THE EFFECT OF THE TRACTOR-IMPLEMENT PASSES ON THE SOIL PENETRATION RESISTANCE OF PLOWED SILTY CLAY SOIL

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SUMMARY

This research was conducted to evaluate the soil penetration resistance of the plowed and unplowed soil expressed by the cone index. The experiments were conducted using deep digger moldboard plow. The experiment parameters are three plowing depths (10, 15 and 25cm) two moisture content levels (16.1% and 24.5%) and five tractor-implement combination passes. The tractor-implement combination was passed vertically on the direction of the plowing once, twice, three, four and five times. The experiments were replicated twice times. The cone index measurement was taken to the soil depths 0-5, 5-10, 10-15, 15-20 and 20-25cm and the measurement carried out in the middle and both sides of the tire rut. The experiments were conducted in silty clay soil. The total weight of the tractor and the moldboard plow is 31.78kN. The inflation pressure of the front and rear wheels are 2.5bar and 1.0bar respectively. The result showed that the soil penetration resistance of the unplowed soil increased from 2819.24 to 5403.55kN/m^2 (91.7%) and from 1318.18 to3766.99 kN/m^2 (185.8%) when the depth increased from 0-5 to 20-25cm for the moisture contents of 15% and 24.5% respectively. When the soil was plowed the soil penetration resistance decreased (average) from 4181.8 to1352.0 kN/m^2 (67%) and from 2584.71 to 1239.50kN/m^2 (52%) for the same moisture content levels respectively. When the tractor-implement combination passed once on the soil surface the highest soil penetration resistance (compaction) recorded for depth of 5-10 in both MC levels while the second highest values was recorded for the soil surface (0-5cm) and then decreased with depth. The highest values of the soil penetration resistances are 4742.45 and 4025.12 kN/m^2 for MC of 16.1% and 24.5% respectively. For five passes the trend of soil penetration resistance remained the same as it was for one pass. But for five passes the values increased considerably, for depth of 5-10 the soil penetration resistance is

6343.30kN/m^2 and 5544.52kN/m^2 for MC levels 16.1% and 24.5% respectively. The results showed that the soil penetration resistance exceeded the value of that of unplowed soil in the first pass in soil of higher MC (24.5%) but for the soil of lower MC (16.1%) it exceeded the value of the unplowed soil at third pass. The soil penetration resistance of the plowed soil decreased as the plowing depth increased for both MC levels. When the soil was passed on by the tractor-implement combination, it was severely compacted and exceeded the values before plowing. In the soil of MC of 16.1% the soil penetration Resistance increased from 1486.27, 1465.22 and 1352.02 kN/m^2 to 4710.17, 4241.77 and 4607.54kN/m^2 (216.9%, 189.5% and 240.8%) while for the soil of MC of 24.5% it increased from 1339.12, 1295.37 and 1239.49kN/m^2 to 3808.26, 3604.34 and 3678.71kN/m^2 (184.4%, 178.4% and 196.8%) for plowing depths of 10, 15 and 25cm respectively.

Keyword: soil penetration resistance, soil moisture content (MC), compaction, number of passes

Introduction

The soil penetration resistance is an indicator to the soil compaction. When the soil penetration resistance is high the soil bulk density is high and that reduces the soil water infiltration and would cause shortage in soil aeration (1,3,8). The soil compaction is caused by the pressure imposed by the implements passes on the soil surface. The pressure affects on the soil depends on the soil texture and moisture content and on the number of implement passes on the soil surface (1,17,18,20). The soils of lighter texture and their moisture content within the suitable rang for compaction the soils compacted more readily than the other types (9,10,12,13). The highest soil penetration resistance recorded at the middle of the contact area of the tractor or implement tires and the compaction results from the implement passes penetrate the soil top layers to the deep layers and that depend on the weight, contact area of the tires and soil texture and moisture content (1,7,8,14,15). The effect of the pressure on the soil compaction is divided to slight, moderate and severe pressures when the penetration resistance values are 30%, 75% and 100% out of the maximum reading of the tool which is 44kN/m^2 respectively (6). The soil is also compacted at the bottom of the furrow (soil smearing) caused by the moldboard body and disk plows. The soil penetration resistance depends on the moisture content and the soil bulk density and on the depth when the soil bulk density is constant (4,5). The soil penetration resistance also increases when the soil moisture content decreases and that because the soil particles become denser which increases its strength (5,11).

The soil penetration resistance is highly affected by the number of passes of the tractor tires or tracks on the soil surface. It increases as the number of passes increases and the highest values would be recorded for the top layers because the pressure underneath the tractor tires concentrated at these layers. The aim of this research is to study the effect of the number of the tractor-implement passes, the soil moisture content and the plowing depth on the soil penetration resistance of plowed silty clay soil (soil compaction).

2.0 materials and methods

2.1 The Massey Ferguson 285S

Massey Ferguson 285S was used to carried out the experiments. The tractor is two wheels drive tractor produced by UZEl Company 1995. The engine power is 56.6kW. The total tractor weight is 30kN. The rear and front wheels weights are 17.37kN and 12.63kN respectively. The rear tires size is 18.4/15-30. The rear tires diameter and width are 1.70m and 0.381m respectively. The size of the front tires 16-7.5. The diameter and the width of the front tires 0.91 and 0.19m respectively. The rear tire grousers height, width and inclination angle are 4cm, 4cm and 45^o respectively. The inflation pressure of the rear and front tires are 1bar ($100kN/m^2$) and 2.5bar ($250kN/m^2$) respectively.

2.1 Moldboard plow

Deep digger moldboard plow was used to conduct the experiments. The plow consists of three bodies. The plow is provided with pin point penetrator to increase the ability of the plow to penetrate the soil to the required depth. The total weight of the moldboard plow is 1.78kN

2.2 The field experiments

The experiments were conducted in unplowed silty clay soil, Agriculture college field, Garmit Ali. The field was divided into three areas. The dimensions of each area are 30x10m. The three areas were plowed using the moldboard plow. The operating depths were 10, 15 and 25cm for the three areas respectively. The operating depth was conducted randomly. The experiments were repeated twice. Each area was divided into two halves. The tractor and the implement combination passed on the surface of the plowed area to compact the soil once, twice, three, four and five times (figure 1). The passes for more than once were repeated on the same tire lane. The same passes were repeated on the second half.

The experiments were conduct at moisture content of 24.5% and 16.1%. The soil physical properties were measured for unplowed, plowed and compacted soils and for both moisture contents. The measurements were taken for depths of 0-5, 5-10, 10-15,15-20 and 20-25cm. The measurements for the compacted lanes were taken across the compacted zone as shown in figure (2). The soil physical properties measured were moisture content, bulk density, cone penetration index and porosity. The measurements were repeated three times randomly.

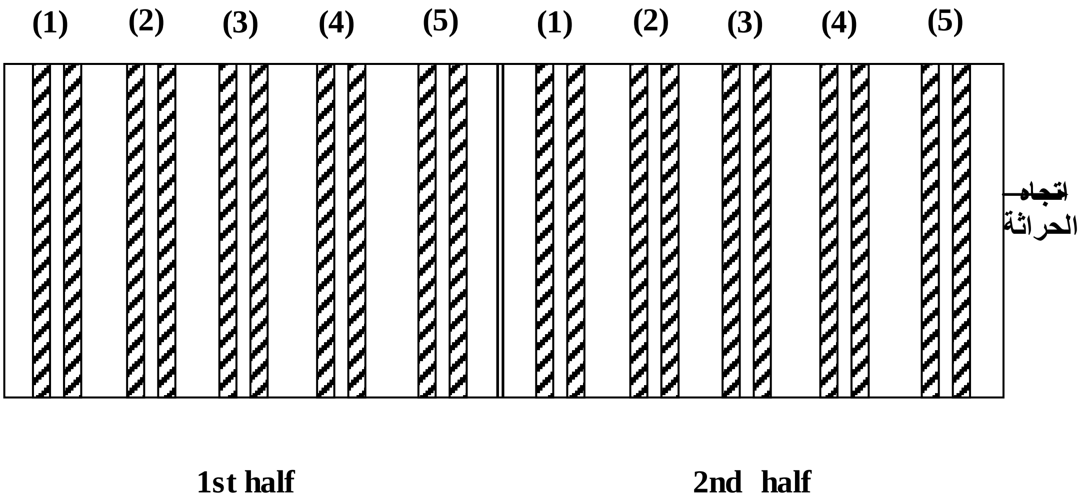


Figure (1): The numbers of passes are cross to the plowing operation for soil compaction.

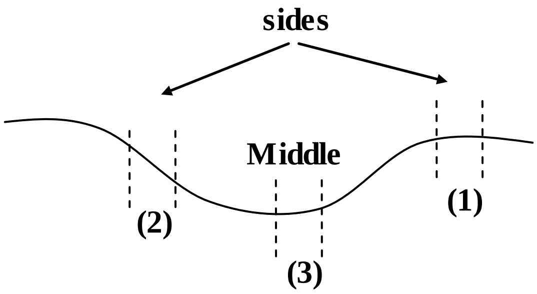


Figure (2): The soil physical measurements across the tire compacted Lane, 1, 2 and 3 are the position of the soil properties measurement.

2.3 Soil physical properties measurement

2.3.1 Soil texture

The soil texture was measured by pipette method as it is mentioned in (1). The results shown in Table (1).

Table(1): The texture of the soil of the field of the experiment

Sand ($g.kg^{-1}$)	Clay ($g.kg^{-1}$)	Silt ($g.kg^{-1}$)
15.40	45.50	39.10

2.3.2 Soil moisture content

The soil moisture content was measured by core method using dry weight for depths 0-5, 5-10, 10-15, 15-20- and 20-25cm for both soils moisture contents 16.1% and 24.5% (2). The results are shown in Table (2)

Table(2): The moisture content of the soil at two moisture content levels for different depths

Moisture content (average) 24.5%				Moisture content (average)16.1%				
Unplowed soil		Plowed soil		Unplowed soil		Plowed soil		
Moisture Content %	Bulk density t/m^3	Moisture Content %	Bulk density t/m^3	Moisture Content %	Bulk density t/m^3	Moisture Content %	Bulk density t/m^3	Depth (cm)
23.21	1.11	22.56	1.010	14.70	1.22	13.71	1.016	0-5
24.60	1.16	23.14	1.015	16.32	1,27	15.44	1.036	5-10
24.91	1.20	23.44	1.019	17.97	1.32	16.20	1.057	10-15
25.70	1.25	24.82	1.024	18.33	1.35	17.35	1.067	15-20
26.78	1.30	25.49	1.031	19.29	1.42	19.05	1.150	20-25

2.3.3 Soil penetration Resistance

The soil penetration resistance was measured for unplowed and compacted soils by a hydraulic penetrometer while for plowed soil by mechanical penetrometer which was designed and calibrated in the agricultural mechanization dept, Agriculture college. The measurement was conducted to depths 0-5, 5-10, 10-15, 15-20, 20-25 cm. The hydraulic penetrometer consists of a cone its base is 1.66cm and the angle of the cone end is 30^0. The penetrometer was used by pushing it vertically in the soil by imposing a constant pressure on it. The hydraulic pressure was measured and the force of penetration is calculated by equation (1):

$F = P*A_1$ ....(1)

Where F= Penetration force (kN)

P= Hydraulic pressure (kN/m^2)

A_1= the area of the hydraulic cylinder ($0.00756m^2$)

The cone index is calculated by equation (2).

$C_n = \frac{F}{A_2}$ ....(2)

Where Cn= cone index (kN/m2)

A_2= Area of the cone base (m^2)

The results of the soil penetration resistance for unplowed and plowed soils are shown in Table (3).

Table (3): The cone index for plowed and unplowed and the soil cohesion soils at two moisture content levels for different depths.

Moisture content 24.5%				Moisture content 16.1%			
Unplowed soil		Plowed soil		Unplowed soil		Plowed soil	
Cone index (kN/m^2)	cohesion kN/m^2	Cone index (kN/m^2)	Depth (cm)	Cone index (kN/m^2)	cohesion kN/m^2	Cone index (kN/m^2)	Depth (cm)
1318.18	10.80	1083.27	0-5	2819.24	14.22	1125.30	0-5
1883.49	11.92	1100.33	5-10	3524.06	16.31	1223.45	5-10
2354.37	14.30	1257.62	10-15	4228.87	16.54	1365.09	10-15
3600.63	15.67	1325.56	15-20	4933.68	17.98	1498.67	15-20
3766.99	16.5	1430.70	20-25	5403.55	18.72	1547.50	20-25

3.0 Results and Discussion

3.1 The effect of the soil depth and the plowing operation on the soil penetration resistance

The soil penetration resistance expressed by the cone index increased as the depth increased in both soil moisture contents (Fig. 3). This was because the soil bulk density increased as the depth increased as it can be seen from Table (2) and that was due to the effect of the soil weight of the top layers which compact the soil at depth. As well as the soil cohesion of both soils increased as the depth increased which positively affected the soil penetration resistance. The soil of lower MC (16.1%) had higher penetration resistance than that of higher MC (24.5%) and that was because the soil of lower MC had higher bulk density and cohesion, they are 1.316$Mg.m^{-3}$ and 16.75$kN.m^{-2}$ for the soil of MC of 16.1% and 1.204 $Mg.m^{-3}$and13.84$kN.m^{-2}$ for soil of MC of 24.5% respectively. The soil particles of MC of 16.1% are denser because the water films around the soil particles are thin which let the particles to impede which causes the soil to resist penetration. However the percentage of increase with depth was higher in the soil of MC 24.5% than in the soil of MC 16.1%, the increase in first soil is 30%, 44%, 63% and 65% while in second soil is 20%, 33%, 43% and 48% for depths 0-5, 5-10, 15-20 and 20-25cm respectively.

When the soils were plowed the bulk density decreased to 1.06Mg.m^{-3} (19.5%) and 1.02Mg.m^{-3} (15.3%) for MC of 16.1% and 24.5% respectively.However the bulk density of the deeper layers of plowed soil remained higher than the surface layers in both MC levels. This was because the soil at depth was less pulverized than the shallow depth due to the higher bulk density and the moisture content.

3.2 The effect of number of passes on the soil penetration Resistance

The tractors and implements passes on the soil surface can cause soil compaction and that depends on the number of passes, weight of the tractor-implement combination, soil texture and soil moisture content (Fig.4).

When the soil was plowed the soil penetration resistance decreased from 3996.25 to 1434.50kN.m^{-2} and from 2668.53 to 1291.22kN.m^{-2} (64% and 52%) for soils of MC of 16.1% and 24.5% respectively. But when the tractor-implement combination passed once on the soil surface of the plowed soil of MC of 16.1% the soil penetration resistance increased to 3899.28kN.m^{-2} (171.8%) but it remained lower than that of unplowed soil by only 2.4%. However, for the soil of MC of 24.5% the soil penetration resistance increased to 3154.67kN.m^{-2} (144%) which exceeded the value of the unplowed soil by 18.2%. The increase in the soil penetration resistance was because the pressure under the tractor tires squeezed the soil clods and particles against the bottom of the furrow causing breaking to the soil structure and that compressed and impeded the soil particles which rised the soil penetration resistance. In the soil of MC 24.5% the soil structure breaking was more sever because the water films around the soil particles were thicker which helped the soil particles to slid on each other caused more compaction and interference between the soil particles.

When the tractor-implement combination passed twice on the soil surfaces for both MC levels the soil penetration resistance increased to 4129.95kN.m^{-2} and 3370.37kN.m^{-2} (187.9% and 161%) for MC of 16.1% and 24.5% respectively. The soil penetration resistance of the soil of MC of 16.1% exceeded that of unplowed soil by 3.3% but for the soil of MC of 24.5% by 26.3%. For five passes the soil penetration resistance increased to 5356.03 and 4400.66kN.m^{-2}(273.4% and 240.8%) and exceeded the values of unplowed soil by 34% and 65% for soils of MC of 16.1% and 24.5% respectively. For the third and the fourth passes the values are medium between two and five passes.

The results showed in general that the soil penetration resistance of soil of MC 16.1% is higher than that of MC of 24.5%. For unplowed soil the penetration resistance of soil of MC of 16.1% is higher by 49.7%. This is because the soil of higher MC had lower bulk density and that was because the water films would push the soil particles apart and that increased the soil porosity which reduced the penetration resistance which it is contrary to that of the soil of lower MC which it is bulk density is higher. The higher bulk density was because the soil particles were dense due to thinner water films which resulted in higher cohesion and that lead to higher penetration resistance. The soil penetration resistance of lower MC remained higher than that for the soil of higher MC for all five passes tested.

3.3 The effect of the number of passes on the soil compaction distribution in the plowed soil profile.

The soil penetration resistance of unplowed soil increased as the depth increased and that was because the soil compaction and the bulk density increased with depth due to the effect of the weight of the upper layers on the lower layers as well as the higher soil cohesion which increased due to the higher moisture content (Figs. 5-9). In the lower MC the soil penetration resistances are 2819.24, 4228.87 and 5403.55kN.m^{-2} for depth 0-5, 10-15and 20-25cm respectively. The soil penetration resistance values of the deeper depths are higher by 50% and 91.7% compared with shallow depth (0-5cm). In the higher MC the soil penetration resistance is also increased as the depth increased. However the rate of increase in this MC is greater than that in the lower MC soil and that was properly because the upper layers were heavier because their higher moisture content. It increased from 1318.18 to 2354.37 and 3766.99kN.m^{-2} for depths 0-5, 10-15 and 20-25cm respectively; it increased by 78.6% and 185.8% compared with shallow depth. However, in general the soil penetration resistance of lower MC is higher than that for the higher MC for all depths and that was because the soil of lower MC had higher Bulk density and cohesion than that of the higher MC. The higher bulk density and cohesion mean the soil particles are dense and adhere to each other which prevent the soil particles displacement and that caused the soil more resistible to penetration. However, the deference between the two MC decreased with depth and that due to the effect of the weight of the upper layers of the higher MC which increased the soil compaction. For depth 0-5cm the soil penetration resistance of lower MC is higher than that of higher MC by 113.8% but for depth 20-25cm the soil penetration resistance is higher by 43%.

When the soils were plowed the penetration resistance decreased considerable, it decreased from (average) 4181.8 to 1352.0kN.m^{-2} (by 67.7%) and from 2584.71 to 1239.50kN.m^{-2} (by 52%) for MC 16.1% and

24.5% respectively. The greater decrease in the lower MC soil was because the soil was better pulverized because it was within the friable state which is contrary to the soil of higher MC where big clods were formed due to the higher MC (plastic state). When the soil was compacted the sever compaction was recorded for the surface layers but decreased with depth. For soil of lower MC the soil penetration resistances are 4228.81, 4758.72, 3758.99, 3383.97 and 2819.24kN.m^{-2} for depths 0-5, 5-10, 10-15, 15-20 and 20-25cm respective and they are greater than that for the plowed soil by 275.8%, 287.6%, 175.4%, 125.8% and 82.2% respectively. The penetration resistance values of the compacted soil of the depths of 0-5 and 5-10cm exceeded that of unplowed soil but for the remaining depths were stayed lower. For soil oh higher MC (24.5%) the penetration resistance are 3704.94, 4025.12, 2995.97, 2515.70 and 2058.30kN.m^{-2} for the same depths respectively and they are greater than that for the plowed soil by 242%, 265.1%, 109.9% and 43.8% respectively. The penetration resistance values exceeded the values of the unplowed for 0-5, 5-10 and 10-15cm but it was lower for depth 15-20 and 20-25cm.The reason of the reduction in the soil penetration resistance with depth after compaction was because the pressure underneath the tractor did not approach the lower soil layers by the same amount of the surface layers. Comparing both MC levels the compaction in the lower MC was higher than in the higher MC level for all depths and that was because the soil of lower MC was more pulverized which reduced the ability of the soil clods to withstand the pressure imposed by the tractor tires on the soil surface. As well as the pressure distributed deeper and in greater amount to the lower layer which broke the soil clods up which resulted in greater compaction. However, in the soil of higher MC the big clods which were formed due to the high moisture content made the soil more resistible to compaction because the big clods withstood the compaction .When the tractor-implement combination passed five times the soil penetration increased considerably in both soils. The soil surface was almost smeared completely and the plowing operation lost the advantages completely. The highest value was recorded to the depth of 5-10cm for both MC levels and for all passes. This was because the tires grousers penetrated the soil down to 5cm where the pressure is at the highest value.

3.4 The effect of the plowing depth on the soil penetration resistance

There is trend the soil penetration resistance increases as the depth increases because the higher bulk density Table (4). But at deeper depth (25cm) the soil penetration resistance decreased by small amount and that would be due to the higher moisture content which permitted the soil particles to slide on each other during soil penetration resistance measurement because the water films around the soil particles behaved as lubricant. This was also the reason of lower t soil penetration resistance of the soil of higher MC. When the soils were plowed the penetration resistance decreased considerably. It decreased by 62%, 65% and 65% in the soil of MC of 16.1% and by 24.5% was 49%, 56% and 48%in the soil of MC of 24.5% for plowing depths of 10, 15 and 25cm respectively.

When the soils were compacted the soil penetration resistance increased considerably and exceeded the values before plowing. It exceeded by 20%, 7.3% and 19.6% in the soil of MC of 16.1% and by 24.5% was 45.3%, 21.5% and 52% in the soil of MC 24.5% for plowing depths 10, 15 and 25cm respectively.

3.5 The interaction effect of the number of passes resistance and the plowing depths on the penetration resistance.

The results showed that the soil penetration resistance decreased as the plowing depth increased for both MC levels and that was because the soil pulverization increased which made the soil easily to move sideways at measuring operation Table (5). When the soil was compacted once, soil penetration resistance of the shallow depth (10cm) increased and exceeded the values before plowing operation by 3% and 25% for MC levels 16.1% and 24.5% respectively. This was because the soil clods were squeezed between the tractor tires and the bottom furrow which compact the soil severely. However, for plowing depths 15 and 25cm, the soil penetration resistance of the lower MC did not exceed the value of the soil before plowing for one pass but it exceeded the values in the third and second passes respectively. This was because the tire pressure did not approach the plowing bottom before the tractor move forward speed but when the effect of the pressure accumulated after the second and third passes the soil compaction exceeded the value before plowing. This was contrary to that in soil of higher MC where the soil penetration resistance exceeded the values before plowing for the three operating depths. This is related to greater clods which transferred the pressure underneath the tractor tires downward to the furrow bottom and the squeezed the soil cold readily. As well as the higher MC helped in sliding the soil particles on themselves and that lead to soil compaction.

The highest soil penetration resistance was recorded at shallow plowing depth (10cm) and five passes in MC level of 16.1% and the deepest plowing depth of 25 in MC level of 24.5%. However, The soil penetration resistance of MC of 16.1% was higher than that for MC 24.5% for all operating depths and all compaction passes.

Table (4): The soil penetration resistance for three plowing depths and two moisture content levels for unplowed, plowed and compacted soil

Moisture content			Plowing depth (cm)		
			10	15	25
	16.1%	Unplowed soil	3925.36	4211.12	3852.27
		Plowed soil	1486.27	1465.22	1352.02
		Compacted soil	4710.17	4241.77	4607.54
	24.5%	Unplowed soil	2620.13	2965.37	2420.11
		Plowed soil	1339.12	1295.07	1239.49
		Compacted soil	3808.26	3604.34	3678.71

$LSD_{0.05}$=1.83

Table (5): The interaction effect of number of passes and the plowing depths on the soil penetration resistance.

<table>
<tr><td rowspan="16">Moisture content</td><td rowspan="8">16.1%</td><td colspan="4">Unplowed soil</td><td colspan="3">Plowed soil</td></tr>
<tr><td>10</td><td>15</td><td colspan="2">25</td><td>10</td><td>15</td><td>25</td></tr>
<tr><td>3925.36</td><td>4211.12</td><td colspan="2">3852.27</td><td>1486.27</td><td>1465.22</td><td>1352.02</td></tr>
<tr><td colspan="2" rowspan="5"></td><td rowspan="5">Number of Passes</td><td>1</td><td>4050.87</td><td>3850.22</td><td>3796.75</td></tr>
<tr><td>2</td><td>4261.12</td><td>4022.18</td><td>4106.55</td></tr>
<tr><td>3</td><td>4407.63</td><td>4235.36</td><td>4773.92</td></tr>
<tr><td>4</td><td>4720.19</td><td>4420.52</td><td>5084.03</td></tr>
<tr><td>5</td><td>5111.07</td><td>4680.57</td><td>6276.46</td></tr>
<tr><td rowspan="8">24.5%</td><td colspan="4">Unplowed soil</td><td colspan="3">plowed</td></tr>
<tr><td>10</td><td>15</td><td colspan="2">25</td><td>10</td><td>15</td><td>25</td></tr>
<tr><td>2620.13</td><td>2965.37</td><td colspan="2">2420.11</td><td>1339.12</td><td>1295.07</td><td>1239.49</td></tr>
<tr><td colspan="2" rowspan="5"></td><td rowspan="5">Number of Passes</td><td>1</td><td>3275.70</td><td>3127.72</td><td>3060.60</td></tr>
<tr><td>2</td><td>3452.11</td><td>3314.75</td><td>3344.26</td></tr>
<tr><td>3</td><td>3720.45</td><td>3587.68</td><td>3663.75</td></tr>
<tr><td>4</td><td>3942.81</td><td>3870.30</td><td>3894.50</td></tr>
<tr><td>5</td><td>4650.27</td><td>4121.27</td><td>4430.46</td></tr>
</table>

$LSD_{0.05}$=1.85

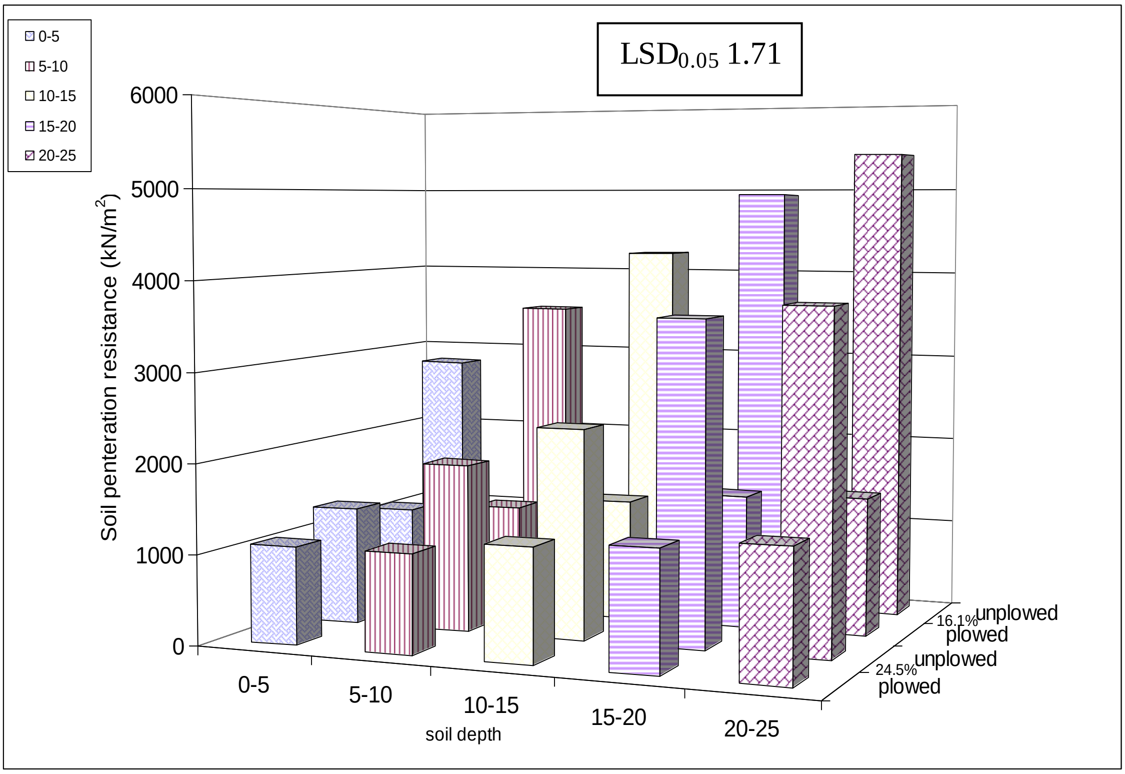


Figure (3): The soil penetration resistance versus the soil depth for plowed and unplowed soil and for both moisture content levels

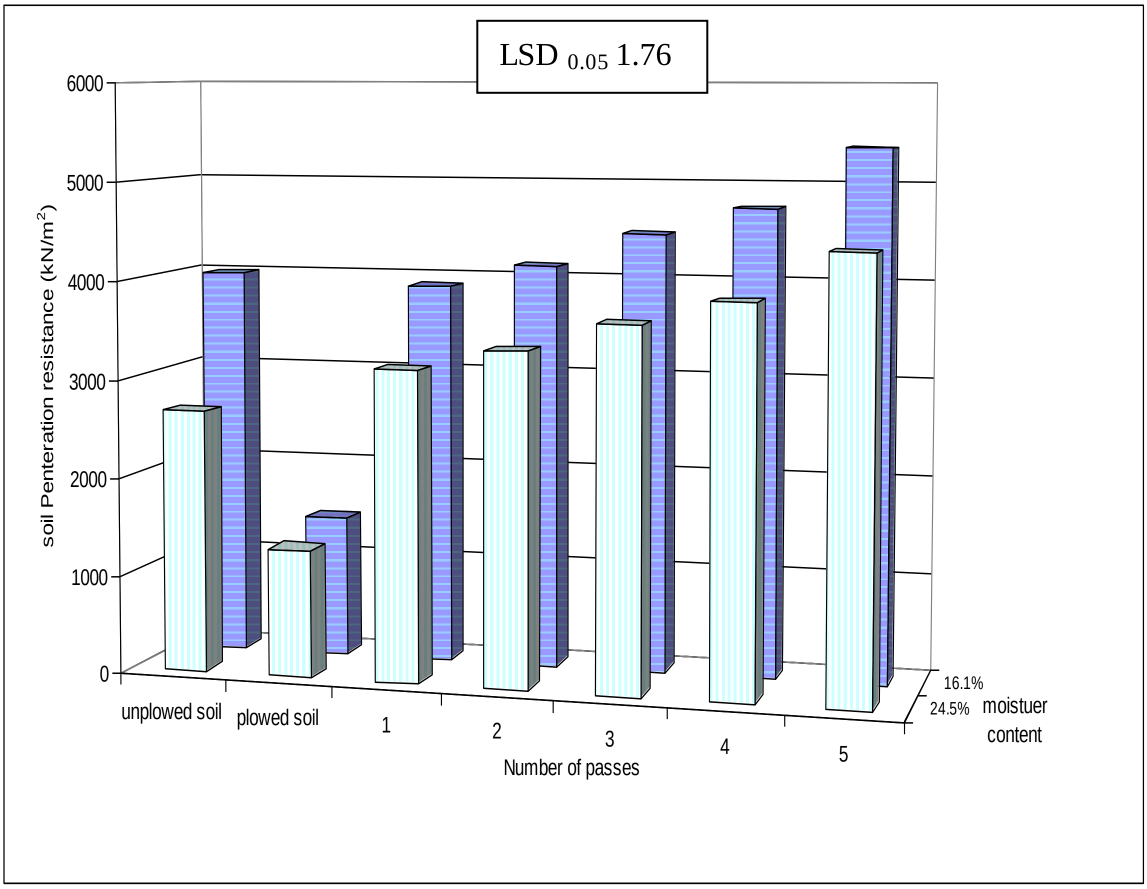
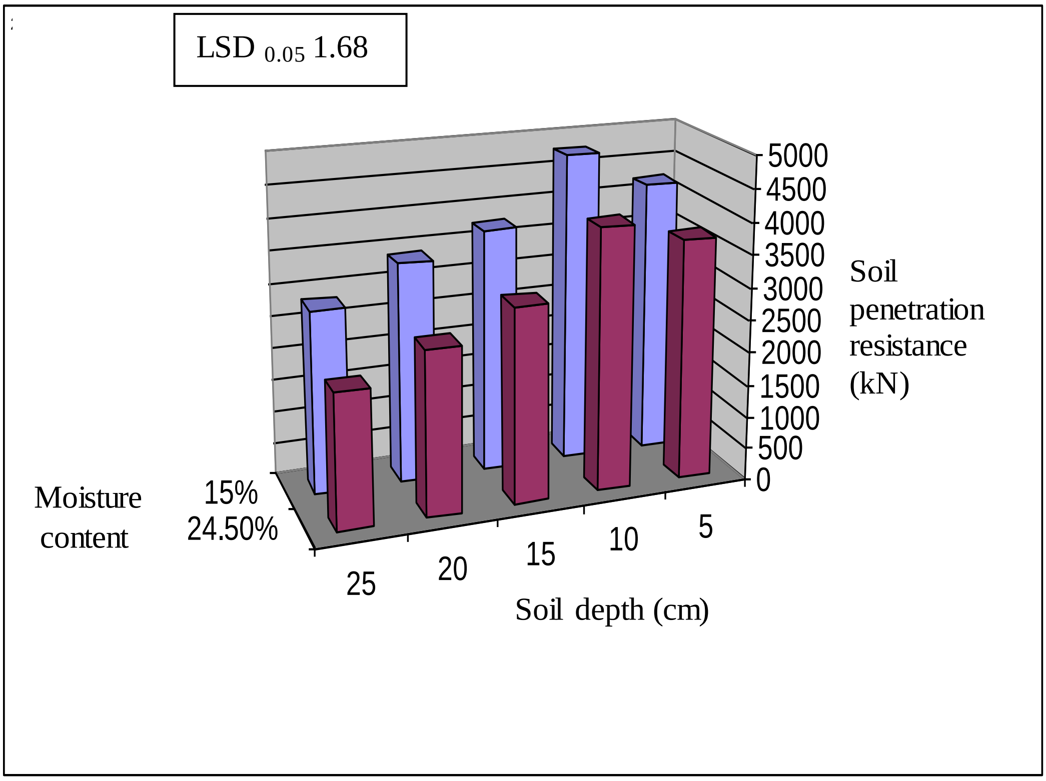
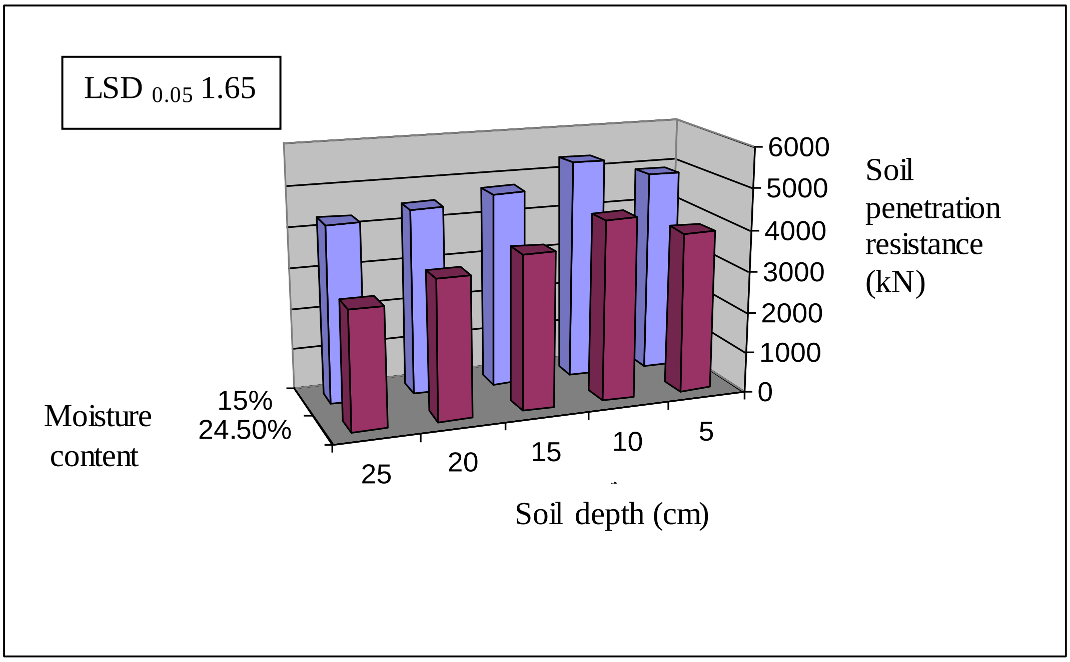


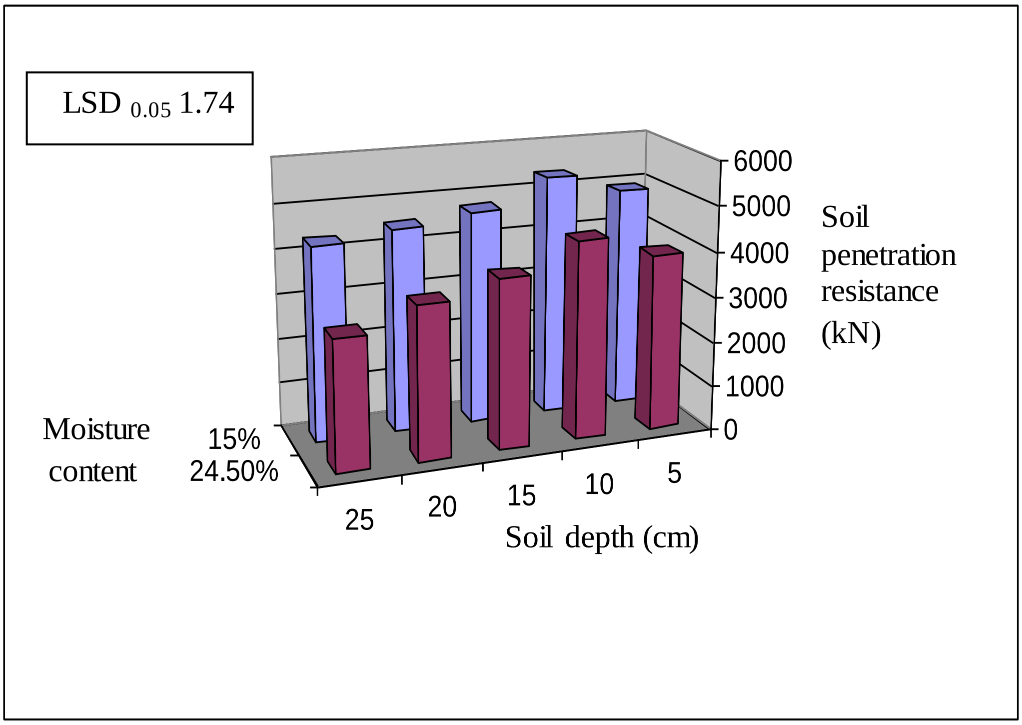
Figure (4): The soil penetration resistance versus the number of passes for two moisture content levels.



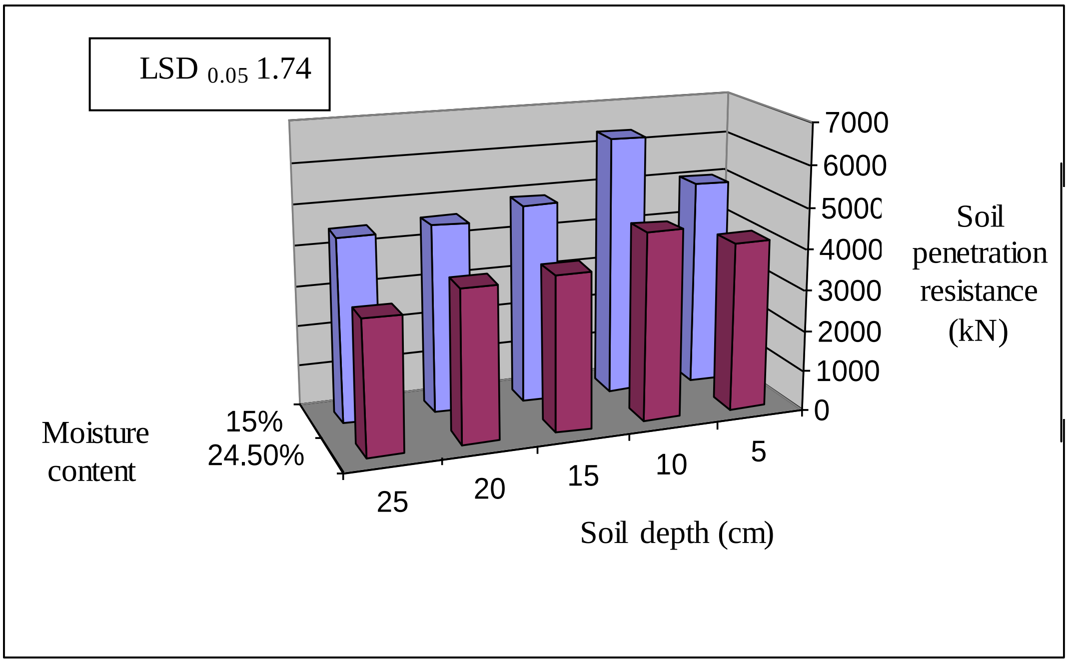
Figure(5): The relationship between the soil penetration resistance and soil depth for one pass on the soil surface.



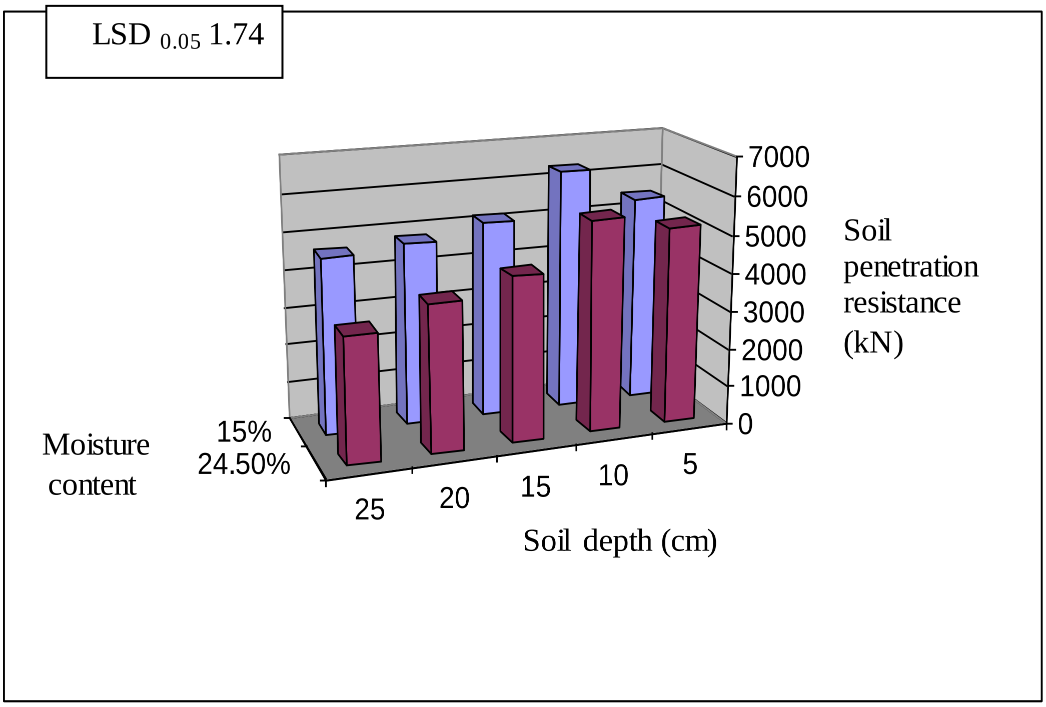
Figure(6): The relationship between the soil penetration resistance and soil depth for two passes on the soil surface.



Figure(7): The relationship between the soil penetration resistance and soil depth for three passes on the soil surface.



Figure(8): The relationship between the soil penetration resistance and soil depth for four pass on the soil surface.



Figure(9): The relationship between the soil penetration resistance and soil depth for five pass on the soil surface.

Conclusions:

The following conclusions can be drawn from the results:

(1) The soil penetration resistance increased as the depth of the soil increased for both soil MC levels (16.1% and 24.5%) but it was higher for lower MC level than higher MC level.

(2) The plowing operation decreased the soil penetration resistance by 64% and 52% in MC levels 16.1% and 24.5% respectively.

(3) Compacting the soil once by passing the tractor-implement combination on the soil of lower MC regained its soil penetration resistance but it was lower than the value before plowing by 2.5% but in the soil of higher MC exceeded the value before plowing by 18.2%

(4) The soil of lower MC exceeded the soil penetration resistance value before plowing operation in the second pass. Passing five times the soil penetration resistance became greater than that before plowing operation by 34% and 65% for MC 16.1% and 24.5% respectively. But the soil of lower MC had higher soil penetration resistance for all passes.

(5) The shallow plowing depth had higher soil penetration resistance than operating depths 15 and 25cm for both MC levels for all passes.

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تأثير عدد مرات مرور الجرار والالة على مقاومة أختراق التربه الغرينيه الطينيه المحروثه

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الخلاصة:

أجري هذة البحث لتقيم مقاومة التربة للاختراق قبل وبعد الحراثة بستخدام دليل المخروط. نفذت التجارب باستخدام ثلاثة أعماق حراثة وهي 10, 15, 25cm ومستوين من الرطوبة وهما 16.1%, 24.5% وكبست التربة خمسة مرات بمرور على سطح التربة المحروثة ، حيث تم المرور مرة واحدة ومرتين وثلاثة وأربعة وخمسة مرات بستخدام الجرار والمحراث الذي يبلغ وزنهما 32kN. تمت حراثة التربة بحراث عميق قلاب. أخذت القياسات للاعماق 0-5, 5-10, 10-15, 15-20, 20-25cm ولوسط وجانبي أثر اطار الجرار(مسار أطار الجرار). نفذت التجارب في تربة غرينية طينية. والوزن الكلي للجرار والمحراث 31.78kN. ضغط هواء ألاطارات الامامية والخلفية2.5 bar و 1 bar وعلى التوالي. أظهرت النتائج زيادة مقاومة التربة غير المحرثة للاختراق مع زيادة العمق. ففي التربة التي رطوبتها 16.1% زادت المقاومة للاختراق من $2819.24 kN/m^2$ الى $5403.55 kN/m^2$ (91.7%) أما في التربة التي رطوبتها 24.5% فأنها زادت من $1318.18 kN/m^2$ الى $3766.99\ kN/m^2$ (185.8%) عند زيادة العمق من 0-5 الى 20-25cm وعند حراثة التربة أنخفضت مقاومة الاختراق من $4181.8 kN/m^2$ الى $1352.0 kN/m^2$ (67%) ومن $2584.7 kN/m^2$ الى $1239.5 kN/m^2$ (52%) للمستوين السابقين من الرطوبة ولنفس الزيادة بالعمق. عند أمرار الجرارمرة واحدة على التربة المحروثة زادت مقاومة التربة المحروثة للاختراق وأعلى قيمة سجلت للعمق 5-10cm وثانى أعلى قيمة سجلت للعمق 0-5cm وللمستوين من الرطوبة ثم أنخفظت مع زيادة العمق وكانت أعلى قيمة $4784.7 kN/m^2$ و $4025.12 kN/m^2$ للمستوين من الرطوبة 16.1% و 24.5% على التوالي. وعند المرور خمسة مرات زادت مقاومة التربة للاختراق بصورة

كبيرة لجميع الاعماق الان أن أعلى قيمة سجلت لنفس العمق 5-10cm وكانت $6343.3 kN/m^2$ و $5544.52 kN/m^2$ لنفس مستويي الرطوبة على التوالي.

أظهرت النتائج أن مقاومة التربة المحروثة للاختراق زادت لتصبح أكبر من قيمتها قبل الحراثة بمرور الجرار مرة واحدة على سطح التربة ذات المستوي الطوبي 24.5% وبالمرور مرتين فى التربة ذات المستوى الرطوبي 16.1%. أنخفضت مقاومة التربة للاختراق عند حراثتها وزاد الانخفاض مع زيادة عمق الحراثة ولكلا المستويين من الرطوبة ألا أنة عند كبسها زادت مقاومة التربة للاختراق وبزيادة تناقصية مع زيادة عمق الحراثة. فللمستوى الرطوبي 16.1% كانت مقاومة التربة المحروثة للاختراق 1486.27 و1465.22 و $1352.02 kN/m^2$ زادت الى 4710.17 و 4241.77 و $4607.54 kN/m^2$ ، أما في التربة ذات المستوى الطوبي 24.5% كانت للتربة المحروثة 1339.12 و 1295.37 و $1239.49 kN/m^2$ زادت الى 3808.26 و 3604.34 و $3678.71 kN/m^2$ لاعماق الحراثة 10 و 15 و 25cm على التوالى أظهرت النتائج زيادة تأثير الكبس كلما قل عمق الحراثة وأعلى كبس عند السطح وينخفض مع زيادة العمق كما كان الكبس أعلى فى التربة التي رطوبتها ضمن المدى الهش (16.1%) .

#: مستل من أطروحة الباحث الثاني