Edição especial – VI Winotec

ISSN 1808-8546 (ONLINE) 1808-3765 (CD-ROM)

DETERMINAÇÃO DA EVAPORAÇÃO DA ÁGUA EM RESERVATÓRIOS SUPERFICIAIS COBERTOS POR DIFERENTES PLANTAS AQUÁTICAS FLUTUANTES

MARCO ANTÔNIO ROSA DE CARVALHO[1]; LILIAN CRISTINA CASTRO DE CARVALHO[1]; LORENA OLIVEIRA DE SOUSA[1]; VINICIUS ALBUQUERQUE DA SILVA[1] E GUILHERME BARROSO DE LIMA[1]

[1]Eixo de Recursos Naturais, Instituto Federal de Educação, Ciência e Tecnologia do Ceará (IFCE), Campus Sobral, Av. Dr. Guarany, 317, Bairro Derby Clube, CEP 62.042-030, Sobral, Ceará, Brasil, E-mail: marcorosa@ifce.edu.br; liliancarv@ifce.edu.br; loreninha_oliveira@hotmail.com; albuquerque.vinicius60@aluno.ifce.edu.br; guilherme.barroso63@aluno.ifce.edu.br

1 RESUMO

A região Nordeste do Brasil, com suas condições de semiárido, vem sofrendo constante período de seca devido aos altos índices de evaporação que apresenta, em alguns casos 300 % acima da pluviosidade. Tais índices propiciam grandes perdas para a região, de uma forma geral, e mesmo para o país. A presente pesquisa estudou uma das ferramentas para controle da evaporação em reservatórios superficiais – plantas aquáticas flutuantes. O trabalho foi realizado na Zona Rural do município de Senador Pompeu-CE, local representativo do semiárido cearense, onde foram instaladas cinco caixas d'água (fabricadas por material plástico) de 310 litros, com diferentes coberturas, para se determinar as taxas de evaporação e evapotranspiração durante três meses de observação. O delineamento foi inteiramente aleatorizado com cinco tratamentos, sendo cada cobertura um tratamento, são eles: área livre de cobertura, com cobertura de taboa (*Typha domingensis*), com cobertura de tiririca (*Cyperus rotundus*), com cobertura de aguapé (*Eichhornia crassipes*) e com cobertura de alface d'água (*Pistia stratiotes*). Os dados dos tratamentos estudados foram submetidos à análise de variância sendo as médias comparadas pelo teste de Tukey a 1%.

Palavras-chave: evaporímetros, macrófitas aquáticas, açude.

CARVALHO, M. A. R.; CARVALHO, L. C. C.; SOUSA, L. O.; SILVA, V. A.; LIMA, G. B.

DETERMINATION OF WATER EVAPORATION IN SURFACE RESERVOIRS COVERED BY DIFFERENT FLOATING AQUATIC PLANTS

2 ABSTRACT

The Northeast Region of Brazil, with its semiarid conditions, has been experiencing constant periods of drought due to high evaporation rates, which, in some cases, are 300% greater than the

Recebido em 03/12/2024 e aprovado para publicação em 12/12/2024
DOI: http://dx.doi.org/10.15809/irriga.2024v29p185-190

amount of rainfall. Such rates cause great losses for the region in general and even for the country. This research investigated one of the tools for controlling evaporation in surface reservoirs—floating aquatic plants. The work was carried out in the rural area of the municipality of Senador Pompeu-CE, a representative location of the semiarid region of Ceará, where five 310-liter water tanks (made of plastic material) with different coverings were installed to determine the evaporation and evapotranspiration rates during three months of observation. The design was completely randomized with five treatments, with each cover being a treatment, namely, an area free of cover, a cover of cattail (*Typha domingensis*), a cover of nutsedge (*Cyperus rotundus*), a cover of water hyacinth (*Eichhornia crassipes*) and a cover of water lettuce (*Pistia stratiotes*). The data from the studied treatments were subjected to analysis of variance, and the means were compared via Tukey's test at 1%.

Keywords: evaporimeters, aquatic macrophytes, reservoir.

3 INTRODUCTION

Water is part of the composition of all living beings, and its balanced consumption is essential for the survival of species. Therefore, its management and conservation require special attention. This responsibility lies with water resource management bodies.

Artificial reservoirs, also known as dams, reservoirs or ponds, are viable alternatives for the accumulation of fresh water, with several objectives, including public supply.

This type of reservoir is the main source of water collection in places where there are no perennial rivers or natural lakes, but in Northeast Brazil, owing to the characteristics of the crystalline soil and semiarid climate conditions, large losses occur throughout the year, much more due to evaporation than infiltration.

Several studies have been carried out in an attempt to minimize the effects of evaporation in large reservoirs, such as wind bar systems, floating bodies, reflective bodies, and monomolecular films, all of which have high costs, major environmental impacts and low operability. These methods should be analyzed and compared with floating aquatic plants, which are already well adapted to our region.

Tundisi and Tundisi (2008) reported that aquatic macrophytes range from small floating organisms (1--5 mm) to large trees, such as cypresses (*Taxodium* spp.) found in swamps in the southern United States. Aquatic macrophytes include emergent plants that are firmly rooted in submerged soil, floating plants with leaves such as water lilies and water hyacinths, and fully submerged plants. Floating macrophytes such as *Lemma*, *Eichhornia azurea* or *Eichhornia crassipes* form large, tangled mats and, in some cases, are connected by roots or stems that absorb all their nutrients directly from the water and not from the sediments.

The general objective of this work is to quantify and comparatively analyze the losses by evaporation or evapotranspiration that occur in free water surfaces and are inhabited by aquatic plants that commonly occur in water bodies in Ceará to support technical studies that may favor the significant reduction of water mirrors in small- and medium-sized reservoirs in the State. Specifically, we have the following objectives: identify the crop with the best ability to reduce evapotranspiration; determine the evapotranspiration of the cattail

crop (*Typha domingensis*); determine the evapotranspiration of the nutsedge crop (*Cyperus rotundus*); determine the evapotranspiration of the water hyacinth crop (*Eichhornia crassipes*); and determine the evapotranspiration of the water lettuce crop (*Pistia stratiotes*).

4 MATERIALS AND METHODS

The experiment was conducted in an experimental area located in the Rural Zone of the municipality of Senador Pompeu, in the Sertão Central Region of Ceará, which has a semiarid climate and is located in the Caatinga biome.

The geographic coordinates of the region where the experiment was installed are as follows: 5° 39' South latitude, 39° 16' West longitude and an average altitude of 217 m.

The average annual temperature is 27°C, and the average rainfall is 730.7 mm per year, which is concentrated between February and April (IPECE, 2014).

The evaporation and evapotranspiration of four crops in five 310-liter water tanks made of plastic, each with a different cover, characterized the five treatments:

1) An uncovered water tank (surface free of floating aquatic plants),
2) A water tank with a cattail covering (*Typha domingensis*),
3) A water tank with a nutsedge covering (*Cyperus rotundus*),
4) A water tank covered with water hyacinth (*Eichhornia crassipes*) and
5) A water tank covered with water (*Pistia stratiotes*).

Statistical analysis was performed according to the criteria established by experimental statistics (Ferreira, 2000). For this analysis, EXCEL spreadsheets were used for analysis of variance; the treatments were compared via the F test, considering a minimum significance level of 1% probability. Comparisons between means were performed by the Tukey test at the 5% probability level.

Evaporation in the water tank was obtained by the difference between the readings for the period (15 days), which was the evaporated volume (ruler reading). There was no rainfall during the research period.

The water tanks were installed close to the ground surface, and to avoid external interference, such as watering animals or even human interference, the reservoirs were protected by barbed wire fences in an area of 0.25 hectares, with controlled vegetation 10 cm from the ground surface (Figure 1).

Figure 1. Arrangement of water tanks

In the four plant treatments, the aim was to maintain the entire surface of the water with plants in a natural state, to develop well without pests or diseases, and to fill 100% of the available area (Figure 2). To this end, a biweekly inspection was carried out**,** which determined the thinning or addition of plants, as needed.

Figure 2. Water tank 100% filled with water

5 RESULTS AND DISCUSSION

The data used in the analyses refer to the period from 09/21/14--12/27/2014, corresponding to 97 days of observations, with six evaporation readings taken during this period. The evaporation values obtained during the research for each treatment are presented in Table 1.

Table 1. Evaporations (in cm) during the survey

Treatments	Repetitions						Total
	I	II	III	IV	V	VI	
Water hyacinth	22.1	37.1	21.9	23.9	28.1	40.7	173.8
Free	16.2	26.2	15.4	16.2	17.1	22.7	113.8
Tiririca	15.7	26.9	15.4	16.4	16.9	22.3	113.6
water lettuce	15.8	26.7	14.8	15.5	16.2	21.8	110.8
Cattail	19.3	48.2	30.7	31.6	35.8	53.1	218.7
Total	89.1	165.1	98.2	103.6	114.1	160.6	730.7

Table 1 shows that repetition II presented the highest evaporation, whereas repetition I presented the lowest evaporation. The treatment with the cattail cover presented the highest evaporation, the treatment with water lettuce presented the lowest evaporation, and the free treatment presented intermediate evaporation.

The results of the analysis of variance demonstrated that there was a significant difference, at the 1% probability level, between the treatments (Table 2).

Table 2. Analysis of variance of treatments (in cm)

Cause of variation	GL	SQ	QM	F
Treatments	4	1563.94	390,985	6.92 **
Residue	25	1413.21	56,5284	
Total	29	2977.15		

The coefficient of variation of the experiment, in the analysis of the treatments, was 30.86%.

To compare the treatment means, the Tukey test was performed at the 5% probability level (Table 3).

Table 3. Comparison of the average evaporation readings for the 5 treatments

Treatments	Average of treatments
water lettuce	18.47 a
Tiririca	18.93 a
Free	18.97 a
Water hyacinth	28.97 ab
Cattail	36.45 b

According to Tukey's test, at a 5% probability level, the treatment with “water lettuce” presented the lowest average evaporation of the readings, despite not differing statistically from the treatments with “tiririca”, “livre” and “aguapé”; the treatment with “taboa” presented the highest average evaporation of the readings but did not differ statistically from the treatment with “aguapé”.

In contrast to the results of previous studies, Marinho *et al.* (2015) reported that water lettuce (*Pistia stratiotes* L.) favored an increase in evapotranspiration and should be removed from reservoirs and used as a natural fertilizer.

6 CONCLUSIONS

The cattail treatment had high evaporation rates, presenting the worst performance in relation to evaporation control in surface reservoirs.

The differences in evaporation among the lettuce, nutsedge and free water treatments were minimal; however, lower evaporation values were observed in the lettuce water treatment, indicating that this method is more suitable for controlling evaporation in surface reservoirs.

7 REFERENCES

FERREIRA, PV **Experimental Statistics Applied to Agronomy**. 3rd ed. Maceió: UFAL, 2000. 419 p.

IPECE. **Basic Municipal Profile, Senador Pompeu**. Fortaleza: SEPLAN, 2014. 18 p.

MARINHO, FJL; AGUIAR, RL; UCHOA, TR; LEITE, SF; NASCIMENTO, AS Evapotranspiration reduction mechanism in a water source located in the semiarid region of Paraíba. **Encyclopedia Biosphere**, Goiânia, v. 11, n. 20, p. 94-103, 2015.

TUNDISI, JG, TUNDISI, TM **Limnology**. São Paulo: Texts Workshop, 2008. 632 p.