

Weed evolution and ecology in drainage canals of central Portugal

Ferreira, T. and Moreira, I.

Departamento de Botânica, Instituto Superior de Agronomia,
Tapada da Ajuda, 1399 Lisboa Codex, Portugal

Summary Two major canals of the Sorraia Irrigation Area were surveyed monthly during 1987/88. Water characteristics and vegetation cover were studied, and evolution following weed harvest. Both canals are highly mineralized and nutrient rich systems; ionic levels show huge fluctuations and a strong dependence of water depth and inflows. Because of its small depth, Guedelha is dominated by Myriophyllum aquaticum and emergents. Following harvest graminæ became established, then coexisted with M. aquaticum and later evolved to a emergent-weed community. As V. Real is deepest, it has a different evolution: dredging during winter floods, establishment of a diverse community during spring, progressive weed dominance by summer end. A harvest in spring resulted in a clear canal for three months, followed by the same occupation pattern. Results are discussed in terms of aquatic weed management.

INTRODUCTION

Several areas in Portugal have irrigation schemes and are used for intensive agriculture; the Sorraia Valley, in lowland Tagus river, is one of the largest and main crops are rice, maize and tomato. Water is drawn from four upstream reservoirs, conducted to crops, discharged into semi-natural canals and finally to the Sorraia.

The water characteristics of the canals strongly depend of these inflows, subjected to the runoff from crop treatments and fertilizations. A highly dense plant community develops and occupies the whole water body, obstructing the flow and degrading the ecosystem (Monteiro et al., 1987). Two exotics are particularly troublesome, Myriophyllum aquaticum (Vell.) Verdc. and Eichhornia crassipes Mart. Solms., but autochthonous emergents and hydrophytes can also act as weeds (Moreira et al., 1989). However, seasonal evolution and vegetation interactions had still not been studied, as well as succession following plant harvest.

METHODS AND MATERIALS

Four selected sites (100m each) on the two main canals were visited monthly. Water temperature, conductivity, dissolved oxygen (DO), pH, water

velocity, canal depth and width were recorded in situ, as well as plant species and canal occupation. Water samples were collected to determine alkalinity, suspended solids (TSS), chloride, total nitrogen, ammonia, nitrate, total phosphorus (TP), phosphates, calcium, magnesium, potassium and sodium. Samples were preserved and analysed according to Standard Methods (16th ed., 1985). Harvest is irregularly done by the Farmers Association with clawed ditch cleaners.

RESULTS

The drainage canals of Sorraia are 2-3m deep and 3-5m wide (Table 1). Water velocity is low, sometimes none during heavy infestations, when low DO also occurs. Conductivity and TSS are subjected to considerable fluctuations as well as major components, nitrates, TP and phosphates. These fluctuations are associated with seasonal evolution, but also with crop treatments and water discharges, especially in the case of the nutrients, in which high values occur in winter, and several times during spring and autumn.

Table 1
Mean and standard deviations of the physical and chemical characteristics of the water in the four studies sites

	TV1		TV2		VR		VR2	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Water Temp. °C	17.5	4.6	19.0	6.7	17.8	5.1	17.6	4.6
DO mg/l	3.5	2.7	5.7	2.8	7.0	2.7	7.1	2.9
pH	6.7	0.2	7.1	0.6	6.9	0.2	7.1	0.3
Cond μ mhos/cm	275.0	53.0	250.0	110.0	282.0	92.0	271.0	65.0
Veloc cm/sec	3.4	2.1	3.7	3.6	15.1	12.9	15.3	11.7
Alk mg CaCO ₃ /l	61.5	18.3	66.5	36.2	75.3	42.3	73.2	43.2
Cl ⁻ mg/l	44.5	14.4	36.5	14.2	51.1	10.8	50.3	15.4
SO ₄ ⁻⁻ mg/l	30.7	11.7	24.3	13.4	24.5	8.5	26.1	8.8
TSS mg/l	21.3	27.8	13.6	7.7	34.5	29.9	31.6	23.6
NKjeldahl mg/l	4.1	0.62	4.49	0.39	4.02	0.55	4.49	0.64
NH ₄ ⁺ mg/l	2.24	0.45	2.25	0.34	2.1	0.39	2.36	0.34
NO ₃ ⁻ mg/l	7.3	8.3	7.2	8.3	6.2	5.9	8.8	9.4
Ca ⁺⁺ mg/l	21.0	7.2	19.4	8.6	17.8	5.0	18.1	5.8
Mg ⁺⁺ mg/l	10.9	2.4	9.2	3.2	9.1	3.6	9.7	3.3
K ⁺ mg/l	4.9	1.9	3.6	1.3	4.9	1.4	4.8	1.1
Na ⁺ mg/l	31.7	11.1	32.2	11.9	33.1	14.8	34.5	13.5
PO ₄ ⁺⁺⁺ gP/l	82.6	73.4	54.5	31.8	169.8	104.3	114.3	102.6
TP ugP/l	223.7	200.3	184.4	105.1	506.1	326.6	334.3	224.6
Depth m	0.6	0.2	0.5	0.3	0.8	0.5	1.1	0.7
Width m	2.9	0.1	2.4	0.9	2.1	0.4	3.1	0.9

Guedelha (TV) is a small canal where water level almost never surpasses 0.5m. As a result, tall emergents are well established, compete with M. aquaticum, and eventually become dominants (TV1 summer 88). Small emergents like Polygonum hydropiper L. are restricted to the edges, though

some of them form large stands in mid-canal, like Apium nodiflorum (L.) Lag and Veronica anagalloides Guss in TV1. Paspalum paspalodes, a very widespread gramineae, can be quite important in any situation.

During a short winter period, the water level increased and less favourable temperatures occurred. M. aquaticum showed signs of weakness, while most part of the tall emergents standing biomass senesced and collapsed (TV2 winter 88). Free spaces were colonized by small emergents and hydrophytes like Lemna gibba L. and Callitriche stagnalis Scop. with an increase in richness and diversity (TV1 winter 87).

Two types of harvest occurred in the canal (Figure 1). A partial harvest of M. aquaticum in May 87 and April 88 in TV1, leaving root systems intact. The open spaces were partially occupied by Lemnaceae and Paspalum paspalodes (Mich.) Scribner and reinfestation of M. aquaticum rapidly pursued; after one, or two months, M. aquaticum and tall emergents occupied again the whole canal. A radical harvest of the plant biomass was done in May 87 at TV2, including roots parts, and resulting in a 1m wider and 0.5m deeper canal. Water depth decreased (0.2-0.3m). In two months time, this system was fully occupied by small emergents, first the gramineae Paspalum paspalodes, Echinochloa crus-galli (L.) Beauv. and Leeria oryzoides (L.) Swartz, then Alisma plantago-aquatica L., A. lanceolatum Wither, Polygonum hydropiper L. and A. nodiflorum. Finally tall emergents became dominant, Sparganium erectum L. and Typha latifolia L. This succession, followed by the winter period, prevented the reinfestation of the canal until May 88.

Vala Real (VR) is wider (3-4m) and deeper (3.5m) than TV, with water depth around 1m. Tall and small emergents occur near the shallow edges, and the mid-canal is preferably colonized by rooted hydrophytes like Potamogeton crispus L., P. fluitans Roth and Zanichellia palustris L.; M. aquaticum and E. crassipes also occur. When water level decreases, at the end of spring, a rich community is established (VR1 August 87, VR2 July 88). Finally, the exotics progressively overgrow the other plants and occupy the whole canal by summer end (VR1 October 87, VR2 August 87).

Winter has a strong effect in VR, where floods wash most plants, with loss of diversity and richness. However, winter can show a smaller effect, as in 88, where no spates occurred. Spring and summer situations have high diversity and richness, when autochthonous hydrophytes dominate, followed by an autumn decrease when the two weeds become dominants (Figure 2).

A radical harvest occurred in May 88. After a two months clear canal, sites were occupied according to their small differences in depth; VR1 with small emergents like A. lanceolatum and P. paspalodes, VR2 with P. fluitans and emergents like P. hydropiper. Then, taller emergents and M. aquaticum appeared and increased in both sites and dominated by autumn end. The spring succession, delayed by the harvest, was reinitiated, although with less hydrophyte richness and general diversity, and again ended in weed dominance.

There are no significative correlations between the chemical characteristics of the water and species cover, except with DO (Table 2). Heavy infestations result in high levels of suspended organic matter, and high oxygen demands, as studied in Monteiro et al., 1987. Emergents and diversity are also associated with low water velocities and depths, because a number of small emergents occupy the canal in those conditions. Due to their different biological types, E. crassipes and M. aquaticum have opposite correlations with depth, however both low; in fact, they show wide tolerance to different depth situations.

Figure 1
 Evolution of the diversity H' and % plant cover in both sites (TV1, A;
 TV2, B) of Vala Guedelhã. * harvest

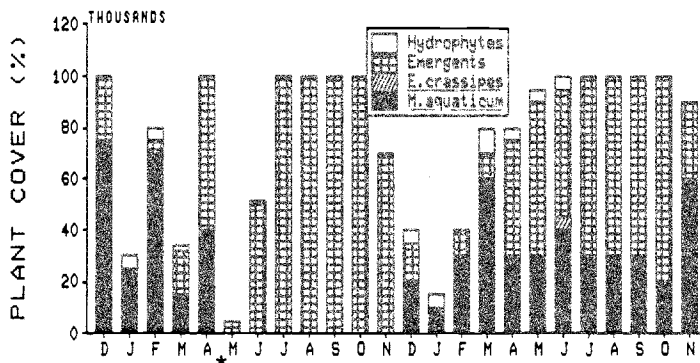
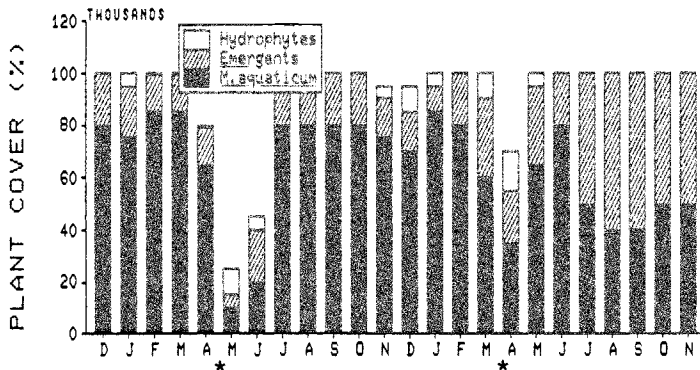
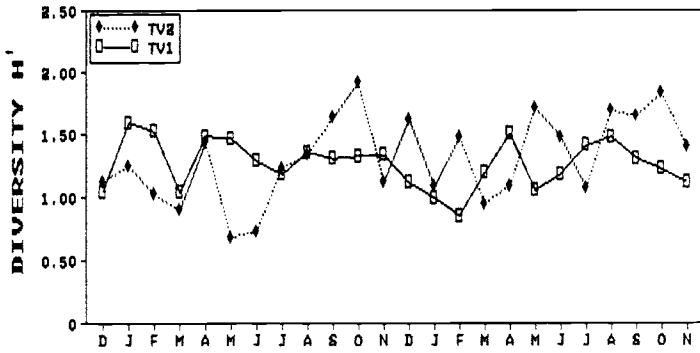
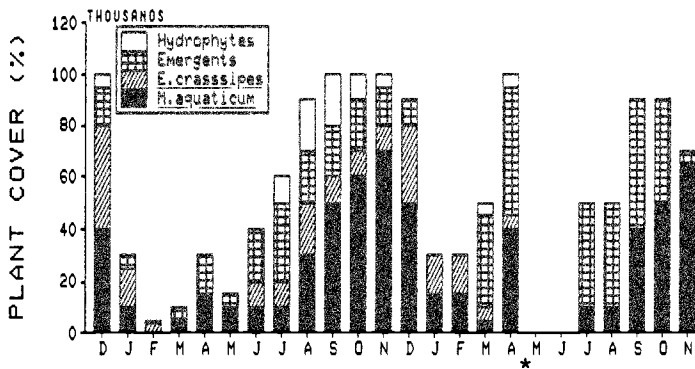
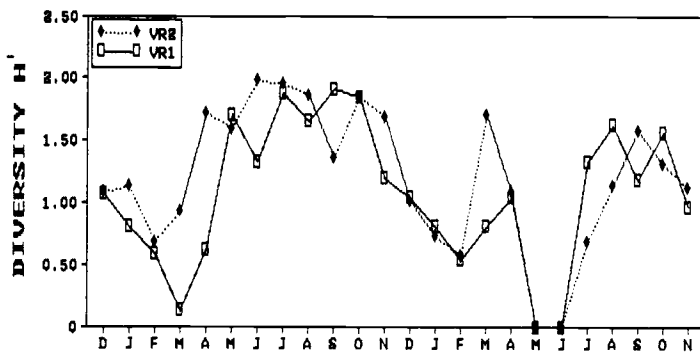
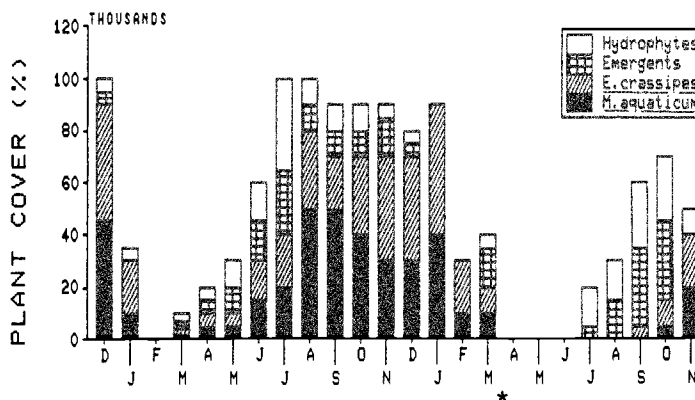


Figure 2
Evolution of the diversity, H' , and % plant cover in both sites (VR1,A; VR2,B) of Vala Real. * harvest



A



B

Table 2
Pearson's correlations between vegetation cover (%) and
some water and canal parameters *p>0.01,n=96

	T°C	DO mg/l	Cond µmhos/cm	Vel cm/sec	Depth m	Width m
<u>M. aquaticum</u>	-0.2512	-0.5468*	-0.5283*	-0.1316	-0.3116	-0.7149*
<u>E. crassipes</u>	-0.2570	-0.1126	0.0510	-0.0026	0.3330*	0.1547
Emergents:tall	0.0340	-0.4399*	-0.0073	-0.3686*	-0.3270*	-0.1074
small	0.4415*	-0.1366	0.3012*	-0.3172*	-0.3617*	-0.5404*
Hydrophytes	0.0200	-0.1557	0.1482	-0.0978	-0.0663	0.0524
Richness (S)	0.0096	-0.4270*	0.0853	-0.5436*	-0.2165	-0.0066
Diversity (H')	0.1119	-0.4025*	0.1808	-0.5234*	-0.2577*	-0.1024

DISCUSSION

Chemical variability of the canals probably results in its occupation by eurytolerant species. The major perturbations are the winter raise in water level and the now-and-then cleanings.

Harvest, and also winter in larger canals, seem to be followed by a succession: invasion by emergents near the edges and autochthonous hydrophytes in mid-canal, establishment of tall emergents, progressive dominance of M. aquaticum and E. crassipes. Richness and diversity follow a parallel pattern.

Probably because of its small depth and permanent water occupation, TV diversity and richness show more constancy. Increases are associated with the harvest or the winter raise of the water level, both resulting in a increase of small emergents species and cover.

Results show that partial harvest is non-effective. However, a harvest in early spring in smaller canals and a summer and less radical harvest in larger ones, coupled with the next winter flows, result in reasonably unobstructed canals the whole year.

References

- Monteiro, A., T. Ferreira and I. Moreira (1987) Seminário sobre Aquacultura, 23-31. Porto.
- Moreira, I., T. Ferreira and A. Monteiro (1989) Portuguese-German Cooperation in Applied Agricultural Research, 1987, 71-106. Lisboa

Résumé - La caractérisation physico-chimique de l'eau et l'occupation par les mauvaises herbes ont été suivis en 1987/88 dans quatre endroits des deux canaux principales de la Zone Irrigée du Sorraia, et aussi son évolution après récolte mécanique. Les résultats sont discutés en fonction de l'efficacité de ce type d'aménagement.