VARIATION OF THE SOIL MOISTURE AND WATER RESERVE DEPENDING ON WORKING METHOD IN FORESTRY NURSERIES

Nicuşor BOJA, Florinel BOJA

"Vasile Goldiş" Western University of Arad, Faculty of Natural Sciences, Engineering and Informatics, Department of Forest Sciences and Agrotourism,& Cocorilor Street nr. 57 Arad, E-mail adress: bojanicu@yahoo.com

***Abstract**: The present research has as a purpose the determination of the optimal work methods of the soil used in forestry nurseries and which are meant to obtain high quality saplings by maintaining a possibly large quantity of water in the soil. The research was carried out in the Iarac forestry nursery in the O.S. Iuliu Moldovan during 2009-2011, on an alluvial soil - the vertical-gleiying subtype. The experiment is multi-factorial – the A X B type. The placement of the sample markets was carried out according to the "divided parcels method" in two repetitions, and the surface of the parcel was 80 m^2. Soil moisture is an important characteristic for the development of the saplings in the forestry nurseries. It suffers big variances in time according to various factors, among which: water interception from rain, outflow, infiltration, retention, capillary ascension etc. A larger quantity of soil moisture can be also obtained through its mobilization by different means of mechanic work. Thus, this research presents the results obtained after the working of the soil through different methods on the physical properties (moisture and water resource), determined at the beginning of the vegetation season and at its middle for the scarified and non-scarified soil. The work method of the soil adjusts the main hydro-physical properties for the determination of the soil fertility in order to assure the productive consumption of the saplings and the avoidance of the loss through evaporation. In conclusion, it is important to keep in mind that the soil works have a direct impact on the moisture and water resource, determining the variance of these indicators at different levels of depth, frequently in a decreasing order from surface to depth, taking into consideration the quantity of rain fallen during the period analyzed, but also the depth at which the soil is dislocated.*

***Key words*:** *technical work, soil moisture, water resource.*

INTRODUCTION

In the present, the water constitutes a vital problem for the growth and development of the saplings in the forestry nurseries, situation which imposes it self to be studied from all perspectives. The water determines the solubility, the transport and the assimilation of the mineral substances towards the saplings; the water is a soil component which ensures permanently the exchange of nutritive substances between the soil and the saplings. In addition, it confers other properties of the soil linked to its work method.

The works of the soil encompass technological processes with a general character, through which they can assure the favorable conditions for the accumulation of possibly larger quantities of water. The simplest information about the water in the soil can be taken by knowing its water quantity. (BOJA N., 2008)

Knowing the soil humidity is important for the orientation of the water resource in the soil at the disposal of the plants, for the determination of the optimal moment of execution of the soil works and the ratio of watering. (ŢOPA D., 2007)

As the water consumption of the saplings is concerned, it is necessary to know the existent quantity of water in the soil, this constituting the water resource of the soil and it is expressed in m^3/ha or in t/ha. (POPESCU I., 1984)

Soil moisture is an important characteristic for the development of the saplings in the forestry nurseries. It suffers big variances in time according to various factors, among which: water interception from rain, outflow, infiltration, retention, capillary ascension etc. A larger quantity of soil moisture can be also obtained through its mobilization by different means of mechanic work, but this aspect will derive after the processing of the soil in a classical and minimal tillage system.

The tillage system of the soil influences the processes linked to the movement of the water in the soil according to the intensity of the stirring and work method, which influence as well: interception, outflow, infiltration, capillary ascension or on the contrary the water loss in the soil. (RUSU T., 2007)

By applying different work methods, the regime of the ecological factors in the soil are adjusted positively, which is finally felt in the fertility state of that soil. The water resource is another physical indicator which reflects the water quantity stored on a certain surface, on its values depending a lot the further development of the saplings. (BOJA N., 2011)

Our research takes into consideration the influence of the tillage system of the soil on some physical properties like moisture and water reserve, during 2009-2011 in the forestry nursery of Iarac.

MATERIAL AND METHODS

The research was carried out in the Iarac forestry nursery in O.S. Iuliu Moldovan during 2009-2011, on an alluvial soil (vertical-gleyed soil). The experiment is multi-factorial – the A X B type. The placement of the sample markets was carried out according to the "divided parcels method" in two repetitions, and the surface of the parcel was 80 m^2.

The factors considered:

Factor A Deep soil loosening:

a_1 - ploughed

a_2 - scarified

Factor B Soil work:

b_1 - plow + disc harrow 2X

b_2 - disc harrow

b_3 . grower

b_4 - paraplow

b_5 - rotary harrow

This paper presents the results obtained after the soil processing through different methods on the physical properties (moisture and water resource), determined at the beginning of the vegetation season and at its middle for the scarified and non-scarified soil. The work method of the soil adjusts the main hydro-physical properties for the determination of the soil fertility in order to assure the productive consumption of the saplings and the avoidance of the loss through evaporation.

For the calculation of the water resource in the soil, both the soil moisture and the apparent density were determined at two moments: at the beginning of the vegetation season and at its middle. The soil moisture for the water was determined 10 out of 10 up to the 30cm/depth for each experimental variant.

The methods of analysis and interpretation of the results as well as the work procedure for the determination of the physical – mechanical properties are those indicated in the specialized literature. (CANARACHE A., 1990)

RESULTS AND DISCUSSIONS

The state of soil moisture modifies permanently according to the quantity of rain, the intensity of evaporation, the water consumption towards the saplings, the technical works carried out. The determination of the soil moisture has a high practical significance and one which is one of the most spread analyses of the soil in research and production.

The three year research was characterized by a quite different pluviometer regime as it can be shown in Table 1 and this is why we considered taking into consideration the quantity of fallen rain in the analyzed interval.

Table 1

Atmospheric rainfall-annual quantities (mm)

Meteorological station	2009	2010	2011
Arad (Iarac nursery)	592,6	755,1	684.5

In order to observe the influence of the work method on the moisture and water resource in the Iarac nursery, six determinations were made for the two physical indicators of the soil in steps from 10 to ten 10 up to 30 cm depth, for each experimented variant, in Tables 2 and 3, 4 and 5 being given their average.

Table 2

The soil moisture (%), according to the work method, between the years 2009-2011

Deep breaking	Soil tillage	Depth, cm	Beginning the vegetation season			Middle of the vegetation season		
			2009	2010	2011	2009	2010	2011
Witness sample		0-10	18.91	20.80	22.69	22.04	19.84	26.45
		10-20	17.14	18.85	20.57	22.18	19.96	26.62
		20-30	16.27	17.90	19.52	20.20	18.18	24.24
Soil ploughing	Plow + disc harrow 2X	0-10	25.37	24.47	24.57	26.38	25.48	25.58
		10-20	23.43	22.53	22.63	24.44	23.54	23.64
		20-30	21.86	20.96	21.06	22.87	21.97	22.07
	Disc harrow	0-10	22.81	22.11	22.21	24.79	24.09	24.19
		10-20	20.62	19.92	20.02	22.60	21.90	22.00
		20-30	20.01	19.31	19.41	21.99	21.29	21.39
	Grower	0-10	20.41	19.71	19.81	22.39	21.69	21.79
		10-20	19.34	18.64	18.74	21.32	20.62	20.72
		20-30	18.12	17.42	17.52	20.10	19.40	19.50
	Paraplow	0-10	16.60	17.10	17.00	18.58	19.08	18.98
		10-20	16.02	16.52	16.42	18.00	18.50	18.40
		20-30	13.93	14.43	14.33	15.91	16.41	16.31
	Rotary harrow	0-10	15.30	15.80	15.70	17.28	17.78	17.68
		10-20	15.93	16.43	16.33	17.91	18.41	18.31
		20-30	17.86	18.36	18.26	19.84	20.34	20.24
Soil scarifier	Plow + disc harrow 2X	0-10	27.37	27.87	27.97	27.75	29.39	29.29
		10-20	23.86	25.93	24.46	25.28	27.45	25.78
		20-30	25.43	24.36	26.03	26.85	25.88	27.35
	Disc harrow	0-10	23.70	26.93	24.30	25.12	28.45	25.62
		10-20	26.43	24.20	27.03	27.85	25.72	28.35
		20-30	23.51	24.01	24.11	24.93	25.53	25.43
	Grower	0-10	23.55	24.05	24.15	24.97	25.57	25.47
		10-20	21.62	22.12	22.22	23.04	23.64	23.54
		20-30	20.43	20.93	21.03	21.85	22.45	22.35
	Paraplow	0-10	23.13	23.43	23.53	24.55	25.35	25.25
		10-20	21.22	21.52	21.62	22.64	23.44	23.34
		20-30	20.05	20.35	20.45	21.47	22.27	22.17
	Rotary harrow	0-10	22.52	22.82	22.92	23.94	24.74	24.64
		10-20	20.15	20.45	20.55	21.57	22.37	22.27
		20-30	19.54	19.84	19.94	20.96	21.76	21.66

In order to analyze the variance of the two physical indicators, after each technical work, it became essential to compare them with the initial state of the un-dislocated soil, called henceforth witness sample.

In order to establish the co-relational dependence between the indicator and the sampling depth, through the analysis of the carriage, two equations were used as it follows: a linear one and a second degree polynomial.

The element of statistical nature which determined the choice of the corresponding curve was the coefficient of determination R^2. In all cases, the coefficient of determination for the second degree polynomial was lesser than that corresponding for the right line.

For each correlation dependence in the series of the five technical works carried out we tested two regression equations and the chosen one was that whose determination coefficient R^2 had the highest value. In the case in which the dependence between variables resulted as being linear, we also established the size of the simple correlation coefficient - r. Finally, we retained only twenty four correlation dependences (fig.1…fig.12), thus only those for which the influence of the independent variable represented more than 50% of the total influences on the dependent variable.

The mechanical processing of the soil through traditional and modern methods is currently put under question due to the high energy consumption and the continuous degradation of the arable horizon through erosion and excessive compaction. (BOJA N. 2009)

The soil processing in the classical tillage system leads to an excessive break-up through repeated interventions, leaving it without vegetal remains through the reversal of the clods in the ploughing process, thus being strongly eroded under the action of the water and wind. (BOJA N. 2010)

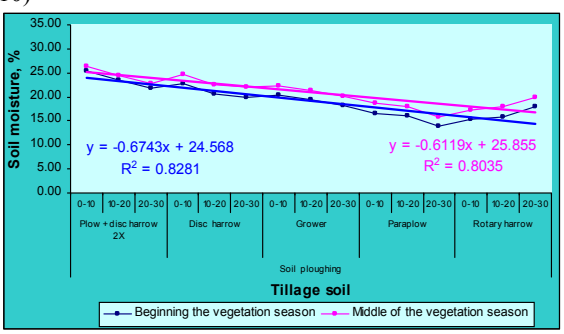

Figure 1. The variance of the soil moisture according to the works of the ploughed soil in 2009

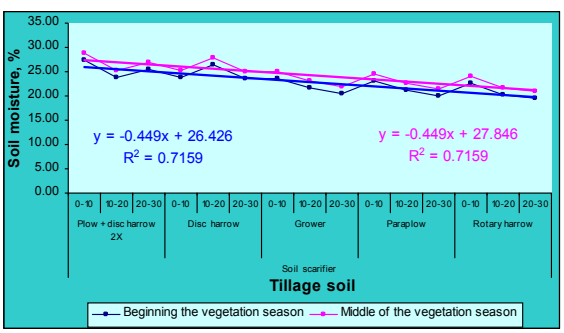

Figure 2. The variance of the soil moisture of the soil according to the works of the scarified soil in 2009

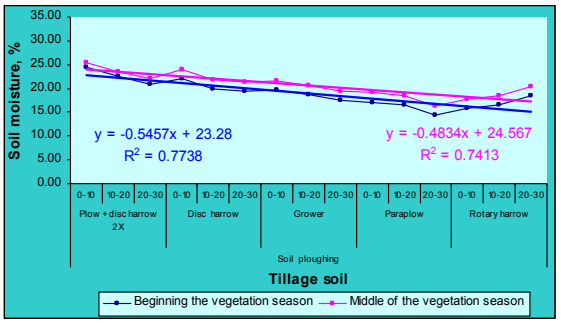

Figure 3. The variance of the soil moisture according to the works of the ploughed soil in 2010

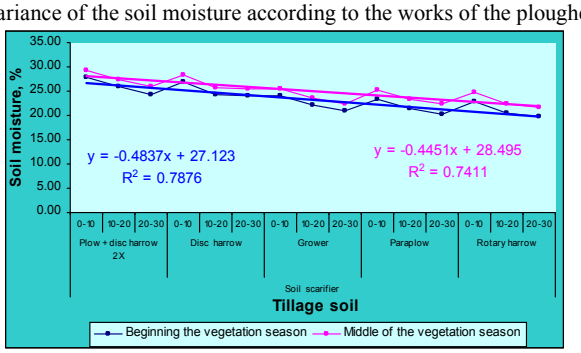

Figure 4. The variance of the soil moisture of the soil according to the works of the scarified soil in 2010

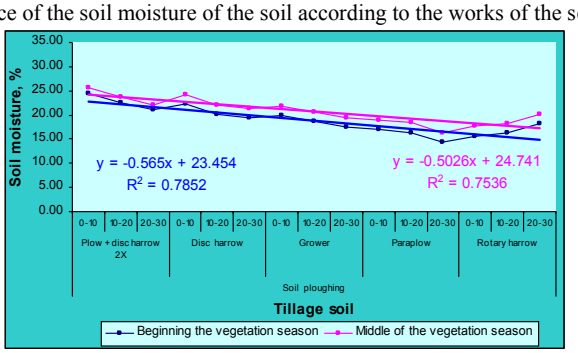

Figure 5. The variance of the soil moisture according to the works of the ploughed soil in 2011

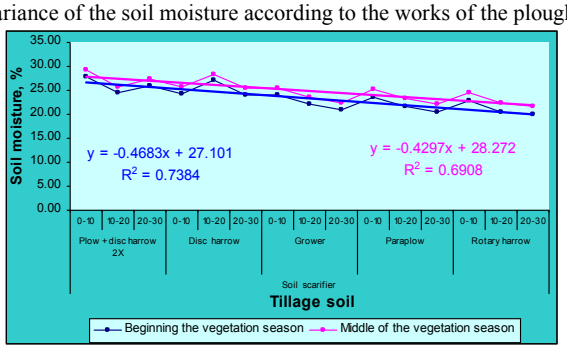

Figure 6. The variance of the soil moisture of the soil according to the works of the scarified soil in 2011

Worldwide, there is the tendency to replace the classical tillage system of the soil, through the extension of the minimum work system, method recommended both from the point of view of the preservation of the soil and for the reduction of energy consumption. (BOJA N., 2011)

Table 3

The water resource (m^3/ha), according to the work method, year 2009

Deep breaking	Soil tillage	Depth, cm	Beginning of the vegetation season	Middle of the vegetation season	Beginning of the vegetation season	Middle of the vegetation season
Witness sample		0-10	176.05	183.75	**956.76**	**1047.98**
		10-20	331.61	367.56		
		20-30	449.10	496.67		
Soil ploughing	Plow + disc harrow 2X	0-10	197.47	247.71	**1050.87**	**1201.59**
		10-20	323.04	373.28		
		20-30	530.36	580.60		
	Disc harrow	0-10	170.43	220.67	**1034.28**	**1185.00**
		10-20	369.73	419.97		
		20-30	494.12	544.36		
	Grower	0-10	166.01	216.25	**933.70**	**1084.42**
		10-20	316.20	366.44		
		20-30	451.49	501.73		
	Paraplow	0-10	132.43	182.67	**1000.28**	**1151.00**
		10-20	325.63	375.87		
		20-30	542.22	592.46		
	Rotary harrow	0-10	135.84	186.08	**914.06**	**1064.78**
		10-20	292.57	342.81		
		20-30	485.65	535.89		
Soil scarifier	Plow + disc harrow 2X	0-10	164.23	244.47	**1122.09**	**1362.81**
		10-20	292.65	372.89		
		20-30	665.21	745.45		
	Disc harrow	0-10	183.50	263.74	**1120.55**	**1361.27**
		10-20	323.92	404.16		
		20-30	613.13	693.37		
	Grower	0-10	160.63	240.87	**1300.59**	**1541.31**
		10-20	428.13	508.37		
		20-30	711.83	792.07		
	Paraplow	0-10	158.34	238.58	**1282.16**	**1522.88**
		10-20	421.96	502.20		
		20-30	701.86	782.10		
	Rotary harrow	0-10	194.21	274.45	**1421.45**	**1603.17**
		10-20	456.48	536.72		
		20-30	770.76	792.00		

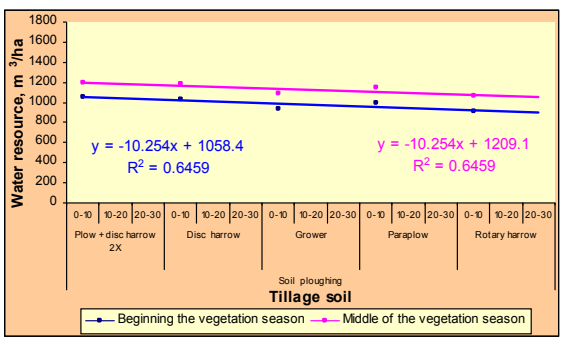

Figure 7. The variance of the water resource according to the works of the ploughed soil in 2009

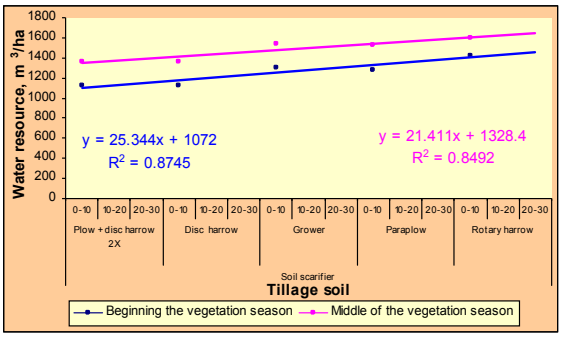

Figure 8. The variance of the water resource of the soil according to the works of the scarified soil in 2009

Table 4

The water resource (m^3/ha), according to the work method, year 2010

Deep breaking	Soil tillage	Depth, cm	Beginning the vegetation season	Middle of the vegetation season	Beginning the vegetation season	Middle of the vegetation season
Witness sample		0-10	193.66	202.12	**1052.44**	**1152.77**
		10-20	364.77	404.32		
		20-30	494.01	546.33		
Soil ploughing	Plow + disc harrow 2X	0-10	204.47	253.71	**1071.87**	**1219.59**
		10-20	330.04	379.28		
		20-30	537.36	586.60		
	Disc harrow	0-10	177.43	226.67	**1055.28**	**1203.00**
		10-20	376.73	425.97		
		20-30	501.12	550.36		
	Grower	0-10	173.01	222.25	**954.70**	**1102.42**
		10-20	323.20	372.44		
		20-30	458.49	507.73		
	Paraplow	0-10	137.43	187.67	**1015.28**	**1166.00**
		10-20	330.63	380.87		
		20-30	547.22	597.46		
	Rotary harrow	0-10	140.84	191.08	**929.06**	**1079.78**
		10-20	297.57	347.81		
		20-30	490.65	540.89		
Soil scarifier	Plow + Disc harrow 2X	0-10	169.23	250.47	**1137.09**	**1380.81**
		10-20	297.65	378.89		
		20-30	670.21	751.45		
	Disc harrow	0-10	188.50	269.74	**1135.55**	**1379.27**
		10-20	328.92	410.16		
		20-30	618.13	699.37		
	Grower	0-10	165.63	246.87	**1315.59**	**1559.31**
		10-20	433.13	514.37		
		20-30	716.83	798.07		
	Paraplow	0-10	161.34	246.58	**1291.16**	**1546.88**
		10-20	424.96	510.20		
		20-30	704.86	790.10		
	Rotary harrow	0-10	197.21	282.45	**1430.45**	**1627.17**
		10-20	459.48	544.72		
		20-30	773.76	800.00		

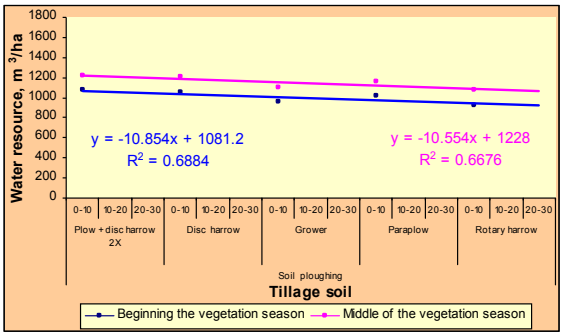

Figure 9. The variance of the water resource according to the works of the ploughed soil in 2010

Table 5

The water resource (m^3/ha), according to the work method, year 2011

Deep breaking	Soil tillage	Depth, cm	Beginning the vegetation season	Middle of the vegetation season	Beginning the vegetation season	Middle of the vegetation season
Witness sample		0-10	181.33	189.26	**985.46**	**1079.41**
		10-20	341.56	378.59		
		20-30	462.57	511.57		
Soil ploughing	Plow + disc harrow 2X	0-10	195.47	246.71	**1044.87**	**1198.59**
		10-20	321.04	372.28		
		20-30	528.36	579.60		
	Disc harrow	0-10	168.43	218.67	**1028.28**	**1179.00**
		10-20	367.73	417.97		
		20-30	492.12	542.36		
	Grower	0-10	165.01	213.25	**930.70**	**1075.42**
		10-20	315.20	363.44		
		20-30	450.49	498.73		
	Paraplow	0-10	134.43	185.67	**1006.28**	**1160.00**
		10-20	327.63	378.87		
		20-30	544.22	595.46		
	Rotary harrow	0-10	137.84	189.08	**920.06**	**1073.78**
		10-20	294.57	345.81		
		20-30	487.65	538.89		
Soil scarifier	Plow + disc harrow 2X	0-10	170.23	249.47	**1140.09**	**1377.81**
		10-20	298.65	377.89		
		20-30	671.21	750.45		
	Disc harrow	0-10	189.50	268.74	**1138.55**	**1376.27**
		10-20	329.92	409.16		
		20-30	619.13	698.37		
	Grower	0-10	166.63	245.87	**1318.59**	**1556.31**
		10-20	434.13	513.37		
		20-30	717.83	797.07		
	Paraplow	0-10	161.34	245.58	**1291.16**	**1543.88**
		10-20	424.96	509.20		
		20-30	704.86	789.10		
	Rotary harrow	0-10	197.21	281.45	**1430.45**	**1624.17**
		10-20	459.48	543.72		
		20-30	773.76	799.00		

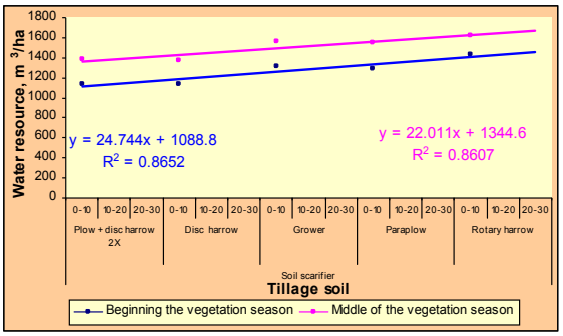

Figure 10. The variance of the water resource of the soil according to the works of the scarified soil in 2010

The correlation connections between water resource Ra m^3/ha, (dependent variable) and the soil works L_s (independent variable), have a linear shape. As a conclusion, we may infer that the soil works have a direct influence on the soil moisture and the water resource, determining the increase or decrease of these physical indicators according to the type of work.

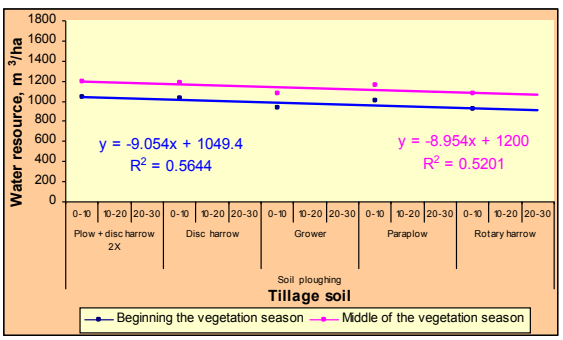

Figure 11. The variance of the water resource according to the works of the ploughed soil in 2011

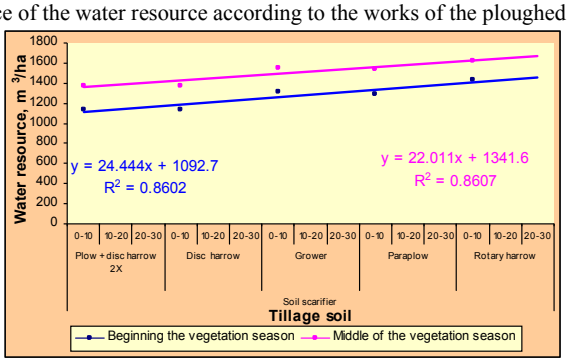

Figure 12. The variance of the water resource of the soil according to the works of the scarified soil in 2011

CONCLUSIONS

After analyzing the soil moisture and the water resource observed during the soil processing by different methods, we can draw the following conclusions:

• The analysis of the data collected shows that the highest value of soil moisture at a 30 cm-depth was obtained at the ploughed variance in the interval 0-10 cm, using the plough and the rotary harrow, while the lowest value was registered in the interval 20-30 cm when the soil processing was made with a paraplow.

• At the scarified variance the highest value of soil moisture at a 30 cm-depth was obtained in the interval 10-20 cm using a disc harrow, while the lowest value was registered in the interval 20-30 cm when the soil processing was made with a rotary harrow.

• The total quantity of water stored at a certain surface, expressed by means of water resource has maximal values for the ploughed variance when the plough and the disc harrow are used and minimal values when the rotary harrow is used.

• At the scarified variance the highest value of the water resource is registered when the soil is processed with a rotary harrow and the minimal values when the disc harrow is used.

• In conclusion, it is important to keep in mind that the soil works have a direct impact on the moisture and water resource, determining the variance of these indicators at different levels of depth, frequently in a decreasing order from surface to depth, taking into consideration the quantity of rain fallen during the period analyzed, but also the depth at which the soil is dislocated.

BIBLIOGRAPHY

1. BOJA N., BOJA F., TEUȘDEA A., CARȚIȘ MIHAELA., 2008, Influence of minimum tillage systems upon the soil physical properties and the reduction ratio, International Symposium Trends In European Agriculture Development, Publishing House Agroprint, Timişoara, Vol 40 (2) p. 25-30.
2. BOJA N., BOJA F., 2009, Determination of soil reduction ratio level after its processing in classical tillage system and in minimum tillage system, Scientific Session Proceedings „Studia Universitas", Series of Engineering Science and Agro-Turism 4/2009, University Press „Vasile Goldiş" Arad, p. 27-34.
3. BOJA N., BOJA F., 2010, Aspects regarding the soil compaction in the forestry nurseries: requirements, means, technology, International Scientific Conference Durable Agriculture – Present and Perspectives, University of Agricultural Sciences and Veterinary Medicine Iasi, Faculty of Agriculture, 21-23 october, vol. 53/2010 nr. 2, p. 151-155.
4. BOJA N., BOJA F., 2011, Research regarding the influence of the work method on the soil moisture and the water resource in the forestry nursery of Iarac, International Scientific Conference Durable Agriculture – Present and Perspectives, University of Agricultural Sciences and Veterinary Medicine Iasi, Faculty of Agriculture, vol. 54/2011, p. 106-111.
5. BOJA N., BOJA F., TOMOIAGĂ M.G., HEJA DELIA, 2011, The influence of the soil working method on moisture and water reserve in forestry nurseries, Engineering Sciences and Agroturism Series „Studia Universitatis", vol. 6, issue 2, University Press „Vasile Goldiş" Arad, p. 15-21.
6. CANARACHE A., and colab., 1990, Tutorial for the study of the soil on the spot and in the laboratory, Publishing House Agro-Silvică, Bucharest.
7. POPESCU, I., 1984, Mechanization of the forestry processing, Publishing House Ceres, Bucharest.
8. RUSU, T., GUȘ, P., 2007, Compaction of the soils– processes and consequences, Publishing House Risoprint, Cluj-Napoca.
9. ȚOPA D., JITĂREANU G., 2007, The Influence of the systems of soil processing on the categories of porosity at the culture of the winter wheat, Compaction of the soils – processes and consequences, Risoprint Publishing House, Cluj-Napoca.