IV INOVAGRI INTERNATIONAL MEETING
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NACIONAL DE IRRIGAÇÃO E DRENAGEM
III SBS – SIMPÓSIO BRASILEIRO DE SALINIDADE

WATER INFILTRATION VELOCITY IN A YELLOW RED ARGISOL IN THE FARMING OF SWEET CORN AND SUNFLOWER

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ABSTRACT: This work was performed in an experiment that is already being done for fifteen years in the rural campus of the Federal University of Sergipe, which studies the impact of soil management changes on production and soil physical properties, the area was divided into three installments, treated with tillage, minimum tillage and conventional tillage in a succession of sweet corn and sunflower, as ground cover. The objective was to obtain the basic infiltration velocity (BIV) by double infiltrometer ring, analyze its variation in relation to the managements and the adequacy of Horton models (1940), Kostiokov (1932), Kostiokov-Lewis (1945) and Phillip (1957). As expected, the treated soil in a milder way had the best results for water infiltration rate. An excellent result was observed, the BIV reached 123 mm h^{-1}, and the area managed with tillage was 1.86 times higher than in conventional tillage. The model that best fit the BIV in all kinds of managements was to Horton, the BIV calculated was equal to that obtained in the field, which is easily explained by the way that the equation progresses.

KEYWORDS: double rings infiltrometers, no-till, conventional tillage.

VELOCIDADE DE INFILTRAÇÃO DA ÁGUA EM UM ARGISSOLO VERMELHO AMARELO NO CULTIVO DE MILHO DOCE E COBERTURA DE GIRASSOL

RESUMO: O presente trabalho foi realizado em um experimento que já vem sendo realizado há quinze anos no campus rural da Universidade Federal de Sergipe, que estuda o impacto da variação de manejo do solo sobre a produção e os atributos físicos do solo, a área foi dividida em três parcelas, tratadas com plantio direto, cultivo mínimo e cultivo convencional, em uma sucessão de milho doce e girassol, como cobertura do solo. O objetivo foi obter a velocidade de infiltração básica (VIB) através do duplo anel infiltrômetro, analisar sua variação em relação aos manejos e a adequação dos modelos de Horton (1940), Kostiokov (1932), Kostiokov-Lewis (1945) e Phillip (1957). Como esperado, o solo tratado de maneira mais branda obteve melhor

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resultados de velocidade de infiltração da água. Foi observado um resultado excelente, a VIB chegou a 123 mm h^{-1}, sendo que a área manejada com plantio direto foi 1,86 vezes maior que no plantio convencional. O modelo que melhor se ajustou a VIB em todos os tipos de manejos foi o de Horton, a VIB calculada foi igual à obtida no campo, o que é facilmente explicado pela forma que a equação evolui.

PALAVRAS-CHAVE: duplo anéis infiltrômetros, plantio direto, plantio convencional.

INTRODUCTION

The sustainability of agricultural areas is conditioned, among other things, the maintenance of soil productivity within production system undergoes changes in physical, chemical and biological properties, by the application of fertilizers and pesticides, machinery traffic, irrigation and change the water regime in river basins (CORRÊA et. al., 2010). Quantitative analysis and interpretation of physical and physical-hydric attributes and major changes generated in soil quality are the key for safe management of natural resources (STEFANOSKI et. al., 2013).

The no-tillage and crop livestock integration are among these management practices and soil conservation. The soil quality is maintained and / or even improved by no soil compaction and greater input of organic matter, due to the straw kept under the soil surface on the no-tilage.

The infiltration is an important physical attribute of the soil water, and it is the process by which water passes through the ground surface. According BRANDÃO (2006), this phenomenon starts with a high speed because the water initially runs by preferential paths, ie macrospore, according to these paths are filled water begins to fill the most difficult paths, microspores, thus the speed decays gradually, until the soil is saturated and the velocity is constant, known like the basic infiltration velocity (BIV).

For BERNARD (2006), the infiltration velocity (IV) of water in a soil is a very important factor for irrigation since it determines the time at which to maintain the water on the soil surface or the duration of the spraying, so as to apply a desired amount of water.

This study aimed to obtain the basic infiltration velocity (BIV) by double infiltrometer ring, analyze its variation with respect to different management and adequacy of Horton models (1940), Kostiokov (1932), Kostiokov-Lewis (1945) and Phillip (1957).

MATERIALS AND METHODS

The study was conducted at the Experimental Station Campus of the Federal University of Sergipe - UFS. The soil of the study area is classified as Yellow Red Argisol, which are characterized as deep to shallow; moderately well drained; very variable design, but with a predominance of medium texture on the surface, and clay in the subsurface; and feature low total average porosity (EMBRAPA, 2006). The region has a rainy climate with dry summer and an average rainfall 1200 mm per year, with rainfall concentrated in the months of April to September.

An experiment was conducted to investigate the influence of different managements in a cultivated by sweet corn (Zea mays L.). The managements that are being used are: conventional tillage (composed of harrowing with harrowing discs + plowing with disk plow + disking), minimum tillage (consisting of 1 or 2 disking with harrowing disks, and the second is only performed when there is considerable incidence of invasive), no tillage and crop succession in cover crops to commercial crop.

The sunflower (Helianthus annuus) was the crop to be used as ground cover. It was used the scheme of experimental tracks, and the soil tillage treatments arranged as tracks and crop in succession as subplots. The crop succession had three repetitions distributed at random.

The infiltration velocity was determined in each sub-plot using the methodology of the dual concentric rings.

The VIBK software was created during the search to make faster and more efficient process, it was developed in Matlab software. It has a structure of vector data, programming features and GUI tools, it becomes a powerful tool for troubleshooting in various knowledge areas. (HANSELMAN e LITTLEFIELD, 2003).

The VIBK software receives as input the variation of time, in minutes, water infiltrated depth in millimeters and returns the basic infiltration velocity in millimeters per hour, those contained in mathematical models Horton (1940), Kostiokov (1932), Kostiokov-Lewis (1945) and Philip (1957), and their graphics.

Comparative analyzes of the results were statistically performed by the coefficient determination (R^2) to evaluate the performance of the infiltration values obtained in field in relation the values calculated from the models Kostiakov, Horton and Kostiakov-Lewis and Philip. The following statistical indices were calculated to make more efficient analysis: residual mass ratio (RMR), adjustment coefficient (AC) and efficiency (EF) as described by BRITO (2009).

$$\text{RMR} = \frac{\sum_{i=1}^{n} O_i - \sum_{i=1}^{n} P_i}{(\sum_{i=1}^{n} O_i)} \qquad (1)$$

$$\text{AC} = \frac{\sum_{i=1}^{n}(O_i - \bar{O})^2}{\sum_{i=1}^{n}(P_i - \bar{O})^2} \qquad (2)$$

$$\text{EF} = \frac{\sum_{i=1}^{n}(O_i - \bar{O})^2 - \sum_{i=1}^{n}(P_i - O_i)^2}{\sum_{i=1}^{n}(O_i - \bar{O})^2} \qquad (3)$$

where:

***Oi* -** It is the observed value,

***Pi* -** it is the estimated value and "n" means the number of observations,

$\bar{O}$ **-** it is the arithmetic mean of the observations,

$\bar{P}$ **-** it is the arithmetic mean of the estimated values.

RESULTS AND DISCUSSION

The results related to the basic infiltration velocity in different soil managements sweet corn planting and succession of coverage with sunflower are shown in Table 1.

Table 1. The average of the basic infiltration velocity (BIV) found for each type of soil management and coverage with sunflower

Soil management	BIV (mm h^{-1})
No-tillage	123
Minimum tillage	66
Conventional tillage	51

Analyzing the results obtained, happened which was evidenced by the authors GONÇALVES (2012) and SOBRINHO et al. (2003), the largest basic infiltration velocity were found in the no tillage, because the soil is usually less compressed, so the existence of macropores favored the increasing the infiltration water in the soil, because as it has been reported by SOBRINHO et al. (2003), excessive use of gratings changes the volume of macropores, forming the so-called "grid walk", which is a densified layer between 10 and 30 cm depth.

The statistical results are shown in table 2 and the curves obtained and infiltration rate calculated for sunflower in all soil management are shown in figures 1, 2 and 3.

Table 2. Basic infiltration velocity and indices statistical for Sunflower in the three types of soil management.

Model	BIV (mm h^{-1})	R^2	RMR	AC	EF
			No Tillage		
Observed values	123	1	0	1	1
Horton	123	0.9467	0.0561	1.2263	0.8725
Kostiakov	114.69	0.9345	0.0106	1.6095	0.8510
Kostiakov-Lewis	114.69	0.9841	0.0886	4.3648	0.5999
Philip	117.38	0.9770	0	1.0474	0.9546
			Minimum tillage		
Observed values	66	1	0	1	1
Horton	66.00	0.9663	0.0645	1.4691	0.9060
Kostiakov	56.16	0.9516	0.0476	2.0143	0.8397
Kostiakov-Lewis	56.16	0.9870	0.2278	5.5243	0.4369
Philip	46.71	0.9678	0	1.0675	0.9367
			Conventional tillage		
Observed values	51	1	0	1	1
Horton	51.00	0.8704	0.1004	1.0899	0.7154
Kostiakov	50.91	0.9159	0.0243	1.5466	0.8240
Kostiakov-Lewis	50.99	0.9306	0.0662	3.8245	0.6599
Philip	54.19	0.9319	0	1.1512	0.8686

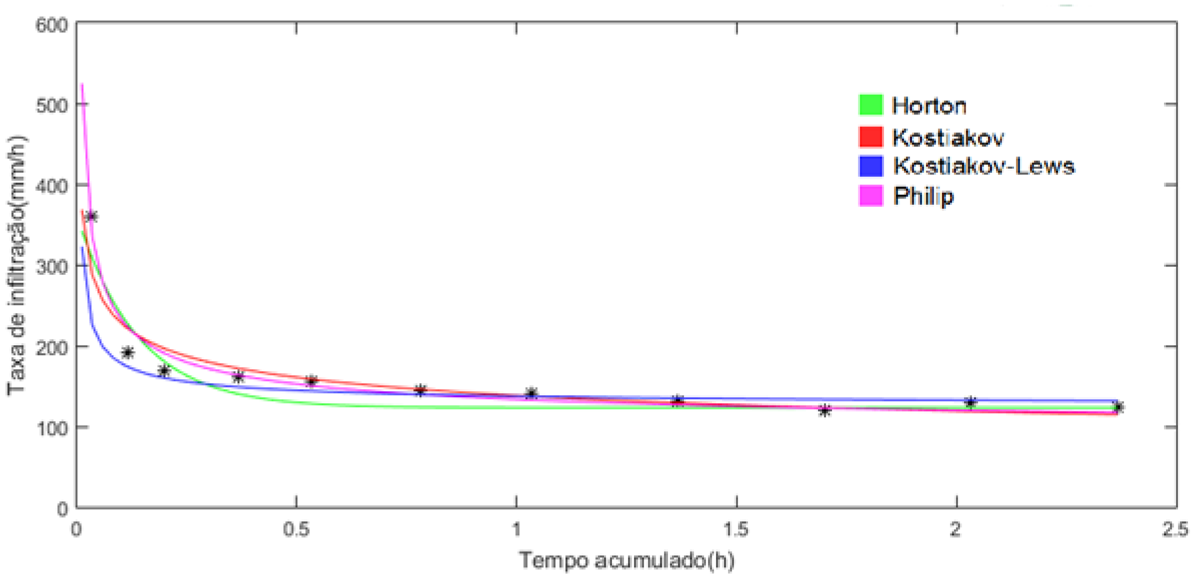

Figure 1. Rates observed and estimated of water infiltration in soil with no tillage sweet corn using as cover sunflower.

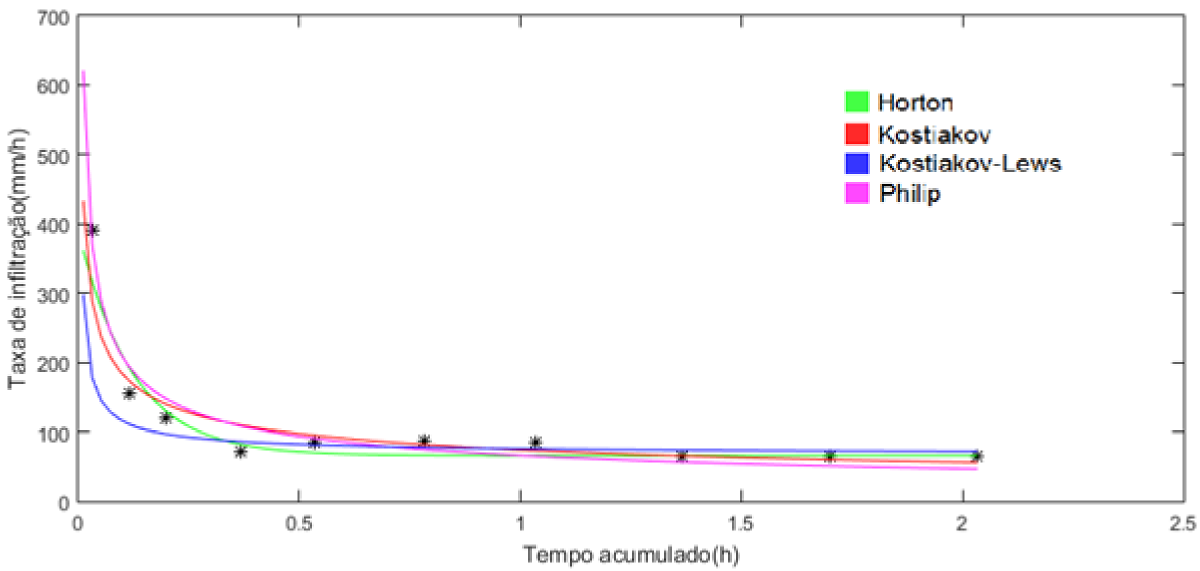

Figure 2. Rates observed and estimated of water infiltration in soil with minimum tillage on sweet corn using as cover sunflower.

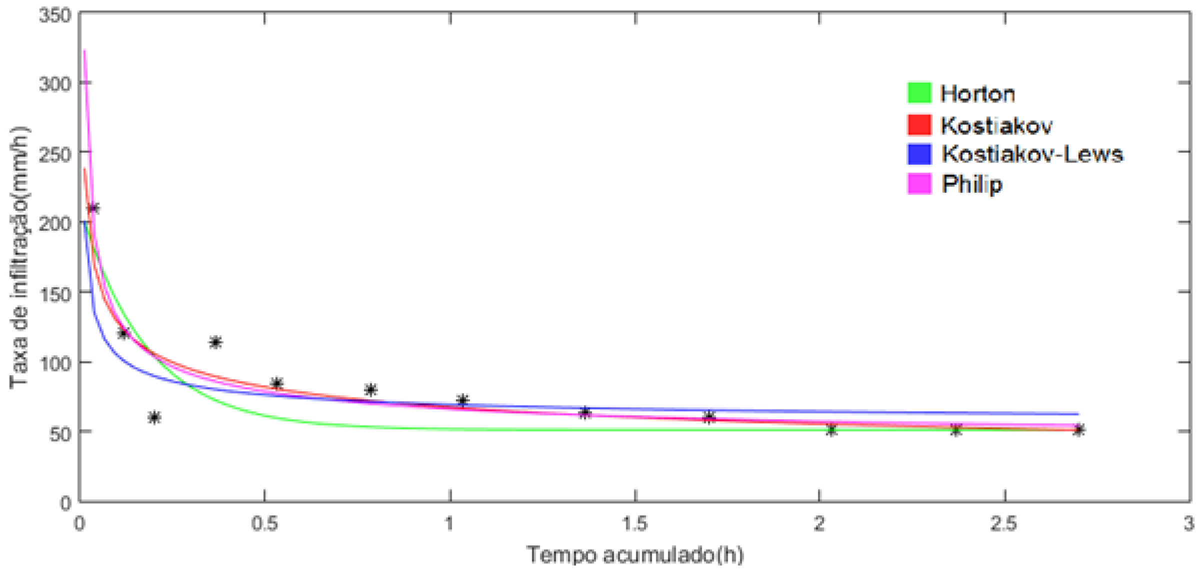

Figure 3. Rates observed and estimated of water infiltration in soil with conventional tillage on sweet corn using as cover sunflower.

In the models, the one that best adjusted the basic infiltration velocity in all kinds of soil managements was to Horton, the basic infiltration velocity calculated was equal to that obtained in the field, which is easily explained by the way that the equation evolves, the first term is the real basic infiltration velocity obtained in the field, since the second term is responsible for attempting to represent the phenomenon to reach the basic infiltration velocity, according to the time increases the second term decreases to a very long time this term approaches zero, so the basic infiltration velocity get close of the value obtained in the field.

Regarding the coefficient of determination (R^2) in all the models of all soil management, the results were satisfactory, all showed more than 88%. The Kostiakov-Lewis model obtained a better result in no-tillage and minimum tillage, and The Kostiakov-Lewis and Horton methods obtained the best results for conventional tillage.

In relation to residual mass ratio (RMR) the Phillips method approached quite to ideal in all soil management, that is, the curve has been adjusting well, so that there was practically no residues, it can also states that for this method the volume of infiltrated water is the same as that obtained in the field. However, the overall result portrays a similar result to the basic infiltration velocity, the aggressive use of the soil destroys the soil structure and it difficults water infiltration into the soil, making the troubled results and thus making it difficult to adjust the curve by the methods, so that the worse results are expected in the conventional tillage.

About adjustment coefficient (AC), the results were satisfactorily similar in all methods except the Kostiakov-Lewis, who did not suit the soil. And again, the Philip method achieved better results in all soil managements.

The methods of Horton, Kostiakov and Phillip obtained better efficiency (EF) than Kostiakov-Lewis method in systems of no-tillage and minimum tillage. In the conventional tillage, the results were not satisfactory and none of the methods could represent the phenomenon with a significant efficiency, confirming once again that the conventional tillage can bring serious damage to the health and stability of the soil. Other information that can be obtained is the low efficiency in all statistical parameters of Kostiakov-Lewis model in all soil managements, it was only satisfactory in the coefficient of determination (R^2), making it clear that only the analysis of the coefficient of determination does not make this kind of reliable statistical study, and show that this model has problems of underestimate the value from the 10 minutes of experiment, as well as overestimating the value of basic infiltration velocity, a fact already evidenced by SOBRINHO et al. (2003).

CONCLUSION

A soil treated with the soil management of no-tillage in relation to other soil managements was more favorable to water infiltration into the soil.

Within the limitations of each model, all they obtained statistically equivalent results, except Kostiakov-Lewis.

The Philip model obtained better results.

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