therefore to determine the effect of the source and amount some of organic waste With a different C:N ratio and is locally available in large quantities and incubated in the soil for different periods in the pores size distribution of soil and to determine the period length of time for addition before planting under the conditions of the study.

Materials and Methods

A field experiment was carried in Babil governorate - Hilla district, province in 1/12/2017 located at latitude 32°24.178"N and longitude 44°26'56.459"E. For silt clay loam soil, it has been graded as Traditional Torrifluvents in the Modern American Classification (Soil survey staff, 2010). Before the start of the experiment, disturbed and normal (undisturbed) soil samples from different field areas measuring 31x12 m with a depth of 0-0.2 m were taken randomly. The disturbed samples were well mixed and a composite sample was taken to measure some of the soil's physical and chemical properties as shown in Table1. The general characteristics of the study soil were estimated according to the working methods listed in Black (1965), including its physical characteristics. The distribution of soil particle size was calculated by pipet method and the bulk density was determined by the density bottle and the moisture content when saturated by the gravimetric process, using the Core method and the particle density, at the field potential and at the wilting point under the strain of moisture (33 and 1500 kpa) in the laboratory, using pressure cells and relay pressure disks.

Table 1 : Some of the physical and chemical properties of the soil for depth 0-0.2 m.

Properties	Measuring unit	The value
Bulk density	Mgm m^{-3}	1.31
Partical density		2.65
Sand	gm kg^{-1}	192.04
Silt		482.28
Clay		325.67
Texture	Silt Clay loam	
moisture content when tension 0 Kpa	%	45.59
moisture content when tension 33 Kpa		30.65
moisture content when tesion 1500 Kpa		17.84
Available water		12.81
ECe	dSm^{-1}	3.5
pH		8.00
Organic matter	gm kg^{-1}	182
Carbonates mineral		226.8

The field soil was tillage of the plow of the mold board to a depth of 0.2 m and harrowing vertically on the tillage lines by the disk harrows, and then the field soil was settled and divided into three equal blocks the area defined for the experiment and a distance of 2 m between one block and another, then each block was divided into 15 experimental units with an area of 2 m^2 per experimental unit, leaving within one duplication a distance of 1 m between one experimental unit and another, increasing the number of experimental units to 45 experimental units. The experiment was designed by split-plot design using the entire RCBD sector's entirely randomized block design (5). The experiment included two factors, Main plot included: the incubation period (P), which included the following periods: after 30 (P1), 60 (P2), 90 (P3) days of the process of mixing organic waste with soil. While the second factor (sub-plot) included the organic waste form and amount (L): no organic residue (control treatment) (L0). Adding buffalo residues by 1% based on soil's dry weight (L1), adding 2% buffalo residues based on soil's dry weight (L2), adding 1% wheat straw residues based on soil's dry weight (L3) and adding 2% wheat straw residues based on soil's dry weight (L4). Buffalo residue aeration was dried and milled, then sieved with a sieve of 2 mm and put in special bags until the soil was mixed, wheat residues were prepared after drying and brushed using field jars to cut wheat straw into small parts, then samples of each type of organic residue were taken and the humidity content was measured at 65^0 in volume. After sieving the sample with a sieve (2 mm) and table (2) showing some of the chemical properties of organic residues used in the experiment, some chemical analyzes were also performed for each residue type described.

Table 2 : Some chemical properties of type of added organic residues.

Type of added organic residues	EC	pH	Organic matter	Organic carbon	Total N	Total P	Total K	C/N Ratio
	DSm^{-1}		gm kg^{-1}					
Buffalo residue	15	8.5	563.7	327.4	13.95	7.62	11.58	23.46
Wheat straw residues	9.8	6.8	721.8	418.7	7.240	1.361	14.92	57.83

The organic waste mixture was incubated in the soil for previous incubation cycles according to its form and level of addition to the experimental unit soil of 0.2m depth. After 50 % depletion of the available water, the experimental units were irrigated by a free flow irrigation system to meet the field potential by continuously sampling the soil and assessing the weighty moisture content. According to Klute (1965), the amount of water added is determined.

At the end of each incubation period, i.e. after 30, 60 and 90 days of mixing, soil moisture characteristic curves were established on undisturbed natural soil samples with core metal cylinders and disturbed soil samples taken from the depth of 0-0.2 m from each experimental unit. This measured the moisture tensions of the various treatments at moisture tension values ranging from 0 kPa to 1500 kPa, as used pressure cells (Tempe Cells) to estimate the moisture content at voltages 0, 10, 33 and 100 kPa, enabling the use of metal core rings containing natural soil samples and pressure plate devices for voltages 200, 500, 1000 and 1500 kPa. They were washed, milled and passed through a 2 mm sieve in which special rubber rings were used for the samples, in which disturbed soil samples were used. This is according to the approach used by Richards (1954) in Black *et al*. (1965). The approximate mass moisture content values at various moisture tensions have been translated into volumetric moisture content (θv) based on each treatment's calculated bulk density values. The logarithm scale derived the relationship between volumetric moisture content and matric water potential. A suitable match was made with the Van Genuchten equation (Van Genuchten, 1980) and defined the relationship between the moisture content (θ) values and the corresponding moisture tensions (Ψ) for different treatments using the following relation:

$$\theta = \theta_0 + (\theta_s - \theta_0)\left[1 + (\alpha\psi)^n\right]^m \qquad ...(1)$$

Both the $\boldsymbol{\theta}_r$ and θ_s are residual and saturated water content respectively, and n and m are constant experimental parameters depending on their value of the relationship between range (m) and distribution of pore size, assuming m=1-1/n. The parameters for the Van genuchten equation (m, n, r, r) are evaluated using a non-linear fitting RETC code algorithm. Moisture characteristic curve data and the Young-Laplace equation (Danielson and Sutherland, 1986) were used to estimate the pore size distribution.

$$r = \frac{2\gamma \operatorname{Cos}\sigma}{P_w g \psi} \qquad ...(2)$$

That is the Ψ : moisture tension (cm), γ surface tension of the water equals 72,7 g sec^{-2} at 20° C, σ is the contact angle between water and soil (assuming it is equal to zero), the water density Pw (1 g cm^{-1}), the ground acceleration g (980 cm sec^{-2}), and the effective pores radius r (cm) which represents the value of the shortest distance between the centre of the pores and any point of the wall of the soil pores (from its circumference), in order to determine the pores of an effective radius r and any strain on the soil from which to determine the size of the porous space representing the sum of pores discharged from the water between each of the two consecutive moisture contents θ_1, θ_2 the radius r is limited between r_1 and r_2 (Russell, 1941) according to the following equation:

$$\theta\Delta = \theta_1 - \theta_2 \qquad ...(3)$$

Then the ratio of the discharged porous space size to the saturated porous space size was then calculated by dividing the porous space size between each of the two successive moisture content on the soil's saturation moisture content.

The values of moisture content based on volume were used to calculate the pore size distribution, as the values of moisture content confined between saturation and moisture tension 330 cm, which have a radius of r greater than 0.000446 cm (<4.46µ) were taken to represent large pores (the size of the drainable soil pores) (Russell, 1941). The values of the moisture content between 330 and 15000 cm are limited to 0.000446-0.000146 cm (4.46-0.147µ) to reflect the size of water-filled pores in the soil. The values of 15000 cm moisture content with a radius of r less than 0.0000147 cm >) 0.147µ were taken as representing the size of the remaining pores in the soil, and this classification was calculated by Startsev and McNabb(2001), Eynard *et al*. (2004).

Statistical Analysis

Results for statistically different properties were analyzed using the Genstat Discovery (2012) program to evaluate the difference between treatments similarities and overlaps and to use the F-test and the lowest moral difference LSD at a probability level of 0.05 to compare averages.

Results and Discussion

Effect of organic residue levels and incubation periods in the pores size distribution of soil

Table 3 showed a significant impact of added organic residue levels on the average ratio of drained soil pores, which decreased from 0.338 to 0.309, 0.288, 0.314 and 0.291 for both L0 and 1% and 2% for each of the buffalo and wheat straw residues respectively. The table findings also revealed a significant effect of the organic residue type on the understudy characteristic values averages, as there was the largest decrease in buffalo residue average characteristics relative to and for both levels of wheat straw. The table results also showed the significant effect of incubation periods on averages of the ratio of drained soil pores, with the highest average of the characteristic under analysis being 0.318 at the P_1 incubation period and the lowest average being 0.297 under the P_3 incubation period influence. The results of the interaction between the levels of organic residues and the incubation period mentioned in Table 3 show that there are significant differences in the values of the characteristic under analysis, with a high of 0.339 at P_1L_0 interaction treatment and a low of 0.272 at P_3L_2 treatment and an increase of 24.567%. The Interaction results also showed that there are significant differences in the values of the characteristics being tested between the two types of residues under the influence of the same level of addiction and for all incubation periods except for the incubation period P_1 and the additional two-level incubation period P_2 as well as the additional two-level incubation period of only 2% between the two types. This result shows that buffalo residues are superior in the amount of reduction on wheat residues at the two incubation periods P_2 and P_3 at the additional level of 1%, while buffalo residues surpassed the amount of wheat residue understudy at both levels 1 and 2% at the incubation period P_3.

From table 4, the water-filled pores ratio showed a significant influence of the additional levels of each type of organic residue in the average water-filled pores ratio, with the highest average of 0.309 at the additional level of L_4 and the lowest average of 0.291 at the control treatment L_0. The findings also indicate significantly higher levels of L_3 and L_4 (level 1 and 2% wheat residue) at the level of L_0 (no addition). The amount of increase in water-filled pores to L_4 (2% wheat residue) was also significantly superior compared to the same level of L_2 buffalo residues. The table findings also showed an increase in the average values of water-filled pores with the increased period of incubation, but this change was not important for all periods of incubation. The results of the interaction between the two factors shown in Table 4 showed a significant impact in water-filled pores values with the highest P_3L_4 value and the lowest P_3L_4 value under P_3L_0 treatment. It was also noted through the results that, as the incubation period increases and the degree of addition of both types of residues increases, significant differences are clearly expressed in the P_3 incubation period relative to the P_3L_0 control procedure, except for the P_3L_1 treatment. It was also found that, as compared to each other, there were no significant differences between the two types of residues at the same stage of addiction for all incubation times and between the two levels of the same type.

The influence of the remaining pores ratio by the factors used in the research showed that the results of Table 5 showed a significant impact of the additional levels of each type of organic residue on the average values of the remaining pores ratio, with a significant increase in the characteristic values under study from 0.371 to 0.397, 0.414, 0.384 and 0.384 and 0.399 for both L_0 and 1% and 2% control treatment for each residue of buffalo and wheat straw, respectively. Table 5 results also showed significant differences in the average values of the ratio of the remaining pores between the two groups of organic residues, as the residues of buffalo were significantly higher and both amounts were compared to the residues of wheat. The table results also showed the significant effect of incubation period scoring averages of the remaining pores ratio. Under the influence incubation period of P_3, the highest average was 0.403 and the lowest average was 0.383 under the influence incubation period of P_1. This finding shows that the average values of the ratio of the remaining pores increase significantly as the incubation period increases. The results of the interaction between the levels of organic residues and the incubation period mentioned in Table 5 show that there are significant differences between the values of the target characteristics, with the highest value of 0.424 under P_3L_2 and the lowest value of 0.368 under P_1L_0. The Interaction findings also showed that there were significant differences between the two types of residues in the values of the ratio of remaining pores. Residues of buffalo and both levels were significantly higher than the residues of wheat straw and for all periods of incubation.

Results from Tables 3, 4 and 5 indicate that the increased level of addition of both types of residues resulted in a significant decrease in the average value of the drained soil pores ratio and a significant increase in the average value of the water-filled pores ratio compared to the level of L_0 (no addition). This is due to the decrease in the size of large pores due to increased organic soil content, which enhances the quality of soil aggregates (size and type), and increases small pores and reduces the size of large pores, resulting in increased water conservation and retention (Zhang *et al.*, 2005) and reduced susceptibility The soil is drainable on the water. It also increases the surface area of the improved soil, raises the capillary pores ratio and therefore improves the ability of the soil to hold water. This was consistent with the findings of Mujdeci et.al (2017), Seguel (2013) and Pagliai (1998). They observed a substantial reduction in the ratio of large pores and an improvement in the ratio of water-filled pores and the remaining pores in the soil with an increased level of organic matter.

There were also significant differences between the two types of organic residues at a confidence level of 5%, as buffalo residues override in decrease the average values of the ratio of the drained soil pores and increase the values of the ratio remaining pores compared to the residues of wheat and for both levels, while the level of addition L_4 (2% residues of wheat) significantly in increasing the ratio of water-filled pores compared to the same level of buffalo residues L_2. This impact on buffalo residues is due to the low C/N ratio of buffalo residues and their increased degradation, which enhances soil construction and the distribution of pore size in the direction of the reduced size of large pores in the soil (Zhang *et al.*, 2014). Reducing the water drain ability is higher than the residue of wheat. And there is a further increase in the number of capillary pores in the soil relative to wheat residues. The effect of buffalo residues in the water-filled pores ratio is also related to the role of wheat residues in reducing soil bulk density values and increasing overall porosity, Which is attributable to the roughness of the wheat residue parts and the increase of their pores, thereby increasing the ratio of water-filled pores more than buffalo residues and this result is consistent with Zhang *et al.* (2012) indicated that water-holding pores increase the residue of wheat in this range of soil moisture characterization curves due to the large size of the wheat residue parts and the higher residue pieces.

The results of Tables 3, 4 and 5 also show that as the incubation period increases, the average ratio of water-filled pores decreases and the ratio of remaining pores increases significantly, as well as the average stored values increase the ratio of water-filled pores with increased incubation period. This is due to the study of organic residues and the high organic carbon soil content, which has enhanced the stability of soil aggregates and increased soil porosity as a result of increased water-filled pores and fine capillary pores. Therefore, the volume of large pores decreases as the number of pores increases sharply when the pores ' diameter is decreased, as well as due to the content of humic acid organic humification matter and high viscosity glues that help to increase the interaction of soil particles to form aggregates containing internal pores (Inside the aggregate) and inter-pores (Russell, 1971). The organic matter ratio is also raised, which plays an important role in raising the surface area and increasing the capillary pores of the soil due to its high surface area and high capillary pores content (Hudson, 1994; Khaleel *et al.*, 1981).

It also indicates from the results of the interaction between the levels of organic residues and the incubation period that as the level of addition of both types of residues increases and the incubation period increases the ratio values of drained soil pores and the ratio values of water-filled pores significantly increases the ratio of remaining pores. And the results of the interaction also excellence buffalo residues in the decrease in the ratio values of the drained soil pores and the ratio values of the remaining pores, while the residues of wheat have excelled in the ratio values of water-filled pores which are important with increased incubation period, in particular the incubation period P_3.

Table 3 : The effect of organic residue levels and incubation periods on in the ratio of the drained soil pores.

Incubation periods	Organic residue levels					Averages
	L_0	L_1	L_2	L_3	L_4	
P_1	0.339	0.323	0.302	0.324	0.305	0.319
P_2	0.338	0.309	0.289	0.316	0.292	0.309
P_3	0.338	0.294	0.272	0.303	0.276	0.297
Averages	0.338	0.309	0.288	0.314	0.291	0.308
$L.S.D_{0.05}$ L 0.002	$L.S.D_{0.05}$ P*L 0.004					$L.S.D_{0.05}$ P 0.003

Table 4 : The effect of organic residue levels and incubation periods on in the ratio of water filled pores.

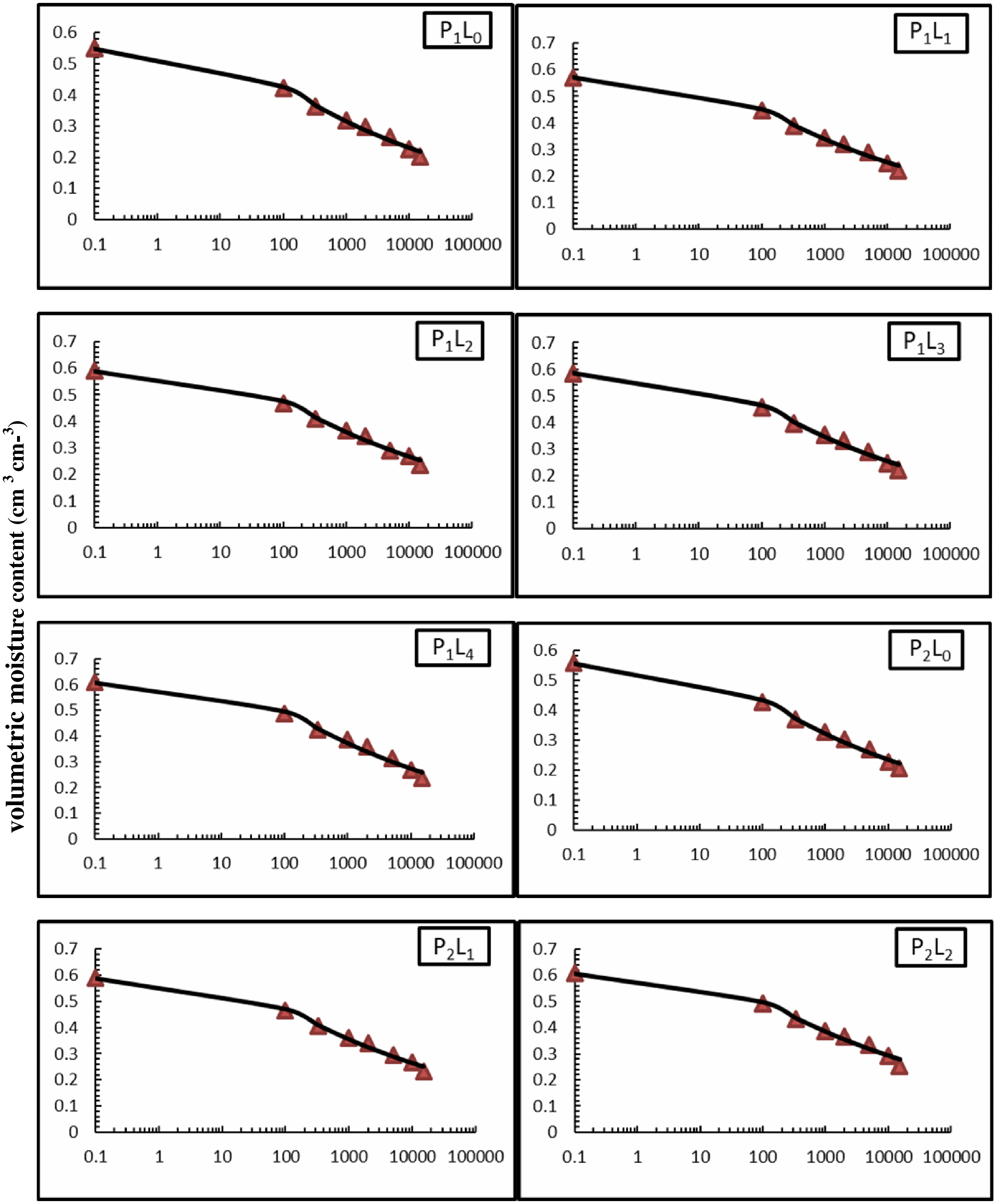
Incubation periods	Organic residue levels					Averages
	L_0	L_1	L_2	L_3	L_4	
P_1	0.292	0.293	0.296	0.301	0.307	0.298
P_2	0.291	0.295	0.296	0.300	0.309	0.298
P_3	0.289	0.294	0.303	0.303	0.312	0.300
Averages	0.291	0.294	0.299	0.301	0.309	0.299
$L.S.D_{0.05}$L 0.008	$L.S.D_{0.05}$ P*L 0.014					$L.S.D_{0.05}$P 0.008

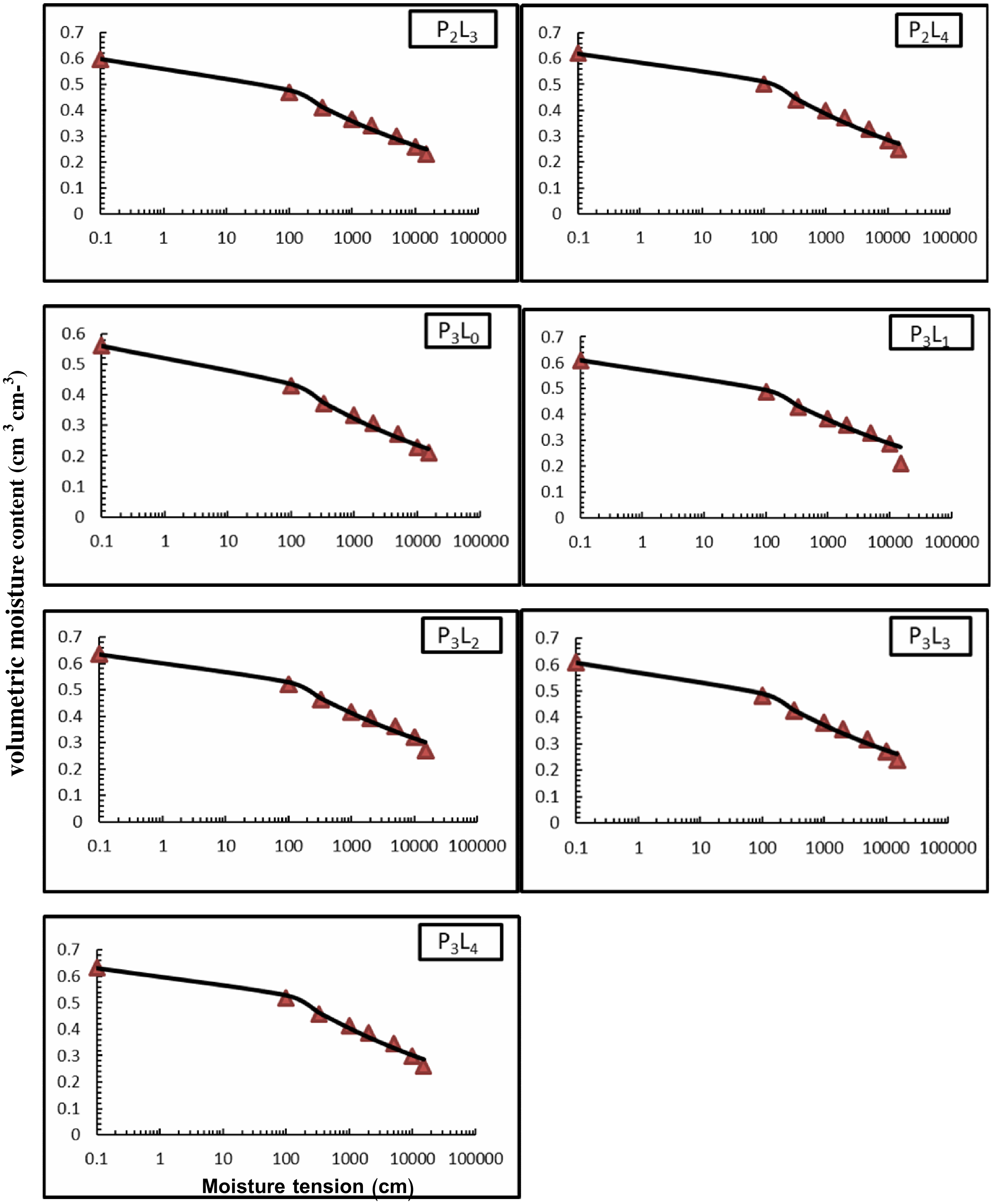
Table 5 : The effect of organic residue levels and incubation periods on in the ratio of remaining pores.

Incubation periods	Organic residue levels					Averages
	L_0	L_1	L_2	L_3	L_4	
P1	0.369	0.384	0.401	0.375	0.387	0.383
P2	0.372	0.396	0.415	0.383	0.399	0.393
P3	0.372	0.412	0.424	0.394	0.412	0.403
Averages	0.371	0.397	0.414	0.384	0.399	
$L.S.D_{0.05}$L 0.00276	$L.S.D_{0.05}$ P*L 0.00473					$L.S.D_{0.05}$P 0.00279

Effect of organic residue levels and incubation Periods in the moisture characterization curves of soil

The moisture characterization curves of various soil treatments are shown in Figure 1. The figure shows a comparison between the moisture characterization curves of different soil treatments, and soil models increase their ability to retain water with increased levels of addition of each residue type and increased incubation period at all levels of soil moisture tension (from 0.1 to 1500 kPa). Especially when low-level moisture tension. Under the influence of control treatments P_3L_2 and P_3L_4, r, the maximum volumetric moisture content at moisture tension was 33 kPa (field capacity) of 0.4619 and 0.4578 cm^3 cm^{-3}. The lowest level in the control procedure was 0.3635 cm^3 cm^{-3}, with an improvement of 27.07% and 25.94%. It is also noted that the moisture content at high moisture tensions (above 100 kPa) is the same behavior as each form of residue increases the degree of addition and increases the incubation period. The highest volume routing content at moisture tension 1500 kPa (permanent wilting point) was 0.2693 and 0.2606 cm^3 cm^{-3} under the influence of treatments P_3L_2 and P_3L_4 and the lowest moisture content was 0.2027 cm^3 cm^{-3} under P_1L_0 (control treatment) An increase of 32.85 and 28.56%. It is also noted that in buffalo residues, as the incubation period increases, the water tension is higher than and for both levels of wheat straw. Changes in water volume kept at different moisture tensions are due to changes in pores volume distribution due to changes in organic soil content. The reason for the increase in volumetric moisture content with the increased level of addition of each type of residue and the increased incubation period is due to the increase in the soil's ratio of organic matter resulting from the addition of these residues, which improve soil structure, decrease their bulk density and increase total porosity by increasing soil aggregate stability, in addition to decomposing added organic residues and raising the ratio of organic humus, which plays an important role in growing the soil's ability to retain water to extend its natural surface area, containing a significant number of active aggregates and increasing capillary pores resulting in increased soil retaining potential (Hudson, 1994; Khaleel *et al*., 1981).


volumetric moisture content (cm ^{3} cm^{-3})
P_1L_0
P_1L_1
P_1L_2
P_1L_3
P_1L_4
P_2L_0
P_2L_1
P_2L_2
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
0.1 1 10 100 1000 10000 100000



Shape 1: The moisture characterization curves for different soil treatments.

Conclusions

From the above findings, we consider that the increase in the level of addition of both types of residues and the increase in the incubation period resulted in a significant decrease in the ratio of drained soil pores and a significant increase in the ratio of water-filled pores and remaining pores compared to level L0 (no addition), Since buffalo residues excelled the values of drained soil pores and increased the values of the remaining pores, wheat residues excelled significant increasing the ratio of water-filled pores with increased incubation period, as found Also significant effect of the type of residues, especially incubation period P3. Such improvements in the distribution of pores resulted in significant changes in the volume of water retained at various moisture tensions due to changes in organic soil content as significant changes occurred between the water characterization curves with different soil treatment, and soil samples are increasingly capable of retained water with increased levels of addition of each residue type and increased incubation period at all levels of soil moisture tension (from 0.1 to 1500 kPa), especially at low moisture tensions.

References

Asghari, S.; Neyshabouri, M.R.; Abbasi, F.; Aliasgharzad, N. and Oustan, S. (2009). The effects of four organic soil conditioners on aggregate stability, pore size distribution, and respiration activity in a sandy loam soil. Turkish J. of Agric. and Fores, 33(1): 47-55.

Black, C.A. ED. (1965). Methods of soil analysis. part2 chemical and microbiological properties.Am.Inc Madison. Wisconsin, USA. Soc. Agron.

Black, C.A.; Evans, D.D.; White, J.L.; Ensminger, L.E. and Clark, F.E. (1965). Methods of Soil Analysis part 1. Agron. Mono No. 9(1): 128-136; 210-215; 371-373; 374-377; 391-397; 400-412; 545-567. Am. Soc. Agron. , Madison Wisconsin, USA.

Danielson, R.E. and Sutherland, L.P. (1986). Porosity. In: Methods of Soil Analysis. Part 1. Physical and Mineralogical Methods. 2nd ed.,(ed. A. Klute). Madison, WI: Am. Soc. Agron. 443-461.

Elsahookie, M. and Waheeb, K.M. (1990). Applications in design of experiments. Dar-Alhikma for printing. Univ. Mosul., 488.

Eynard, A.; Schumacher, T.E.; Lindstrom, M.J. and Malo, D.D. (2004). Porosity and pore-size Distribution in cultivated Ustolls and Usterts. Soil Sci. Soc. Am. J., 68: 1927-1934.

Goncalvesa, R.A.B.; Gloaguen, T.V.; Fole gatti, M.V.; Libardi, P.L.; Lucas, Y. and Montes, C.R. (2010). Pore size distribution in soils irrigated with sodic water and wastewater. R. Bras. Ci. Solo., 34: 701-707.

Hudson, B. (1994). Soil organic matter and available water capacity. J. Soil Water Conserv, 49: 189–193.

Ibrahim, M.M.; Mahmoud, E.K. and Ibrahim, D.A. (2015). Effects of vermicompost and water treatment residuals on soil physical properties and wheat yield. International Agrophysics, 29(2): 157-164.

Khaleel, R.; Reddy, K.R. and Overcash, M.R. (1981). Changes in soil physical properties due to organic waste applications: a review 1. J. of Envir. Qua., 10(2): 133-141.

Klute, A. (1965). Laboratory measurement of hydraulic conductivity of saturated soil. In Black, C.A. *et al*. (eds.). Methods of Soil Analysis. Agron. Mono. Am. Soc. Agron. Madison. Wisconsin USA, 9(1): 253-361.

Mujdeci, M.; Isildar, A.A.; Uygur, V.; Alaboz, P.; Unlu, H. and Senol, H. (2017). Cooperative effects of field traffic and organic matter treatments on some compaction-related soil properties. Solid Earth, 8(1): 189-198.

Nimmo, J.R. (2004). Porosity and pore size distribution. In Hillel, D. (ed.) Encyclopedia of Soils in the Environment: London, Elsevier., 3: 295-303.

Noufal, E.H.A. (2005). Effect of application agriculture organic wastes on properties of a sandy soil, and barley grown on the soil. I- Physical and chemical properties of the soil. Annals of Agriculture science, moshtohor, 43(3) :1309–1323.

Pagliai, M.; Marca, M. La and Lucamante, G. (1985). Relationship between soil structure and time of landspreading of pig slurry. In wng-term Effects of Sewage Sludge and Farm Slurries Applications (Eds. J.H. Williams, G. Guidi and P. L'Herrnite), Elsevier Applied Science Publishers, London, 45-56.

Pagliai, M. (1998). Soil porosity aspects. Int. Agrophys., 4: 215–232.

Richards, A. (1954). Diagnosis and improvement of saline and alkali soils agriculture. Hand book No. 60. USDA Washington.

Russell, M.B. (1941). Pore size distribution as a measure of soil structure. Soil sci. soc. Am. Proc. 6: 108- 112.

Russell, E.W. (1971). Soil Structure: its maintenance and improvement. J. Soil Sci. 22(2): 127-151.

Seguel, O.; Baginsky, C.; Contreras, A.; Covarrubias, J.I.; González, C. and Poblete, L. (2013). Physical properties of a fine textured haplocambid after three years of organic matter amendments management. J. Soil Sci. and Plant Nutr, 13(3): 690-705.

Soil survey staff (2010). Keys to soil taxonomy. 10^{th}ed. NCRS.USDA. Washingtons, USA.

Startsev, A.D. and McNabb, D.H. (2001). Skidder traffic effects on water retention, pore-size distribution, and van Genuchten parameters of boreal forest soils. Soil Sci. Soc. Am. J., 65: 224-231.

Stingaciu, L.R.; Weihermüller, L.; Haber Pohlmeier, S.; Stapf, S.; Vereecken, H. and Pohlmeier, A. (2010). Determination of pore size distribution and hydraulic properties using nuclear magnetic resonance relaxometry: A comparative study of laboratory methods. Water Res. Res. 46(11).

Van Genuchten, M.Th. (1980). A closed. From equation for predicting the hydraulic conductivity of unsaturated soil. Soil Sci. Soc. Am. J., 44: 892-898.

Zhang, Q.; Worsnop, D.R.; Canagaratha, M.R. and Jimenez, J.L. (2005). Hydrocarbon-like and oxygenated organic aerosoils in Pittsburgh: insights into sources and processes of organic aerosols. Atmospheric Chemistry and Physics, 5: 3289–3311.

Zhang, J.K.; Jiang, C.S.; Hao, Q.J.; Tang, Q.W.; Cheng, B.H.; Li, H. and Chen, L.H. (2012). Effects of tillage-cropping systems on methane and nitrous oxide emissions from agro-ecosystems in a purple paddy soil. Environmental Science, 33: 1979–1986.

Zhang, X.F.; Xu, S.J.; Li, C.M.; Zhao, L.; Feng, H.Y. and Yue, G.Y. (2014). The soil carbon/nitrogen ratio and moisture affect microbial community structures in alkaline permafrost-affected soils with different vegetation types on the Tibetan Plateau. Res. Microbiol. 165: 128–139.