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THE RELATIONS BETWEEN TILLAGE SYSTEMS, SOME SOIL PHISICAL CONDITIONS, AND AVILABLE WATER

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ABSTRACT

The plant requires optimum soil- air- water relationships from the time the seed is planted. Five different plowing and three field experiments were carried out in Gemiza, El-Gharbia government, (clayley soil) during three successive agricultural seasons of 2006/2007, 2007 and 2007/2008. In three seasons three crops were planted,

The study showed the decrease of percentages of soil particles after tillage comparing to the soil particles before tillage at 0-15 cm depth. The percentage of decrease was 5.13%, 4.08%, 1,25%,and 0.87%with (M-R),(2ch-w),(R), and (ch-R)treatments, respectively. Available water was decreased with (M-R), and (2ch-w). the percentage of decrease 1.19%,and 1,1%, respectively at depth 0-15 cm .other treatments the percentage of available water was increased. The percentage of increased Was 0.2%, o, 41%, and 0.04% with (ch-R), (R), and no tillage, respectively.

INTRODUCTION

The structural condition of the seedbed is one of the keys to the successful growth of crops. The plant requires optimum soil- air- water relationships from the time the seed is planted. All tillage operations should aim at the production and maintenance of good optimum soil- air- water relationships. Therefore, plowing should be visualized as the first tillage operation in the preparation of the seedbed. Since there are many reasons to believe that the major destruction of soil granulation takes place by surface tillage operation after plowing, the importance of plowing in obtaining optimum soil- air- water relationships should be apparent. In the plowing operation produced a fairly satisfactory seedbed that will require only a small amount of surface tillage, then good plowing will aid materially in the preservation of optimum soil- air- water relationships. There is an optimum range of soil moisture for each soil that permits the most effective results in plowing. This is the moisture range of the friable consistency .If plowed when it is not friable, a soil will usually be left in a cloddy condition. The breaking down of such clods requires many surface tillage operation, such as disking, rolling, harrowing, for a quick preparation of the seedbed. This study has described five different plowing and the type of reaction on the soil conditions.

The Russian investigators (Krause, 1931; sokolovsky, 1933) have emphasized the importance of granulation and porosity as measures of soil- air- water relationships. The soil's pore space should be about equally divided between capillary and non–capillary pores. When the non- capillary porosity is lower than 10 percent by volume of the total soil, there is a poor soil- air- water relationship. Harold et al. (1970) found that soil bulk density was higher in no tillage system (1.39 g/cm^3) than in conventional tillage system (1.26

g/cm³) for depth (0-75cm). Hatem (1970)found that the highest level of pore spaces of unit volume percentage was at the optimum moisture content (21.4%) for tillage operation on clay soil. He added that this moisture level produced the highest pulverization. Buckman and Brady (1971) stated that bulk density is affected by the quantity of pore spaces as well as the solids. The bulk density of clay ,clay loam ,and silt loam surface soils ranges from 1.00 to 1.6 g/cm³ depending on their conditions . The effect of soil compaction following factor wheel passage during .EL-Shal (1976) found that the bulk density and consequently the soil porosity was significantly affected by the different tillage treatments, the study indicated the highly effected by equipment operation which increased the bulk density resulted. Preparing the soil by using the mouldboard plough followed by the disk harrow is the most effective method on improvement soil physical properties and a high yield resulted .He added that the soil compaction is a phenomenon resulted by the effected of many variable factors some of these factors are due to physical properties of the soil such as soil moisture content, soil texture and salt content. Other factors are result to the effect of using tillage equipments and factor wheels. The value of compaction per square centimetre in relation to porosity seems to follow flat linear relation. Ismail (1980) reported that the soil density increased in the no-tillage treatment at about 10% moisture content. This reduction in density believed to be primarily due to the reduction in moisture content. The bulk density was higher under no Tillage treatment than all other treatment .Generally ,soil bulk density is increased in all treatment in both layer after planting the density of top layer (0-6cm)was less than the bottom layer (6-13cm). Burger et al .(1984) studied the effects of soil moisture contents on soil bulk density ,it was found that the level of soil moisture significantly affected the degree to which soil was compacted. At 18% the overall soil density was 0.1g/cm³,while at 21% moisture ,it was 0.18g/cm³, .He added that the effect of soil moisture level on porosity did not have a significant effect on the change in total porosity of impact soils, while the number of passes of the machines significantly affected porosity. Lindstrom and Onsted (1984) studied the system of soil physical parameters they found that, the system forms an undesirable surface condition characterized by high bulk density, high penetration resistance and low saturated hydraulic conductivity compared to mechanical tillage system. Zen El-din (1985) found that the reduction in soil moisture content due to tillage operation increased by increasing the plowing depth for all the plows while the soil bulk density, generally decreased due to tillage with all treatments. The reduction in soil bulk density increasing by increased the ploughing depth. Ahmed et al.(1988) studied the effect of compaction on the soil physical properties and crop yield and concluded that the crop yield is highly reduced by compaction process. Erbach (1987) defined soil moisture content as water held by the soil and normally is expressed as a percentage of dry soil weight or as percentage of soil volume. the moisture content of surface soil influence plant growth preference of tillage, planting and chemical, application equipment, soil conditions created by tillage equipment traffic ability, and bulk density change caused by equipment and animals. Younis et al. (1991) reported that reduction in the moisture content at the top layer (0-

10cm) increased with increasing plough depth. The minimum value obtained with no tillage followed by disk harrowing treatment , while the rotary, disk, mouldboard, and chisel ploughs were in the same order of change. At the top layer, the maximum reduction was obtaining with chisel plows a traditional method (57%). Soil density generally decreased due to tillage in all treatment. The reduction in soil density increased by increasing the ploughing depth. The maximum reduction was obtaining with the rotary plough at 20cm ploughing depth. This result was expecting since the plough pulverizes and turns the soil more than other plows**.**

MATERIALS AND METHODS

Field experiment was carried out at the farm of the Agricultural Research Station , El –Gmiza , El- Gharbia Governorate ,Ministry of Agricultural Egypt . To study the effects of seedbed preparation system on the soil-air-water, ratio table. (1) Soil specification , table (2) Soil mechanical analysis.

Table(1) Some soil specification.

Soil specification/depth	0 – 15	15 – 30	30 – 45	45 -60
Bulk Density (g/cm³)	1.122	1.13	1.167	1.162
Field capacity % wt.	42.7	39	36.8	34.9
Wilting Point % wt.	22.21	21.3	20.1	19.6
Available Water % wt	20.49	17.7	16.7	15.3

Table(2) Soil mechanical analysis

Depth cm	Contents %				
	Sand	**Silt**	**Clay**	**Textural class**	**Ca Co3**
0 – 15	15.21	41.02	43.76	Clayey	3.32
15 – 30	12.14	37.87	49.99	Clayey	4.37
30 – 45	10.71	40.32	48.97	Clayey	4.3
45 -60	10.5	39.65	49.86	Clayey	4

The experimental area was divided into 15 strips according to five seedbed preparation systems 2ch-w, ch-R, R, M-R, and no tillage. All experiment strips area was (12.5m x 80m).The tillage treatment design was distributed completely random.

Soil bulk density and pore volume:

The Soil bulk density was measure with a cylindrical prop (100cm³ content). The soil samples are taken at five depths : 0-10,10-20, 20-30,30-40and40-50cm. The samples from the cylindrical prob. was dried chambers at 105ºC.Soil bulk density was determined by equation(a)

$$Ds = Wsd / Vt \quad \text{......} \quad (a)$$

Where:

Ds : Soil bulk density, g/cm³
Wsd : Dry soil weight, g
Vt : Total soil volume, cm³

The pore volume (Vp) was obtain from the soil bulk density with the aid of the equation (b):

Vp= Ds / Dss*100………………………………………………………. (b)

Where:

Vp : Pore volume (total), %
Ds : Soil bulk density, g/cm³
Dss : Density of the solid soil substance, g/cm³

Soil moisture content:

Soil moister content was determined by drying the samples at 105ºC. The soil moister was measured at two different depths: 0-15, 15-30,. The –extracted samples were transporting in sealed jars. The jars were weighted with the lid, and after being placed on trays for insertion in the drying chamber the lids were removing. After 24 hr all jars were taking out and cooled in an exsiccator. The jars with the lids were weighting exactly the calculation of the moisture content was accomplished by the following equation (d)

Ms= 100*(Wsw- Wsd)/Wsw ………………………………..(d)

Where:

Ms : Soil moisture content, %
Wsw : Wet soil weight, g
Wsd : Dry soil weight, g

Irrigation Water applied (Wa):

The water applied was measured by flow water from measuring the net head from the center of A 90º triangular notch and water surface (H) above A90º triangular notch. The calculation of water discharge was applying inside according to the following this equation (e):

$$Q = 2.49H^{5/2} \qquad (e)$$

Where:

Q : Actual discharge, m³/sec
H : Operation of head, m

Field water available (Wav):

The water available was estimated at five depths 0-10,10-20, 20-30,30-40and40-50cm (average active depth of roots).The water available was obtained from moisture content, soil bulk density and volume of soil following this equation (f):

Wav= ((Msf- Msw)dDs4200)/Wd ………………………………..(f)

Where:

Wav : Water available,m³/fed
Msf : Moisture content at field capacity, %
Msw : Moisture content at welting point, %
d : Depth , m
Ds : Soil bulk density, g/cm³
Wd : Water density, g/cm³

Soil particles ratio : the between soil bulk density and soil real density

Soil ratio= ((Dss - Ds)/ Dss)*100…………………………..(H)

Where

Ds : Soil bulk density, g/cm³

Dss : Density of the solid soil substance, g/cm³

RESULTS AND DISCUSSION

Three field experiments were carried out in Gemiza, El-Gharbia government, (clayley soil) during three successive agricultural seasons of 2006/2007, 2007 and 2007/2008. Five plowing treatments were carried out using paths chisel plow before wooden blade (2ch-w), one path chisel plow before rotary plow (ch-R), rotary plow (R), moldboard plow before rotary plow (m-R), and no tillage for traditional .The soil mechanics' investigators as commonly defined the ideal soil, air, and water ratio for gross plants as 50% soil particles , 25% capillary porosity (soil water) , and 25% non- capillary porosity (soil air) fig(1)

<table>
<tr><td>Capillary
porosity
Soil water content
25%</td><td rowspan="2">Soil particles content
50%</td></tr>
<tr><td>non- capillary porosity
Soil air content
25%</td></tr>
</table>

Fig (1) Ideal soil physical conditions

Soil physical condition before tillage treatments table (3) showed that the percentages of soil, air, and water ratio at depths 0-15 cm first the ratio was 42.34%, 36.58%, and 20.9% for soil, air, and water respectively. The second15-30 cm the ratio was 42.64%, 35.87%, and 21.4% for soil, air, and water respectively.

Table (3) Some soil physical condition before tillage treatments

Treatment	Depth Cm	Capillary porosity Soil water content %	non- capillary porosity Soil air content %	Soil particles content %
Soil before treatments	**0-15**	**20.9**	**36.58**	**42.34**
	15-30	**21.4**	**35.87**	**42.64**

Comparing with the ideal soil physical conditions, soil and water percentage at the two depths were decreased. The percentages of the soil decrease was 7.66%, and 7.36% at depths of 0-15cm and 15-30 cm, resp. The percentage of water decrease was 7.84%, and 7.24% at two depths resp. To improve the results , it should be carried out with organic matter .On the other hand , the percentage of air was increased more than ideal ratio .The percentages of increase was 7.84%, and 7.24% at two depths resp.

Fig (2) the relationships percentages of soil, air, and water ratio before tillage

Table (4)Some soil physical conditions after tillage treatments.

Treatments	Depth Cm	Capillary porosity Soil water content %	non- capillary porosity Soil air content %	Soil particles content %
2Ch-W	0-15	19.9	41.84	38.26
	15-30	20.5	39.24	40.26
Ch-R	0-15	19.2	39.33	41.47
	15-30	21	38.51	40.49
R	0-15	19.5	39.41	41.09
	15-30	21.2	35.89	42.91
M-R	0-15	20.3	42.91	37.21
	15-30	20.1	41.22	38.68

Some soil physical condition after tillage treatments table (4) showed that the percentages of soil, air, and water ratio at depths 0-15 cm and 15-30cm. At the first depth 0-15, the ratios were 38.26%, 41.84%, and 19.9% for soil, air, and water, respectively with (2ch-w) treatment 41.47%, 39.33%, and 19.2% for soil, air, and water, respectively with (ch-R) treatment, 41.09%, 39.41%, and 19.5% for soil, air, and water, respectively with (R) treatment, 37.21%, 42.91%, and 20.6% for soil, air, and water respectively. With (M-R) treatment. At the second depth 15-30 cm the ratios were 40.26%, 39.24%, and 20.50% for soil, air, and water, respectively with (2ch-w) treatment 40.49%, 38.51%, and 21% for soil, air, and water, respectively with (ch-R) treatment, 42.91%, 35.89%, and 21.2% for soil, air, and water respectively with (R) treatment, 38.68%, 41.22%, and 20.1% for soil, air, and water respectively with (M-R) treatment. Comparing to the soil physical condition before tillage treatments the soil particles percentage at depth 0-15 cm was decrease by 4.08%, 0.87%, 1.25%, and 5.13% with 2ch-W, ch-R, R, and M-R treatments respectively.

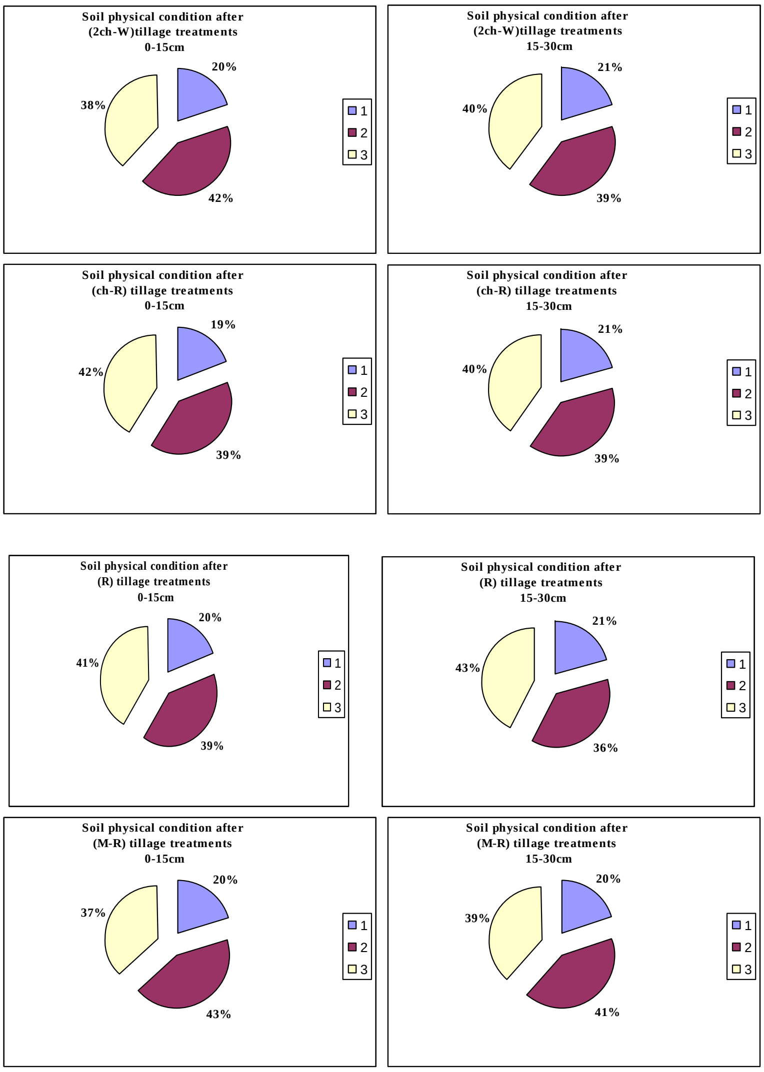

Fig (3) The relationships percentages of soil, air, and water ratio after tillage treatments

The greatest decrease was with the M-R treatment resulting from soil layer replacement from 15- 30 to 0-15 depth with plowing the second greatest decreased occurred with 2ch.W treatment, because the wooden blade was not enough to break-down and pressure the soil. R treatment had the third decrease value resulted from no equipment transfer after plowing soil surface, and the ch-R treatment had the smallest decrease percentage. At the second depth 15-30cm. The percentages of change was 2.38%, 2.15%, -0.27%, and 3.96% with 2ch-W, ch-R, R, and M-R treatments respectively. The greatest decrease occurred with the M-R treatment resulting from soil layer replacement from 0.15cm to the 15-30 cm depth with plowing, 2ch-W treatment had the second greatest decrease because the plow depth was 21 cm then and 7cm in this layer depth was not plowed. Ch-R treatment had the third decrease value resulted from the plow depth was 17 cm then and 13cm in this layer depth was not plowed. The R treatment had the smallest increase percentage resulted from the tractor movement during plowing. Fig (3) showed that the relationships between percentages of soil, air, and water ratio after tillage treatments.. Water percentage at depths was decreased before tillage treatments. The percentages of decrease was 1%, 1.7%, 1.4% and 0.6% at depth 0-15cm with 2ch-W, ch-R, R, and M-R treatments, respectively.. In 15-30 cm depth the decrease was 0.9%, 0.4%, 0.2% and 1.3% with 2ch-W, ch-R, R, and M-R tillage treatments respectively.. That resulted in moisture percentage decrease resulted tillage operation. Air percentage at depths was increase before tillage resulted tillage operation. The percentages of increase were 5.26%, 2.75%, 2.83%, and 5.91% at depth 0-15cm with 2ch-W, ch-R, R, and M-R tillage treatments, respectively. The percentages of increase were 3.37%, 2.64%, 0.02%, and 5.36% at depth 15-30cm with 2ch-W, ch-R, R, and M-R tillage treatments respectively.

Table (5) Some soil physical conditions after 48 hr from irrigation with tillage treatments

Treatments	Depth cm	Capillary porosity Soil water content %	non- capillary porosity Soil air content %	Soil particles content %
2Ch-W	0-15	41.6	17.15	41.25
	15-30	39.7	18.45	41.85
Ch-R	0-15	42.9	15.1	42
	15-30	39.2	18.72	42.08
R	0-15	43.11	14.97	41.92
	15-30	39.11	17.95	42.94
M-R	0-15	41.51	16.30	42.18
	15-30	43.21	14.56	42.23
No tillage	0-15	42.74	9.71	42.55
	15-30	39.11	17.98	42.91

Soil physical condition after 48 hr from irrigation with tillage treatments

Table (5) shows the percentages of soil, air, and water ratio at depths 0-15 cm and 15-30cm. At the first depth 0-15 the ratio was 41.25%, 17.15%, and 41.6% for soil, air, and water respectively with (2ch-w) treatment 42%, 15.1%, and 42.9% for soil, air, and water respectively with (ch-R) treatment, 41.92%, 14.97%, and 43.11% for soil, air, and water respectively with (R) treatment, 42.18%, 16.3.%, and 41.51% for soil, air, and water respectively with (M-R) treatment, and the ratio were 42.55%, 9.71%, and 42.74% for soil, air, and water respectively with (no tillage) treatment . At the second depth 15-30 cm the ratio were 41.85%, 18.45%, and 39.7% for soil, air, and water respectively with (2ch-w) treatment 42.08%, 18.72%, and 39.2% for soil, air, and water respectively with (ch-R) treatment, 42.94%, 17.95%, and 39.11% for soil, air, and water respectively with (R) treatment, 42.23%, 14.56%, and 43.12% for soil, air, and water respectively with (M-R) treatment, and the ratio was 42.91%, 17.98%, and 39.11% for soil, air, and water respectively with (no tillage) treatment. Comparing to the soil specification table (1), available water was change resulted in change in soil physical condition .That's the direct effect of using different tillage treatments and the rearrangement of capillary porosity and non-capillary porosity by irrigation water. Irrigation water moved the soil particles from the surface layer 0-15cm to the second layer 15-30cm and full of the non-capillary porosity and changed percentage of it to capillary porosity.. The change of available water was decrease with 2ch-w and M-R tillage treatments at depth 0-15 cm by 1.1%, and 1.19% respectively. On the other hand, the change of available water was increased with the other treatments by 0.2%, 0.41%, and 0.04% with ch-R, R, and no tillage respectively at 0-15 depth and 0.7%, 0.2%, 0.11%,, 4.21%, and 0.11% with 2ch-W, ch-R, R, M-R, and no tillage, respectively at depth 15-30 cm.

Table (6) Effect of soil physical condition after 48 hr from irrigation with tillage treatments on available water

Treatments	Depth cm	Capillary porosity Soil water content%	Available Water % wt
2Ch-W	0-15	41.6	19.39
	15-30	39.7	18.4
Ch-R	0-15	42.9	20.69
	15-30	39.2	17.9
R	0-15	43.11	20.9
	15-30	39.11	17.81
M-R	0-15	41.51	19.3
	15-30	43.21	21.91
No tillage	0-15	42.74	20.53
	15-30	39.11	17.81

Summary and conclusion:

The study was showed the decrease of percentages of soil particles after tillage comparing to the soil particles before tillage at 0-15 cm depth. The percentage of decrease was 5.13%, 4.08%, 1,25%,and 0.87%with (M-R),(2ch-w),(R), and (ch-R), treatments respectively. Available water was decreased with (M-R), and (2ch-w). by 1.19%,and 1,1% respectively at depth 0-15 cm .other treatments the percentage of available water was increase by 0.2%, o,41%, and 0.04% with (ch-R), (R), and no tillage, respectively.

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العلاقة بين نظم الحرث وبعض خواص التربة الطبيعية والماء المتاح

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اجريت التجارب الحقلية بمحطة بحوث الجميزة محافظة الغربية لثلاث مواسم زراعية موسم شتوي (برسيم علف)٢٠٠٦/٢٠٠٧وموسم صيفي (قطن)٢٠٠٧وموسم شتوي(بنجرعلف) ٢٠٠٧/٢٠٠٨ باستخدام خمس معاملات حرث مختلفة وهي الحرث بمحراث حفار سكتين يلية زحافة خشبية والحرث بمحراث حفار سكة واحدة يلية محراث دوراني و الحرث بالمحراث الدوراني والحرث بالمحراث القلاب المطرحي يلية الدوراني ومعاملة بدون حرث. وقد تم اخذ القياسات التالية:

- قياس الكثافة الظاهرية- قياس الرطوبة الارضية وتم من القياسات حساب كل من نسبة الفراغات الهوائية نسبة المواد الصلبة في العينه وحساب الماء المتاح بالتربة بعد الري ب٤٨ ساعة وقد تم اخذ القياسات وعمل الحسابات السابقة قبل الحرث وبعد الحرث وبعد الري ب٤٨ ساعة.

الهدف من البحث : هودراسة العلاقة بين نظم الحرث المختلفة وظروف التربة الفيزيائية وكذلك تأثر نسب الماء المتاح في التربة بعد الري ب ٤٨ ساعة بكل من نظم الحرث المختلفة وكذلك الخصائص الفيزيائية للتربة

وقد اظهرت نتائج البحث الآتي:

تغيرت قيم نسب التربة للهواء للماء عند عمق صفر-١٥سم مع كل نظام حرث مقارنة بقيم الأرض الطبيعية قبل الحرث وقد كانت اعلي نسبه قيم للتغييربنقص نسبة حبيبات التربة عند الحرث بالمحراث القلاب المطرحي يلية الدوراني يلية المحراث الحفر سكتين يلية الزحافة الخشبية يلية الدوراني ثم اقل نسبه تغيير في الحراث الحفار سكة واحدة يلية الدوراني وكانت النسب كالتالي ٥,١٣% و٤,٠٨%و١,٢٥%و ٠,٨٧%. وكذلك كان هناك تغيير بسيط بالنقص في قيم الرطوبة الأرضية ناتج من معاملات الحرث او الظروف الجوية وكانت هذة القيم كالتالي ١%و ١,٧%و ١,٤%و ٠,٦% والقيم مرتبة تبعا لعمليات الحرث التالية المحراث الحفر سكتين يلية الزحافة

الخشبية -الحراث الحفار سكة واحدة يلية الدوراني- الدوراني- عند الحرث بالمحراث القلاب المطرحي يلية الدوراني.

تغيرت قيم نسبة المحتوي الرطوبي بالتربة مقارنة بخصائص التربة الفيزيائية نتيجة عمليات الحرث المختلفةوكانت نسب التغيير كالتالي نقص في نسبة الماء المتاح في الطبقة السطحية صفر- ١٥ سم لكل من معاملة الحرث بالمحراث القلاب المطرحي يلية الدوراني ثم الحرث بالمحراث الحفار سكتين يلية الزحافة الخشبية وكانت نسب النقص كالتالي ١,١٩%و١,١% اما باقي المعاملات فقد تزايدت قيم الماء المتاح بالنسب الاتية ٠,٢% و ٠,٤١%و ٠,٠٤% لمعاملات الحرث بالمحراث الحفار يلية الدوراني ثم الدوراني ثم بدون حرث٠

مماسبق يتضح وجود علاقة منطقية واضحة بين كل من طرق الحرث المختلفة ونسبة الماء المتاح للنبات نتيجة التغير في خصائص التربة الطبيعية نتيجة الحرث٠

قام بتحكيم البحث

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