Determining suitable methods for the control of *Mimosa pigra* in Tram Chim National Park, Vietnam

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Abstract

A series of field experiments was carried out in Tram Chim to test the effectiveness of various control methods. Stem cutting, burning and the combination of stem cutting and burning were not effective. Living mimosa plants were difficult to burn, and cut stems re-sprouted quickly after treatment. Fire triggered mimosa seed germination. Cutting stems at the beginning of the flood season was more effective in killing mature mimosa than cutting during the dry season. The herbicide metsulphuron was more effective on seedlings and young than on mature plants. It was concluded that no single method was successful on its own in eradicating mimosa in Tram Chim. We recommended a forceful eradication method that combines stem cutting, fire, flood and herbicides, each method targeting a specific growth stage of mimosa. The integrated eradication should be a part of a broader strategic mimosa management plan.

***Keywords*:** mimosa, weed management, Mekong Delta, control techniques.

Introduction

Mimosa, *Mimosa pigra* L., is among the most dangerous alien invasive plant of freshwater wetlands of the Mekong Delta, Vietnam. The invasion of mimosa is particularly troublesome in protected areas as it threatens to reduce biological diversity. Tram Chim National Park is a 7,600 ha wetland protected area in the Mekong Delta that is badly infested by mimosa and the infestation has gone beyond easy management. The weed now covers approximately 2,000 ha and is capable of doubling its area in merely a year (Triet *et al*. 2004). It is important to establish an effective weed management program that can quickly bring the mimosa to a level manageable by Tram Chim's staff. A series of field experiments was carried out in Tram Chim to test the effectiveness of five control methods: (i) stem cutting, (ii) burning, (iii) combination of stem cutting and burning, (iv) combination of stem cutting and flood, and (v) chemical control with the herbicide metsulphuron. These methods were selected on the basis of their simplicity, low cost, and taking into account the ecological characteristics of Tram Chim, the technical skill of Tram Chim management staff and the availability of expert training.

This paper reports the results of those experiments and recommends a strategy for the management of mimosa at Tram Chim. Findings from this study may also be applicable to other protected areas in Vietnam as well as in the lower Mekong basin that are affected by mimosa invasion.

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Methods

Description of control methods

For stem cutting, mimosa stems were cut by bush knives or pruning scissors. Before cutting stems, all mimosa fruits and seeds were collected, removed from the site and burned. For burning, mimosa plants were sprayed with gasoline and burned. When the combination of stem cutting and burning was used, mimosa stems were cut and left in the field for three to four days to be sun dried and then sprayed with gasoline and burned.

In the combination of stem cutting and flooding, mimosa stems were cut at the beginning of the flood season and the cut stems were submersed in water for the entire flood season. Tram Chim is inundated by rain and by floodwater from the Mekong about four to six months every year. In the chemical control treatment, mimosa foliage was sprayed with metsulphuron (brand name Ally produced by DuPont Chemicals) using backpack sprayers at a rate of 15 g/100 L of water. Metsulphuron has proved effective on mimosa, has a very low mammalian toxicity (acute oral LD_{50} in rats greater than 5000 mg/kg) and is not classified as hazardous according to criteria of Worksafe Australia (Anon. 1998). Chemical control trials were done in conjunction with training for Tram Chim staff in weed-management methodology conducted during 2000 and 2001 (Storrs 2000, Storrs and Ashley 2001, Storrs *et al*. 2002).

Experimental design

The first four treatments were tested together in a randomised block design experiment carried out in 2000. Herbicide management was tested separately in several trials conducted between 2000 and 2002.

Treatments were assigned to 10 m^2 environmental units or plots. Environmental units were arranged in blocks that had similar mimosa density. Each block consisted of four environmental units on which each of the four treatments was randomly assigned. All together, the experiment employed 40 environmental units in 10 blocks. There was a second level of blocking that included the two types of habitat where mimosa plants were growing. In Tram Chim, mimosa first invaded along earth dikes on the sides of canals and then advanced into nearby grasslands. The difference in elevation between dikes and grasslands is from one to two metres and therefore there is a difference in flood depth and inundation time between the two habitats. Five experimental blocks were placed in each of the two habitats.

In each environmental unit, data were collected from ten 1 m^2 quadrats, placed regularly within each unit. In each quadrat, the following parameters were measured; mimosa stem density (number of stems per square metre), stem height, canopy aerial coverage, above-ground biomass, number of seedlings, seedling height, number of new shoots and height of new shoots. These parameters were measured before the treatments were applied, immediately after treatment, and one month and two months after treatment. Above-ground biomass was weighed when fresh and then dried to constant weight and dry weight was measured. For the stem-cutting treatment before the flood season, the experimental units were visit once a month until the end of the flood season when floodwater had receded, and the roots of treated mimosa stems were inspected to estimate survival.

Results and discussion

Experimental results of the four treatments — stem cutting, burning, combination of cutting and burning and combination of cutting and flood — are presented in Table 1. Data showed that stem cutting, burning and a combination of these were not effective in controlling mimosa. Mimosa stems re-sprouted quickly after being cut. Two months after treatment, new shoots growing from cut stems reached average heights of 60 to 70 cm and were able to flower and bear fruit. One month after treatment, mimosa stem density had increased to about half of the values before treatment (Figure 1). It was difficult to burn fresh mimosa plants, and large amounts of gasoline were used before the fire could be ignited (about two litres of gasoline per square metre). Burns were easier to conduct in areas that had sparse mimosa canopy because there were more grasses on the ground to provide fuel. The experiment showed that fires triggered the germination of mimosa seeds. The number of seedlings in experimental units under the burn treatment were significantly higher than those under other treatments (Figure 2). Therefore, even though not effective in killing mature mimosa plants, fire can be used to facilitate the germination of mimosa soil seed-bank. It was observed in the experiment that young mimosa seedlings were more vulnerable to control treatments such as fire, chemical or manual.

The combination of stem cutting and flooding was the most effective control method among those tested. Cut stems, when submersed in water, were not able to re-sprout. Five months after treatment, when floodwater had receded, it was estimated that about 75% to 90% of treated

plants had died. The remaining plants lived and re-sprouted. Most of the cut stems that survived after the flood season were those growing on dikes, where the plants were subject to shorter inundation times.

Metsulphuron was very effective in killing seedlings and young plants but not so effective on mature mimosa. Most of the mature plants dropped their leaves after being sprayed. However, some survived the treatment (no quantitative measurement was made on chemical control trials, only qualitative observations). The use of small backpack sprayers might contribute to the low effectiveness of chemical treatment. Low volumes of metsulphuron sprayed by small hand pumps might not cover the entire leaf surface of tall mimosa plants, thus reducing the effectiveness of the chemical.

Table 1. Means, and standard errors (in parentheses), of measured experimental parameters. Abbreviations for parameters are: SD stem density, NS number of new shoots, H.NS height of new shoots, DB dry above ground biomass, SE number of seedlings, SH seedling height. Meaning of suffixes: b – measured before treatments were applied, a – immediately after treatment, 1 – one month after treatment, 2 – two months after treatment.

Experimental parameters	Stem cutting	Burning	Cutting and burning	Cutting and flood
SD-b (stems m^{-2})	2.0 (1.51)	2.31 (1.45)	2.41 (1.78)	1.65 (1.01)
SD-a (stems m^{-2})	0 (0)	0.57 (0.91)	0 (0)	0 (0)
SD-1 (stems m^{-2})	1.39 (1.56)	1.22 (1.00)	1.13 (1.15)	0 (0)
SD-2 (stems m^{-2})	1.20 (1.27)	1.20 (1.05)	1.13 (1.15)	0 (0)
NS-1 (shoots m^{-2})	3.75 (4.51)	2.84 (4.16)	4.42 (5.33)	0 (0)
H.NS-1 (cm)	34.57 (30.36)	27.62 (31.29)	32.75 (26.51)	0 (0)
NS-2 (shoots m^{-2})	2.78 (3.64)	2.18 (2.83)	2.97 (3.79)	0 (0)
H.NS-2 (cm)	63.70 (60.09)	59.70 (57.21)	65.78 (56.63)	0 (0)
DB-0 (g m^{-2})	679.4 (610.5)	(not measured)	(not measured)	328.1 (360.8)
DB-2 (g m^{-2})	61.4 (86.7)	(not measured)	(not measured)	0 (0)
SE-a (seedlings m^{-2})	0.48 (0.23)	0.67 (0.24)	0.85 (0.32)	0 (0)
SE-1 (seedlings m^{-2})	0.38 (0.17)	4.86 (1.65)	0.57 (0.21)	0 (0)
SE-2 (seedlings m^{-2})	0.44 (0.18)	3.23 (1.25)	0.44 (0.13)	0 (0)
SH-1 (cm)	2.38 (0.73)	6.88 (1.99)	3.46 (1.13)	0 (0)
SH-2 (cm)	4.92 (1.56)	9.81 (1.79)	6.20 (1.45)	0 (0)

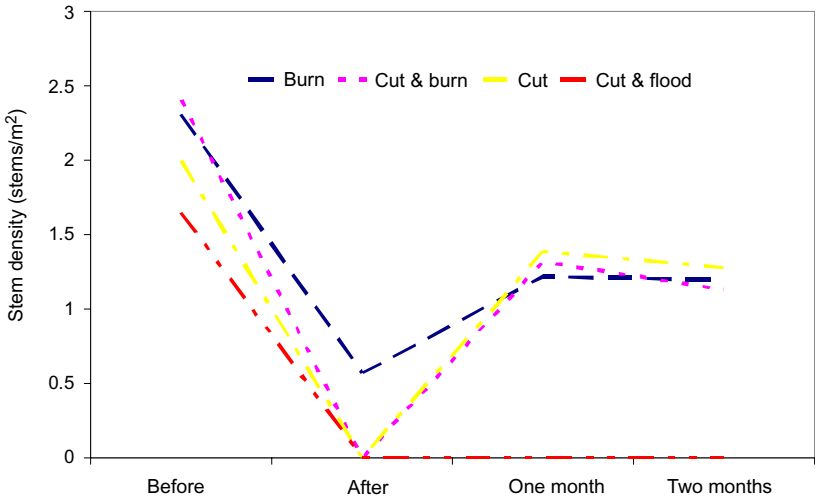

Figure 1. Mimosa stem density under four control treatments; burning, stem cutting, a combination of these and combination of cutting and seasonal flooding. Stem density was measured before the treatment was applied, immediately after treatment, and one month and two months after treatment.

Recommendations

Results of the study showed that no single treatment method was effective in controlling mimosa at Tram Chim. Each method was, however, more effective on a certain growth stage of the plant. Fire was effective in triggering the germination of mimosa seeds; metsulphuron can kill mimosa seedling and young plants very effectively; cutting and submerging mimosa stems in flood water killed more mature plants than cutting during dry season and can prevent cut stems from re-sprouting during the time of submersion. Those findings suggested that management plans combining several control methods, each targeting a different growth stage, may offer the best strategy for reducing mimosa in Tram Chim. A year-round mimosa management plan for Tram Chim is recommended as detailed in Table 2.

Weed management of a specific species should be only one component within a strategic weed management program. Such a program may consist of the following components (adapted from Storrs 2000):

- *Prevention*. One of the most powerful weapons against weed incursions is to prevent them in the first place. Prevention is also the most cost-effective way to stop the establishment of weeds and consequent damage to the environment. At Tram Chim, prevention measures may include quarantining of mimosa infested areas, control on the movement of construction sands and soils into the core zone, control on the movement of people and boats into the

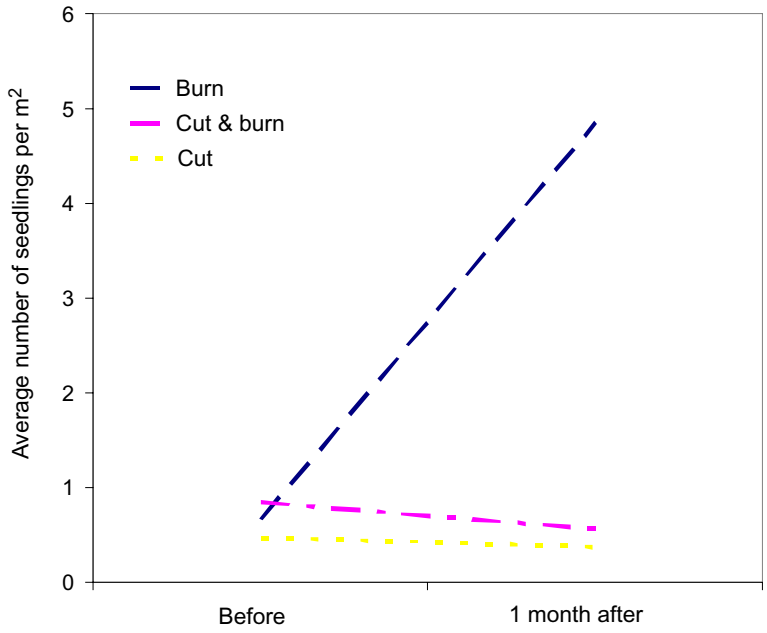

Figure 2. Number of mimosa seedlings under three treatment methods; burning, stem cutting and a combination of these, measured before and one month after treatment.

Table 2. Recommendations for mimosa management in Tram Chim National Park, Vietnam.

Timing	Control method	Target	Purpose
January–February	•Stem pulling, cutting •Chemical	Seedlings, young plants, new shoots	Kill seedlings and new shoots coming out after floodwater recedes
March–April	•Burn	Soil seed bank	Trigger seed germination
May–June	•Chemical	Seedlings	Kill seedlings emerging after the burns
July–September	•Stem cutting	Mature plants	Kill mature plants
October–December	•Flood	Mature plants	Prevent cut stems from re-sprouting, kill cut stems

core zone, control of livestock grazing in the core zone, control of the harvest of mimosa plants for fuel wood by local people as this can be an important source of mimosa seed spread.

- *Reduction of invasion susceptibility.* Including reducing disturbances that facilitate mimosa invasion such as canal digging, livestock grazing and improper harvesting of mimosa. Reduction of mimosa invasion in Tram Chim should also include replanting native plant species on treated areas.
- *Monitoring and early intervention*. Early detection and intervention is a powerful and cost-effective way to reduce weed infestations (Triet *et al*. 2001). Mimosa invasion in Tram Chim has been monitored since 1999 and the mimosa map has been updated every year (Thi 2000, Triet *et al*. 2004).
- *Effective management of existing infested areas*. This includes careful planning and implementation of eradication and habitat rehabilitation activities. More attention should be paid to eradicating newly infested areas in Block A1 of the core zone where only small areas of mimosa are present.
- *Capacity building*. Training for Tram Chim staff on various aspects of environmental weed management as well as providing necessary equipment and materials. At the moment, the operational budget of Tram Chim National Park does not cover funding for weed control activities inside the park.
- *Community support*. Effective involvement of the local community will benefit mimosa management activities in Tram Chim. There have been some educational programs to raise community awareness of the ecological and economical impacts of mimosa on the park and the surrounding areas. Community organisations such as the women's and farmers' unions have been actively involved in mimosa control activities in Tram Chim.
- *Research and evaluation*. Providing reliable data for planning and implementing mimosa control activities. Research and evaluation will also help adjusting weed management activities for better efficiency.

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