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EVAPOTRANSPIRATION FROM *EICHHORNIA CRASSIPES, PISTIA STRATIOTES, SALVINIA HERZOGII* AND *AZOLLA CAROLINIANA* DURING SUMMER IN ARGENTINA[1]

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ABSTRACT

Water loss due to evapotranspiration (E) was evaluated for four types of aquatic floating plants. The field trial was kept under a constant plant cover not higher than 5 cm. Cylindrical one hundred litre pans separated 1.1 m each other were used. A complete random lattice design with three replications was employed. Several treatments were carried out on waterhyacinth (*Eichhornia crassipes* (Mart.) Solms.); water lettuce (*Pistia stratiotes* L.); Salvinia (*Salvinia herzogii* de la Sota) and water fern (*Azolla caroliniana* Willd.), all of which were compared to free water. The evapotranspiration of water lettuce (84,000 l/ha/d), Salvinia (87,000 l/ha/d) and water fern (71,000 l/ha/d) did not show significant differences with evaporation (E_o). The E of waterhyacinth was 150% higher than the E of the other species. The rate E/E_o was 2.67 for waterhyacinth and close to one for the other aquatic plants.

Key words: aquatic floating plants, climate, water loss, wetlands, water lettuce, water fern.

INTRODUCTION

Besides waterhyacinth, aquatic macrophytes such as water lettuce, Salvinia and water fern, constitute a group of floating hydrophytes covering large areas in the ponds of the alluvial valley of the Middle Paraná River (4, 8).

Excluding waterhyacinth, the other plants exhibit a reduced biomass (12). Notwithstanding, it is interesting to point out that in still and generally shallow waters these plants grow very well and rapidly cover wide areas.

Mitchell (10) describes the problems caused by water lettuce and water fern (*Salvinia*) in several parts of the world. They are referred to as weeds with high rates of growth which interfere with other aquatic biota and man's activities (dam filling, water loss, etc.). Considering this fact, these species may provoke similar problems to irrigation systems, channels and ports of the future dam of the Middle Paraná River. Also, they behave as weeds in the rice fields of the region by competing for nutrients.

Previous publications from other countries are numerous as regards evapotranspiration (E) in the mentioned hydrophytes (3, 6, 7, 11, 14, 15). But this information is not sufficient since climatic variations, measurement methods, plant height and plant cover greatly influence the variability of water loss values.

Due to the lack of available data for this region, research was carried out on the E of floating aquatic plants and their relation with E_o (evaporation) during summer season.

METHODS AND MATERIALS

The experiment was carried out at the experimental field station of the Agricultural Sciences Faculty (Paraná, Argentina, 31°50′ S and 60°31′ W) from December 1982 until March 1983. The field of the trial was kept under constant plant cover not higher than 5 cm.

E and E_o were evaluated by the drop of water level (11) measured by a glass tube with a metal ruler attached (5, 6) connected to one hundred litre pan's base. Pans were seperated 1.1 m from each other. A random design with three blocks was used (13) where treaments were T1) waterhyacinth (average plant height 30 cm); T2) water lettuce (8 cm); T3) Salvinia (3 cm); T4) water fern (1 cm); T5) free water (E_o). Those for E were kept with 100% plant cover, replacing plants and water as necessary.

Measurements were made each 24 hours until December 31, 1982. Afterwards, they were made twice a week, except on rainy days.

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TABLE 1. MEAN RECORDS (x̄), MINIMUM (MIN.), MAXIMUM (MAX.), MEAN TEMPERATURES (T), RELATIVE MOISTURE (HR), AND MEAN VALUES OF SUNLIGHT (RS), WIND VELOCITY (V), AND EVAPORATION –PAN TYPE A– E_o, FOR DECEMBER 1982 AND JANUARY TO MARCH 1983, AT AGRIC. EXP. STATION INTA-PARANÁ.

	T (C)			HR (%)			RS (Ly)	V	E_o
	x̄	min.	max.	x̄	min.	max.	(cal.cm²)	(km.h⁻¹)	(mm)
December/82	24.1	18.0	29.9	64	40	90	601	6.1	207.8
January/83	26.0	20.8	31.4	66	42	88	553	6.3	206.6
February/83	23.0	18.4	28.3	75	54	93	479	6.5	138.3
March/83	21.1	16.2	26.3	76	54	94	463	6.0	127.4

The climatic factors having greatest influence on E and E_o are summarized in Table 1. The weather station records were of the Paraná Agrometeorological Station from the Agric. Exp. Station INTA-Paraná, located 3 km from the field station.

RESULTS AND DISCUSSION

The meteorological conditions measured at the weather station are presented in Table 1.

The differences observed among treatments (relative values) kept approximately the same proportions. For that reason, and with the purpose of making the statistical analysis, the group of days devoted to measurements were considerated as only one experiment (Table 2).

The analysis of variance showed that the blocks were homogeneus and differences among treatments were significant at the 1% level (variation coefficient 6.89%). The Tukey Test gave significant differences at the 1% level between T1 (waterhyacinth) and the other treatments. The later treatments did not show differences among themselves.

Daily medium water loss per treatment expressed in cm. d^{-1} was: 1.96; 0.84; 0.87; 0.71 and 0.74 for T1, T2, T3, T4 and T5, respectively, and average rate E/E_o was 2.67; 1.14; 1.20; and 0.96 for treatments 1 to 4. If water loss records (Table 2) are transformed to 24 hours, the tendency is similar in all treatments with values diminishing according to the climatic conditions.

The E_o measured in the trial was correlated to the E_o from INTA-Paraná (Table 2), a satisfactory adjustment being obtained, r=0.98 (P=99%) corresponding to the following equation:

$$E_o \text{ (trial)} = 1.79 + 1.26 \times E_o \text{ (INTA)}$$

Using the same methodology, Lallana, *et al.* (5), determined losses of 1.26 $cm.d^{-1}$ by E for waterhyacinth during February and March, and a rate E/E_o 1.96. Both values were comparatively lower than the values in this paper. This is partly due to the different periods of measurements and to the environmental conditions under which the trials were conducted.

In India, Brezny *et al.* (1), obtained a daily water loss of 1.99 $cm.d^{-1}$ for water lettuce during May (hottest

TABLE 2. WATER LOSS VALUES PER TREATMENT (T) EXPRESSED IN CM DURING THE MEASUREMENT PERIOD AND E_o MEASURED IN PAN TYPE A (E_o–INTA) FROM THE AGRIC. EXP. STATION INTA-PARANÁ. RELATIVE VALUES (%) FOR TREATMENTS, T2, T3 AND T4 AS REGARDS T1[1].

	cm					cm	Percents		
Date	T1	T2	T3	T4	T5	E_o-INTA	T2/T1	T3/T1	T4/T1
17-20/12/82	6.53	2.83	2.83	2.33	2.63	2.13	43	43	36
21-22/12	2.33	0.80	0.77	0.63	0.70	0.63	34	33	27
22-23/12	3.10	0.93	0.93	0.80	0.83	0.71	30	30	26
23-27/12	10.27	4.53	4.57	3.73	4.27	3.33	44	44	36
27-28/12	1.80	0.63	0.80	0.63	0.77	*[2]	35	44	35
28-29/12	4.37	1.83	1.80	1.57	1.63	*	42	41	36
29-30/12	1.90	0.93	0.93	0.80	0.80	1.02	49	49	42
30/12-3/01/83	8.60	3.43	3.30	2.93	3.13	2.91	40	38	34
3-6/01	7.27	2.93	3.07	2.83	2.87	2.23	40	42	39
6-7/01	1.87	0.93	0.83	0.60	0.53	*	50	44	32
7-10/01	4.97	3.13	2.77	2.90	2.73	1.91	63	56	58
10-12/01	2.10	0.90	0.73	0.77	0.77	*	43	35	37
15-17/01	3.57	1.80	1.73	1.60	1.60	1.23	53	51	47
27/01-1/02	8.37	3.63	3.53	3.60	3.33	2.95	43	42	43
1-3/02	3.77	1.77	1.90	1.53	1.37	1.37	47	50	41
3-7/02	8.30	3.50	4.03	3.10	2.90	*	42	49	37
7-8/02	1.63	0.50	0.57	0.30	0.63	*	31	35	18
15-17/02	2.93	1.50	1.83	1.07	1.10	1.15	51	62	37
21-23/02	2.70	1.43	1.80	1.13	1.06	1.08	53	67	42
28/02-3/03	2.10	0.76	0.90	0.63	0.70	0.65	36	43	30
3-7/03	5.33	2.50	3.23	2.26	2.20	1.99	47	61	42
7-9/03	3.26	1.40	1.36	1.03	1.23	1.14	43	43	32

[1]T1=waterhyacinth, T2=water lettuce, T3=Salvinia, T4=water fern and T5=free water (E_o trial).
[2]Were not considered since the times for measurement did not coincide with those from INTA-Paraná.

month) and a rate E/E_o of 1.07. This E value is twice the value determined in this paper (0.85 $cm.d^{-1}$), but the rate E/E_o is similar. The highest values for E in India might be attributed to the tropical climate where the climatic factors might increase not only E but also E_o thus keeping a constant rate, in comparative terms. If low temperature months are considerated, the E values happen to be lower than E_o values (1). Similar results were observed by Lugo, *et al.* (7) with other aquatic plants.

The low variation coefficient of the experiment and the period of measurements (4 months) should allow extrapolations with a certain degree of confidence. Therefore, evapotranspiration of waterhyacinth, water lettuce, Salvinia and water fern, should represent 196,000; 84,000; 87,000 and 71,000 $l.ha^{-1}.d^{-1}$, respectively. It was also possible to prove that, E_o in the trial was 15% higher than the one obtained in INTA-Paraná in a pan type A (Table 2), probably due to the border effects in the different evaporating surfaces. This fact should let us infer that E values above are overestimated due to the experimental conditions under which the experiment was carried out. Notwithstanding, these species are normally found in natural conditions with different degrees of cover, thus forming communities where one species exerts dominance over the others depending, fundamentally, upon the environment where they grow (ponds, streams, "madrejón"[3]).

The values found bring out the importance that water losses would represent for aquatic plants which will have to be taken into consideration when projecting hydraulic constructions.

According to data obtained through aerial photographs (1973-74) from the flooded zone of the reservoir (Middle Paraná Proyect), aquatic plants occupied 73,347 ha (9). Among them, waterhyacinth constituted the 80% of the hydrophytia. Taking this cover into account and, assuming a relative structural homogeneity of the population, E for a summer period would represent 3.45×10^8 $m^3.$ $month^{-1}$, considering the values of this trial.

From the standpoint of E, medium water losses for water lettuce have little importance (0.84 $cm.d^{-1}$) as do, Salvinia (0.87 $cm.d^{-1}$), and water fern (0.71 $cm.d^{-1}$). At the same time, these plants did not show differences with E_o (0.74 $cm.d^{-1}$).

Considering the mean value for E of waterhyacinth (2.67 $cm.d^{-1}$) as 100%, water losses of water lettuce, Salvinia and water fern as compared to waterhyacinth, represented in average values 44, 46 and 37% respectively (Table 2).

[3]A. Burkart, 1957. Kind of deeper and longer pond.

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