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Effect of tree roots on water infiltration rate into the soil

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ABSTRACT- To study the effect of tree roots on increasing water infiltration in soil and also to determine and assess the coefficients of different infiltration models, some infiltration tests were performed in three tree plantation areas in Badjgah, Fars province with different soil textures (clay loam for pear plantation, sandy loam for grape plantation, loamy sand for pine trees). In each plantation, four double rings were installed, whereas two double rings were placed under the tree in two sides of the tree truck with 50 cm distance and the other two double rings were placed on open space between the trees. Vertical infiltration of water into the soil was measured and the coefficients of five models of infiltration (i.e. Kostiakov, Kostiakov-Lewis, Philip, Soil Conservation Service (SCS) and Horton) were assessed. Furthermore, soil texture and initial soil water content were determined in these points. Results showed that all models accurately fitted to the measured values. The infiltration rate under the trees was higher than those between the trees due to the occurrence of roots and root channels that improved the rate of infiltration of water into the soil. The 180-minute infiltration under the trees increased 69% and 354% in loamy sand and clay loam, respectively compared with those on open space between the trees.

INTRODUCTION

Increasing the urban area and population in cities over the last decades caused an overuse of ground water resources on the one hand and an increase of the sewage discharge to groundwater that makes them polluted, on the other hand. Different patterns of land use and the increasing demand for using the groundwater created a strategy of the best management practice (BMP) as a method for managing the runoff. This strategy increases infiltration of water into the soil, improves the quality and enhances groundwater recharge (Bartens et al., 2008).

By increasing urbanization, the concept of low impact development (LID) management in the 1990 s as the BMP became more apparent compared with the traditional managing of the surface runoff. The ultimate goal of LID is to divide and minimize the surface runoff with the best management of runoff and to increase the infiltration of water into the soil (Dietz, 2007).

LID has become popular for surface runoff management, and most of the municipalities have regulations which are necessary regarding the LID activities in new city developments. Other use is financial incentive to advance this new form of runoff management and control. However, there is not enough research on the effectiveness of LID in runoff management. In LID strategy, surface runoff infiltration into the soil has a special importance over the traditional storm water collector networks. Thus, this infiltration is enhanced for managing the runoff of urban areas (DeBusk, 2008).

In rural lands, forests, grasslands and wetlands, most of the obtained water from rainfall and melting snow infiltrates slowly into the ground. In contrast, in urban areas and developed lands, infiltration rates are very low (Gregory et al., 2006) that could be improved by tree plantation.

The objective of this study is to evaluate the potential of different tree plantations in increasing infiltration in different soil textures in Badjgah, Fars province as a method of BMP.

MATERIALS AND METHODS

In this research, the infiltration tests were conducted in three tree plantations in Badjgah, Fars province with different soil textures (pear orchard and pine trees situated in the College of Agriculture and grape vines situated in the College of Veterinary). Tree ages ranged between 30-40 years. Some physical properties of soils in 0-30 cm depth for these three locations are shown in Table 1. Furthermore, soil textures and the initial soil water contents were determined in these places.

In each plantation, four double rings (with 2 replications) were installed, whereas two double rings were placed under the tree in two sides of the tree trunk with 50 cm distance and the other two double rings were placed on open space between the trees.

Table 1. Soil texture and the initial soil water content in 0-30cm depth for three various experimental places

Place	Silt (%)	Clay (%)	Sand (%)	Soil texture	The gravimetric initial soil water content (%)	
					Between two trees	In 50 cm distance from every tree
Around the pear tree	34	37	31	Clay loam	4	2.5
Around the grape tree	29	10	58	Sandy loam	1	1
Around the pine tree	12	9	86	Loamy sand	1.5	1.5

Vertical infiltration of water into the soil was measured and the coefficients of five models of infiltration, that is, Kostiakov, Kostiakov-Lewis, Philip, Soil Conservation Service (SCS) and Horton were assessed and the coefficients of infiltration equations were estimated by Solver software in 0-30 cm depth. For evaluating the infiltration equations, the coefficient of determination (R^2) and standard error (SE) were used. The model which had the maximum value of R^2 and the minimum value of SE was introduced as the suitable model.

RESULTS AND DISCUSSION

The coefficients of infiltration models for cumulative infiltration and the infiltration rate and different soil textures and places (under and between tress) are presented in Tables 2 to 7 and graphically are shown in Figs. 1 and 2. The R^2 and SE values accounted for the fitting curves showed that all of the five equations described in this study accurately fitted to the measured data.

Based on the mean measured values, the cumulative infiltration after 180 min elapsed time for different textures and places (under trees and between them) are shown in Tables 8 and 9.

Therefore, tree plantation can be considered as a suitable solution for increasing the infiltration and reducing the surface runoff. Then, we investigated the effectiveness of several parameters on increasing the infiltration of water in soil.

The Effect of Tree Species on Infiltration

Urban forest has been known as an effective way for controlling the surface runoff. Tree rainfall interception is the amount of rainfall that trees prevent to reach the ground. So, the rain is temporarily stored on the canopy surface (Sanders, 1986). Usually, 1.6% of annual precipitation intercepts by trees (6.6 m^3 for each tree). The large trees and evergreen ones have the most important role in the interception of rainfall if they are well-adapted to local growing conditions, and their benefits will be apparent in longtime (Xiao and McPherson, 2002). Furthermore, trees direct the rainfall into the ground through trunk flow (Johnson and Lehmann, 2006) and are effective in removing the pollution by root (Szabo et al., 2001). In optimized conditions and maximized canopy, they can intercept more than 79% of a daily rainfall of 22 mm (Xiao and McPherson, 2002). The canopy can also be limited by urban soil conditions such as compaction, high pH and reduction in root volume. Water flow occurs along the root channel; so, forest and afforestation have a wide effect on the flow of water into the soil (Johnson and Lehmann, 2006). In flooded conditions, in an area with trees, water infiltration in soil is twice to seventeen times as much as an area without trees (Bramley et al., 2003). Although previous studies shed light on the effect of plantation on the infiltration in soil, the effect of different tree species on infiltration was not thoroughly investigated.

Cumulative infiltration equations under canopy and outside different trees are shown in Tables 2 to 7. It is indicated that infiltration in 50 cm distance from every tree (under canopy of tree) is higher than those obtained between two trees due to the increase of biological drills obtained from tree roots which are channels that increase water infiltration in soil. Cumulative infiltrations at 180 min elapsed time for different tree cultivations are shown in Table 8. It is indicated that infiltrations under tree canopy are 69, 152 and 354% higher than those obtained outside the trees for pear, grape and pine trees, respectively. Therefore, the order of species effect on infiltration enhancement is pine>grape>pear.

Table 2. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration under canopy of pear tree with clay loam texture

Model	The equation of cumulative infiltration	The equation of Infiltration rate	SE	R^2
Kostiakov	$i = 2.51t^{0.53}$	$I = 1.33t^{-0.47}$	12.14	0.997
Kostiakov-Lewis	$i = 2.99t^{0.44} + 0.06t$	$I = 1.31t^{-0.56} + 0.06$	12.09	0.994
Philip	$i = 2.69t^{0.5} + 0.02t$	$I = 1.34t^{-0.5} + 0.02$	12.05	0.996
Horton	$i = 0.13t + 15.60\,(1 - e^{-0.05t})$	$I = 0.13 + 0.78e^{-0.05t}$	12.48	0.990
SCS	$i = 2.23t^{0.55} + 0.6985$	$I = 1.23t^{-0.45}$	12.07	0.996

Table 3. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration between two pear trees with clay loam texture

Model	The equation of cumulative infiltration	The equation of infiltration rate	SE	R^2
Kostiakov	$i = 1.57t^{0.34}$	$I = 0.53t^{-0.66}$	2.34	0.993
Kostiakov-Lewis	$i = 2.11t^{0.19} + 0.02t$	$I = 1.32t^{-0.81} + 0.02$	2.07	0.998
Philip	$i = 0.76t^{0.5} + 0\ t$	$I = 0.38t^{-0.5}$	3.00	0.977
Horton	$i = 0.03t + 3.99\ (1- e^{-0.22t})$	$I = 0.03 + 0.88\ e^{-0.22t}$	2.38	0.988
SCS	$i = 1.11t^{0.39} + 0.6985$	$I = 0.43t^{-0.61}$	2.29	0.992

Table 4. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration under canopy of grape tree with sandy loam texture

Model	The equation of cumulative infiltration	The equation of infiltration rate	SE	R^2
Kostiakov	$i = 1.15t^{0.82}$	$I = 0.94t^{-0.18}$	21.99	0.999
Kostiakov-Lewis	$i = 2.96t^{0.005} + 0.46t$	$I = 0.01t^{-0.995} + 0.46$	22.66	0.995
Philip	$i = 1.49t^{0.5} + 0.34t$	$I = 0.74t^{-0.5} + 0.34$	21.82	0.999
Horton	$i = 0.40t + 8.33(1- e^{-0.04t})$	$I = 0.40 + 0.33\ e^{-0.04t}$	21.99	0.999
SCS	$i = 1.02t^{0.84} + 0.6985$	$I = 0.86t^{-0.16}$	21.88	0.999

Table 5. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration between two grape trees with sandy loam texture

Model	The equation of cumulative infiltration	The equation of infiltration rate	SE	R^2
Kostiakov	$i = 2.29t^{0.50}$	$I = 1.14t^{-0.50}$	8.23	0.990
Kostiakov-Lewis	$i = 3.59t^{0.24} + 0.12t$	$I = 0.86t^{-0.76} + 0.12$	8.33	0.979
Philip	$i = 2.28t^{0.5} + 0.003t$	$I = 1.14t^{-0.5} + 0.003$	8.26	0.990
Horton	$i = 0.13t + 9.47(1- e^{-0.12t})$	$I = 0.13 + 1.14\ e^{-0.12t}$	8.27	0.990
SCS	$i = 1.95t^{0.53} + 0.6985$	$I = 1.03t^{-0.47}$	8.17	0.990

Table 6. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration under canopy of pine tree with loamy sand texture

Model	The equation of cumulative infiltration	The equation of infiltration rate	SE	R^2
Kostiakov	$i = 1.45t^{0.68}$	$I = 0.99t^{-0.32}$	13.88	0.999
Kostiakov-Lewis	$i = 1.99t^{0.44} + 0.18t$	$I = 0.87t^{-0.56} + 0.18$	13.85	0.997
Philip	$i = 1.88t^{0.5} + 0.14t$	$I = 0.94t^{-0.5} + 0.14$	13.73	0.998
Horton	$i = 0.23t + 10.32\ (1- e^{-0.06t})$	$I = 0.23 + 0.62\ e^{-0.06t}$	13.96	1
SCS	$i = 0.40t^{0.80} + 0.6985$	$I = 0.32t^{-0.20}$	15.58	0.976

Table 7. Coefficients of infiltration models determined by Solver software in 0-30 cm depth for the mean of cumulative infiltration between two pine trees with loamy sand texture

Model	The equation of Cumulative infiltration	The equation of infiltration rate	SE	R^2
Kostiakov	$i = 1.02t^{0.64}$	$I = 0.65t^{-0.36}$	8.87	0.999
Kostiakov-Lewis	$i = 2.41t^{0.08} + 0.16t$	$I = 0.19t^{-0.92} + 0.16$	8.21	0.983
Philip	$i = 1.26t^{0.5} + 0.07t$	$I = 0.63t^{-0.5} + 0.07$	7.80	0.999
Horton	$i = 0.13t + 6.09(1- e^{-0.07t})$	$I = 0.13 + 0.43\ e^{-0.07t}$	7.91	0.999
SCS	$i = 0.79t^{0.69} + 0.6985$	$I = 0.54t^{-0.31}$	7.78	0.999

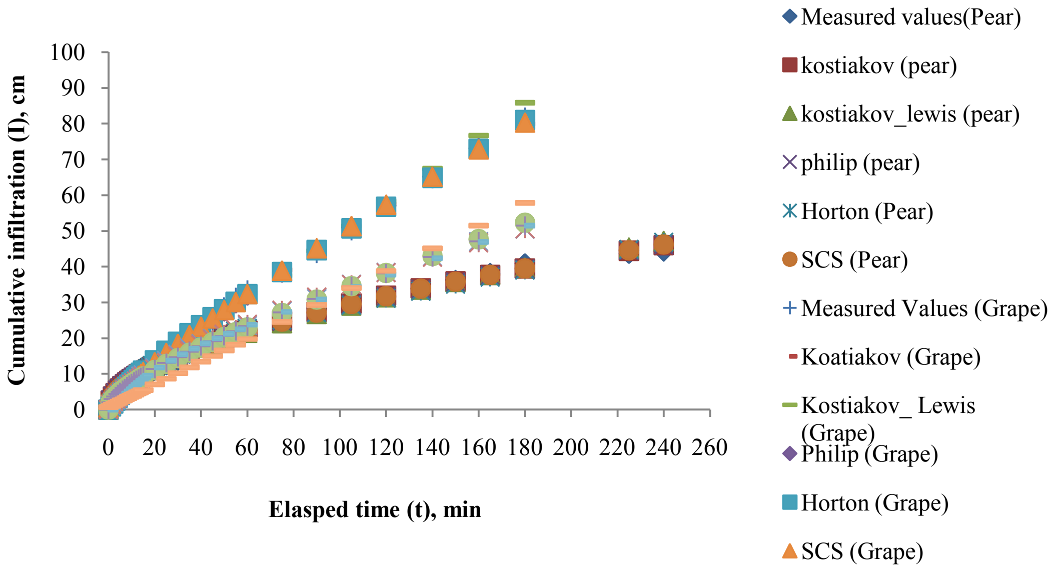

Fig. 1. Comparing the mean measured values and predicted values by different models for mean cumulative infiltration under canopy of pear tree (with sandy loam texture), grape tree (with loamy sand texture) and pine tree (with loamy sand texture)

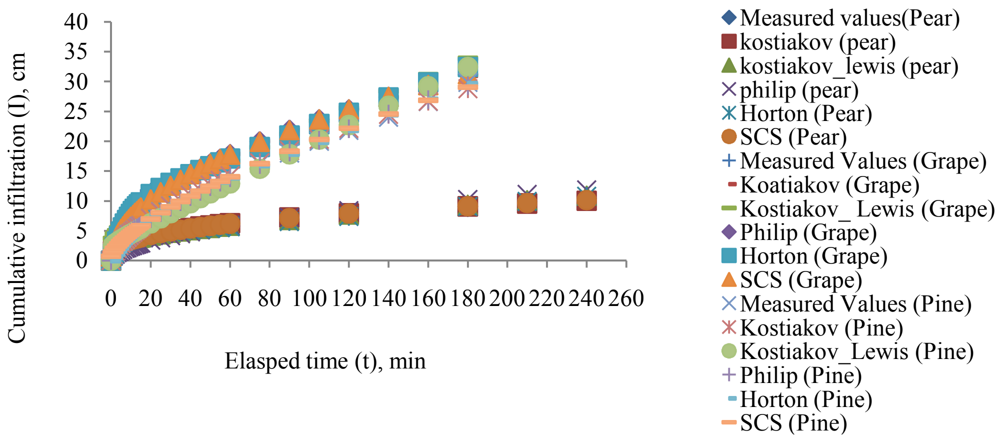

Fig. 2. Comparing the mean measured values and predicted values by different models for mean cumulative infiltration between two pear trees (with sandy loam texture), grape trees (with sandy loam texture) and pine trees (with loamy sand texture)

Table 8. Soil texture and the mean cumulative infiltration value during the 180 minutes

Location	Soil texture	Cumulative infiltration (cm)		Increase in the value of cumulative infiltration under the canopy of the tree compared to between the two trees (%)
		Between two trees	In 50 cm distance from every tree	
Around the pear tree	Clay loam	9.00	40.90	354
Around the grape tree	Sandy loam	32.30	81.85	153
Around the pine tree	Loamy sand	29.85	50.50	69

Table 9. The mean of initial soil water content and final constant infiltration rate at 180 minutes

Soil texture	Final constant infiltration rate (cm/min) Between two trees	In 50 cm distance from every tree	Increase in final constant infiltration rate under the canopy of tree relative to between two trees (%)	Gravimetric initial soil water content (%) Between two trees	In 50 cm distance from every tree
Clay loam	0.02	0.18	800	4	2.5
Sandy loam	0.12	0.46	283	1	1
Loamy sand	0.16	0.18	12.50	1.5	1.5

Soil Texture Effect on Infiltration

Water infiltration in soil is a basic process in water cycle because it controls the relationship between groundwater and surface runoff (Ward and Robinson, 1989). The properties of soil play a main role in this process (Cerdà, 1997). So, modifications to ecosystems can create many differences in infiltration to decrease the erosive processes (Cerdà, 1998). Pitt et al. (1999) examined the effect of two parameters, soil moisture and compaction, on infiltration in sandy and clay soils. Table 10 shows that with a small change in these parameters, the infiltration could be changed greatly in sandy soils but the results were not the same in clay soils (Pitt et al., 1999).

Table 10. Comparison of infiltration rate from different test series (Pitt et al., 1999)

Soil texture	Conditions	Mean of infiltration rate (mm/h)
Sandy soils	Non compacted	414
Sandy soils	Compacted	64
Clay soils	Non compacted(dry)	220
Clay soils	Compacted (dry and saturation)	20

Also, in this research, the effect of compost as soil amendment was studied. The results showed that soil amendment by compost caused to improve the infiltration, soil water retention, bulk density and soil structure and also the infiltration of water into the soil would be increased from 1.5 to 10.5 times. Unfortunately, increasing the compost, especially in new developed areas, causes to increase concentration runoff; so, more studies are needed to determine the optimized amount of the compost.

Soil compaction has a reversed effect on infiltration. In sandy soils of the north of Florida with minimum compaction, the significant reduction in infiltration has been occurred. Therefore, to prevent runoff occurrence in urban areas in these soils, it is necessary to prevent soil compaction. The subsoils of the urban areas are compacted by roads, buildings, and parking lots.

In addition, penetration of roots through impermeable layers can effectively help surface runoff infiltration as an I-BMP (Infiltration Best Management Practice) method (Barley, 1963). The subsoils of the urban areas are impenetrable. Although high soil strength may inhibit the root penetration into the soil, the drills of tree roots can act as channels to travel the water (Kozlowskiand and Pallardy, 1997). Also, the subsoils reserve the moisture for a long time and provide a possibility to exploit the potential of roots for increasing infiltration (Bartens et al., 2008).

Effects of soil texture on infiltration are shown in Table 9. The infiltration in sandy loam is higher than that in loamy sand and it is least for clay loam. Furthermore, increases in infiltration under tree canopy in clay loam, sandy loam and loamy sand are 354, 152 and 69%, respectively compared with those obtained in open space outside the tree canopy. It is indicated that this increase is higher in clay loam due to micropores occurrence. Therefore, root channeling with increase in macropores caused higher effects on enhancing infiltration. We speculated that infiltration increase in loamy sand was low due to the macropores occurrence in this soil and it resulted in lower effectiveness of root channeling.

Basic infiltration rates under canopy and outside tree canopy are presented in Table 9. Tree root channeling caused the basic infiltration rate to increase from 13 to 800% in different soil textures. It is indicated that the channeling effect on the infiltration rate was higher than that for cumulative infiltration. The root of trees, known as the biological drills, attended to this subject marginally, presumably, because roots penetrate fewer in compacted soils and small roots have little impact on infiltration of water in soil (Cresswell and Kirkegaard, 1995).

In a study, it was proved that the roots of woody plants caused to increase the flow of water into the soil, and increased the macropores and hydraulic conductivity. Of course, this research proved this fact six years after the time woody plants were removed and their roots were decayed (Yunusa et al., 2002). Furthermore, Table 11 shows that the effectiveness of tree roots on the infiltration rate in soils with heavy texture is higher than those in soils with light texture.

Table 11. The description of last studies' results for evaluating the effect of forestation on increasing the infiltration

Source	Vegetation		Soil Texture	Infiltration (mm/h)		
	Before	After		Before	After	Increase Infiltration (%)
Mapa (1995)	Grass	*Tectonia grandis* (12 years)	Clay	26	57	119
Mapa (1995)	Crops	*Tectonia grandis* (12 years)	Clay	29	57	965
Hulugalle and Ndi (1993)	Crops	*Cassia spectabilis + crops* (1year)	Clay	3	5.5	83
Hulugalle and Ndi (1993)	Crops	*Cassia spectabilis + crops* (1year)	Clay	3.3	5.5	67
Chirwa et al. (1993)	Crops	*Sesbania sesban* (3 years)	Clay	13	95	631
Chirwa et al. (1993)	Crops	*Gliricidia sepium* (3 years)	Clay	13	44	238
Chirwa et al. (1993)	Crops	*Leucaena leucocephala* (3 years)	Clay	13	37	185
Chirwa et al. (1993)	Crops	*Acacia angustissima* (3 years)	Clay	13	55	323
Chirwa et al. (1993)	Crops	*Acacia + Sesbania* (3 years)	Clay	13	71	446
Chirwa et al. (1993)	Crops	*Gliricidia + Sesbania* (3 years)	Clay	13	119	815
Hulugalle and Kang (1990)	Crops	*Gliricidia sepium* (8 years) + crops	Loamy	47	152	223

The Relationship Between Infiltration aAnd Initial Soil Water Content

Soil water content affects the infiltration rate and higher soil water content results in lower initial infiltration rate. However, for a given soil texture, the basic infiltration rate is not affected by soil water content. Measured soil water contents for different plantations/soil textures under tree or outside tree canopy are shown in Table 9. It is indicated that no significant difference occurred in soil water contents in different conditions. Therefore, it is not effective in differences in infiltration rates for various soil textures/plantations under tree or outside tree canopy. Thus, any differences which occurred in infiltration rates were due to either soil textures/plantations or channeling root conditions.

In general, low infiltration rate may be a result of higher soil compaction. However, in this study, lower infiltration rate outside the tree canopy is not due to higher soil bulk density since soil between the tree rows was tilled annually in spring especially in grape plantation while under tree canopy it was undisturbed. Again, this indicated that higher infiltration rate under tree canopy is a result of root channeling. Furthermore, it is indicated that the difference between the infiltration rates under tree and outside tree canopy for pine trees was lower than that obtained for grape and pear plantation. This might have occurred due to very light texture with a high sand content (86%). The relationship between the increase in infiltration rates under tree and outside the canopy and sand content in soil is obtained by regression analysis as follows:

$$Lny=9.35-0.075x, \qquad R^2=0.93$$

where y is the increase in infiltration rates under tree and outside the canopy (%) and x is the sand content in soil (%). The sand content of the soil was the most important and effective parameter that entered the regression model with a significant probability level with high R^2 value (0.93) and other parameters did not enter the regression model.

CONCLUSIONS

Five infiltration models (Kostiakov, Kostiakov-Lewis, Philip, Soil Conservation Service (SCS) and Horton) accurately fitted to the measured data. The values of coefficient of determination (R^2) and standard error (SE) showed that all of the models have the best fit with the measured data. The infiltration of 180 min under canopy of the tree for clay loam, sandy loam, and loamy sand was about 69 to 354% higher than that outside the canopy. These differences for basic infiltration rates were 13 to 800%. Furthermore, the effectiveness of tree roots on the infiltration rate in soils with heavy texture (clay loam) was higher than that in soils with light texture (loamy sand). Higher differences between the cumulative infiltration and basic infiltration rates under tree canopy and outside canopy in heavy textured soils are due to the tree root channeling effect that is more pronounced compared to the small pores in these soils. Other physical differences in soil under the tree canopy and outside canopy were not effective in infiltration differences.

REFERENCES

Barley, K. (1963). Influence of soil strength on growth of roots. *Soil Science*, 96, 175–180.

Bartens, J., Day, S.D., Harris, J.R., Dove, J.E., & Wynn, T.M. (2008). Can urban tree roots improve infiltration through Compacted subsoils for storm water management? *Journal of Environmental Quality*, 37, 2048–2057.

Bramley, H., Hutson, J., & Tyerman, S.D. (2003). Floodwater infiltration through root channels on a sodic clay floodplain and the influence on a local tree species *Eucalyptus largiflorens*. *Plant Soil*, 253, 275–286.

Cerdà, A. (1997). Seasonal changes of the infiltration rates in a Mediterranean scrubland on limestone. *Journal of Hydrology,* 198, 209–225.

Cerdà, A. (1998). The influence of aspect and vegetation on seasonal changes in erosion under rainfall simulation on a clay soil in Spain. *Canadian Journal of Soil Science*, 78, 321-330.

Cresswell, H.P., & Kirkegaard, J.A. (1995). Subsoil amelioration by plant roots: The process and the evidence. *Journal of Soil Research*, 33, 221–239.

DeBusk, K.M. (2008). Storm water treatment by two retrofit infiltration practices. Master of Science in Biological Systems Engineering. M.Sc. Thesis, Virginia Department of Conservation and Recreation (DCR), Virginia, Atazoni.

Dietz, M.E. (2007). Low impact development practices: A review of current research and recommendations for future directions. *Water Air and Soil Pollution*, 186 (1-4), 351-363.

Gregory, J.H., Dukes, M.D., Jones, P.H., & Miller, G.L. (2006). Effect of urban soil compaction on infiltration rate. *Journal of Soil and Water Conservation*, 61(3), 117-124.

Johnson, M.S., & Lehmann, J. (2006). Double-funneling of trees: Stem flow and root-induced preferential flow. *Ecoscience*, 13(3), 324-333.

Kozlowski, T., & Pallardy, S. (1997). Physiology of Woody Plants. 2nd edition. San Diego, CA. Academic Press.

Pitt, R., Lantrip, J., Harrison, R., Henry, CH.L., Xue, D., & O'Connor, T. (1999). Infiltration through disturbed urban soils and compost-amended soil effects on runoff quality and quantity. Research Report of United States Environmental Protection Agency and Office of Research and Development Washington. DC 20460.

Sanders, R.A. (1986). Urban vegetation impacts on the urban hydrology of Dayton, Ohio. *Journal of Urban Ecology*, 9, 361-376.

Szabo, A., Osztoics, A., & Szilagyi, F. (2001). Natural wastewater treatment in Hungary. *Water Science Technology*, 44, 331–338.

Ward, R.C., & Robinson, M. (1989). Principles of Hydrology. London. McGraw-Hill.

Xiao, Q., & McPherson, E.G. (2002). Rainfall interception by Santa Monica's municipal urban forest. *Manufactured in The Netherlands*, 6, 291-302.

Yunusa, I.A.M., Mele, P.M., Rab, M.A., Schefe, C.R., & Beverly, C.R. (2002). Priming of soil structural and hydrological properties by native woody species, annual crops, and a permanent pasture. *Journal of Soil Research*, 40, 207–219.

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اثر ریشه‌های درخت بر سرعت نفوذ آب در خاک

مریم کاظمی‌زاده* ، علیرضا سپاس‌خواه

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اس- سی- اس

کوستیاکف

چکیده- برای بررسی اثر ریشه‌های درخت بر افزایش نفوذ آب در خاک و هم‌چنین برای تعیین و ارزیابی ضرایب معادله های مختلف نفوذ، اندازه‌گیری هایی در سه ناحیه درختکاری شده در باجگاه، استان فارس با بافت‌های مختلف خاک (لوم رسی در باغ گلابی، لوم شنی در باغ انگور و شن لومی در جنگل کاج) انجام شد. در هر کدام از سه ناحیه، چهار استوانه دوگانه اندازه‌گیری نفوذ آب کارگذاری شد به نحوی که دو استوانه زیر تاج درخت در طرفین تنه درخت بفاصله ۵۰ سانتی متر از آن و دو استوانه دیگر در فاصله بین درختان مابین دو درخت کارگذاری شدند. نفوذ عمودی آب در خاک در این استوانه‌ها اندازه‌گیری شد و ضرایب پنج معادله نفوذ {کوستیاکف، کوستیاکف- لوئیس، فیلیپ، سرویس حفاظت خاک (SCS) و هورتن} ارزیابی شدند. بعلاوه ، بافت خاک و مقدار اولیه آب خاک در نقاط اندازه‌گیری نیز تعیین شدند. نتایج نشان داد که تمام معادله‌ها به داده‌های اندازه‌گیری شده بخوبی برازش داده شدند. سرعت نفوذ در زیر تاج درخت از مقدار آن در فاصله بین درختان بخاطر وجود ریشه و کانال‌های ریشه که باعث بهبود در سرعت نفوذ آب به خاک شده بیشتر بود. میزان نفوذ ۱۸۰ دقیقه‌ای در زیر تاج درخت در مقایسه با فاصله بین درختان در خاک‌های شن لومی و لوم رسی به‌ترتیب ۶۹٪ و ۳۵۴٪ افزایش یافته است.