Burning As A Supporting Treatment In Controlling Waterhyacinth In The Sudan 1 - Routine Burning

B. F. MOHAMED AND F. F. BEBAWI

Faculty of Science, University of Khartoum, Sudan

HISTORY

The history of waterhyacinth *(Eichornia crassipes* (Mart.) Solms) in the Sudan is relatively recent. Nevertheless, it has developed from a merely occasionally encountered, free-floating plant in March 1958, to an explosive infestation of great magnitude by August 1958. Gay (1) reported that the pioneer waterhyacinth met very favorable conditions in the White Nile. The warm, turbid, and sluggish upper White Nile waters afford an ideal nursing habitat for waterhyacinth. The stream is wide and has frequent bends permitting adequate refuge for this weed. That accounts for its exceedingly rapid reproductive capacity. In addition, the problem has been intensified by favorable physical forces of dispersal of vegetative reproductive units. Current and wind actively contribute to dissemination and fragmentation of colonies into smaller, more readily buoyant units. Similarly, seeds are favorably transported by wind, as well as by current.

Waterhyacinth was first declared as a noxious weed in the White Nile in Autumn, 1958. This season coincides with the high flood of the White Nile that has evidently transported dense communities downstream, thus creating the beginning of a real problem.

Initial control measures were confined to hand removal. As would be expected, that procedure ultimately fell short of solving the problem. Docks continued to build up masses of drifting waterhyacinth faster than the bulk could be removed. Terminals of agricultural canals became repeatedly choked, in spite of active manual clearance. The situation, therefore, demanded more serious thought. Improved mechanical appliances such as forks, rakes, sawboats, and draglines mounted on the bow of paddle steamers managed to ease the situation temporarily.

CONTROL MEASURES

Since 1960, both mechanical and chemical control measures have been adopted. While chemical treatment has its limitations, including prohibition during the cotton (*Gossypium barbadense* and *G. hirsutum* L.) growing season, mechanical removal operations are continued throughout the season of heavy infestation. Mechanically removed masses of waterhyacinth are piled into large heaps on the river banks.

There is a seasonal decline in infestation during winter (December to March). Waterhyacinth retreats to its distant southern limits, the swampy Upper Nile region. The greater part of the main course of the White Nile becomes free of waterhyacinth under the influence of various elements of climate. First, prevailing winds shift from southerly in summer to northerly in winter, thus reversing the infestation drift of northward spread. Then, the low level of water during winter (unlike autumn high flood) is associated with a reduced speed of current northward. Winter has been found to be unfavorable for germination, and vegetative performances are suppressed. This is supported by field evidence indicating low seedling density and stunted growth.[1] Southerly retreat is frequently accompanied by progressive localized compaction of waterhyacinth into dense marginal mats along the main course (Figure 1). Where the river meanders, forming oxbows, depressions, and shallow streams, masses of waterhyacinth of various sizes become stranded and congested into thick carpets (Figure 2).

Heaps, mechanically removed from the main course and deposited on the riverside (Figure 3), and naturally stranded mat accumulations are subject to gradual dehydration. The mortality of individual components depends upon their location in a heap as well as upon the relative humidity of the surroundings. The greater part of the bulk is usually rendered bone dry through dessication under the blazing sun. As expected, a certain pro-

[1]Bebawi, F. F. 1971. Ecological studies on *Eichornia crassipes* in the Sudan. Unpublished field data.

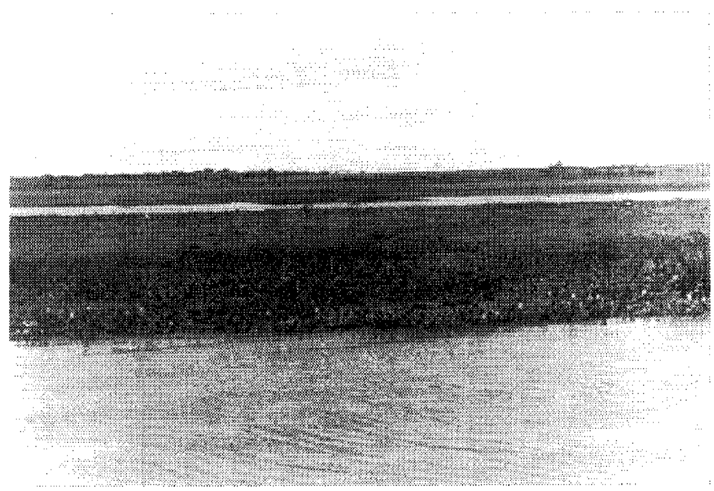

Figure 1. Compaction of waterhyacinth into dense marginal mats in Kosti, November 1971. Main channel is clear with the foreground bank area congested with live waterhyacinth and the elevated bank background with dry flat stretches of this vegetation.

Figure 2. South of Renk, November 1971, swampy depressions with stranded waterhyacinth congested into carpets.

portion would manage to survive inside heaps and in congested accumulations or carpets. It is to be noted that unpredictable showers, commencing in early June, help to sustain the life of some individuals. Field observations have shown that some individuals in exceedingly moist depressions experience vegetative dormancy and survive until the river rises. Alternatively, and perhaps in addition, seasonal streams carrying run-off destined to pour into the river assist in washing down these plants into the main course, thus reinfestation centers might arise in this way.

Viable seeds within heaps and in dense carpets are likely to become lodged in situ in the debris. On the other hand, seeds in relatively thin dry mats may be favorably exposed to dispersal by wind. A possible destination of the latter would be the main course of the White Nile nearby. In the former case, however, viable undispersed seeds would meet optimum conditions to germinate in situ; the spongy, partly decomposed litter becomes saturated with water when high flood flow reaches its maximum limits and inundates the ground where the plant material has been piled up.

Figure 3. Heap of mechanically removed waterhyacinth deposited on slightly elevated bank in May 1971, prior to routine burning.

BURNING PROCEDURES

In view of the above, it would appear that there is good reason to assume that sporadic heaps of mechanically removed waterhyacinth and naturally stranded communities, both located along the banks of the White Nile, form nucleii for future local reinfestations. Burning such potentially threatening centers is therefore an inevitable precaution.

Routine burning has been part of control practices since 1960. The procedure consists of igniting readily combustible heaps piled on the slightly elevated banks of the White Nile. It also covers flat stretches of carpets in depressions and accumulations on seasonally inundated oxbows and side streams. The campaign commences about mid-March at the northerly limits, to reach the southern region by mid-July.

Unskilled labor is employed for routine burning practices. Often rural temporary laborers are hired locally to burn dry marginal accumulations and heaps in the vicinity of villages. Land campaign, organized waterhyacinth control units, patrol the banks on various locomotives to cover a stretch of approximately 500 km from Gebel Aulia dam to Renk (Figure 4).

Environmental conditions during an average burning season are presented in Table 1. The general characteristics of the climate are those of a warm, dry season with moderate, predominantly northerly wind.

Traditionally, routine burning is conducted according to a procedure involving the ignition of combustible matter, starting the flames at the northern extremities of each accumulation. The primary intention is to enable the prevailing wind to accelerate the process. This facilitates a fairly brisk fanning of flames resulting in a speedy ashing of the plant material. It was presumed that quick burning is of advantage since: (1) by avoiding prolonged smoldering it safeguards against local complications such as damage extending to property such as huts, livestock, and crops in the vicinity of the fire; and (2) quick burning is timesaving and therefore economical.

Witnessing a variety of instances of routine burning during the 1971 land campaign brought to notice some interesting observations. Close examination of debris after burning raised queries relating to the efficiency of routine burning. It was noted that briskly fanned burning produced scorching flames that leave lightly charred remnants of a coarse nature. The overall impression is that the result resembled the consequences of accidental vegetational fires of light intensity. Fluffy, dry combustible matter in flat natural accumulations caught fire readily, and the material was consumed within a short time. On

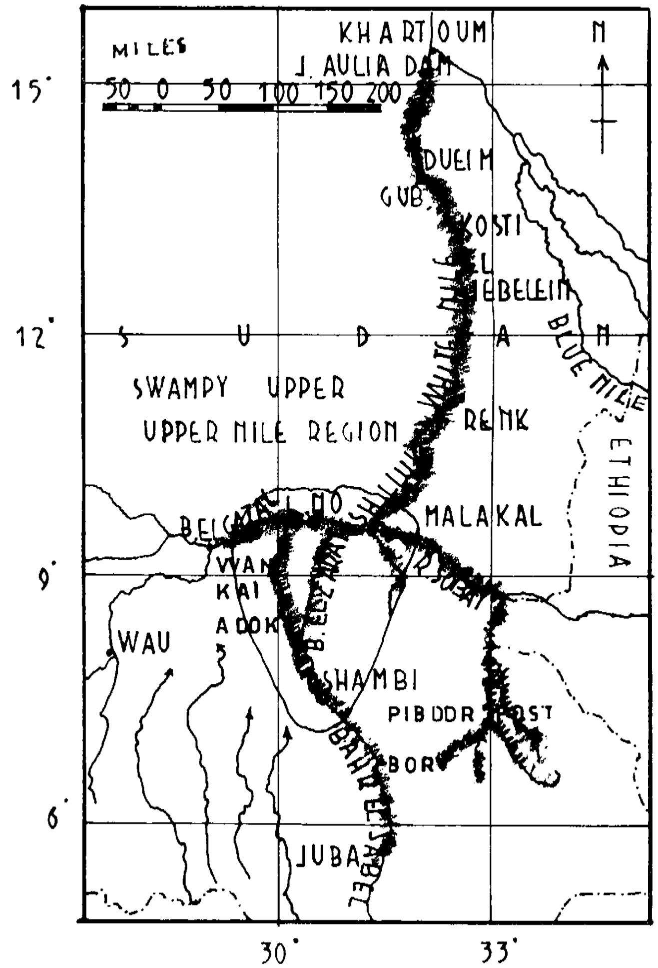

Figure 4. Areas of waterhyacinth infestations in the Sudan. Darkened areas indicate river area infested with waterhyacinth.

the other hand, heaps compacted by virtue of bulk experienced a lingering fire of a different character. Abundant smoke and sparks were associated with glowing and intense radiating heat. Burning heaped dry waterhyacints left sufficiently ashed fine residue. The aftereffects were undoubtedly indicative of a relatively severe burning intensity.

The above visual observations on burning both flat natural accumulations and heaps suggested a set of experiments designed to provide evidence in support of the effectiveness of the latter. Furthermore, the influence of

Table 1. Environmental Conditions During the 1971 Burning Season.

Station and location	Air temperature[a] (C)	Relative humidity[a] (%)	Wind direction	Scalar wind speed[a] (mph)
Gebel Aulia Lat. 15° 14′ N., Long. 32° 30′ E.	31.3	36	NW	6
Kosti Lat. 13° 10′ N., Long. 32° 10′ E.	30.6	35	N	6
Renk Lat. 11° 39′ N., Long. 32° 47′ E.	29.5	42	NW	9

[a]Values are the means for March, April, May, June, and July.

Figure 5. Mechanically piled heap (5 by 5 by 5 m) of dry waterhyacinth at Gulli, May 1971. Thin marginal natural accumulation of plants is evident with the main river channel (right) free of waterhyacinth.

wind upon the relative efficiency of burning was thought to be worthy of investigation.

EXPERIMENTAL BURNING

All experiments were carried out in Gulli (Dueim district) during May to June 1971. The experimental site represents a central region where varied accumulations of dry waterhyacinth are available for the purpose. A standard surface area of 5 by 5 m ranging between 30 to 50 cm in thickness was used for flat natural accumulations (one stratum). Heaps were made up to measure 5 by 5 by 5 m (Figure 5). Routine burning (flame carried with the wind) was applied to all samples. A portable Electrothermal Pyrometer, fitted with long leads ending in thermocouples, was used to determine the temperature. In all experiments the sensitive terminal of the thermocouple was fixed at a distance of approximately 5 cm above ground. For each sample, the thermocouples were moved in order to record the temperature where the fire started and at its midpoint and end.

The results obtained from the experiments are in agreement with expectation (Table 2). Preliminary observations and suggestions derived from thorough examination of remnants of routine burning practices are confirmed by the experimental evidence. Conclusions derived from the results may be summarized as follows: (1) flat accumulations achieve better burning results (higher temperature) under moderate wind than under brisk

Table 2. Temperature of Waterhyacinth During Burning Under Two Different Wind and Plant Accumulation Conditions.

Condition of waterhyacinth	Wind speed: Moderate	Wind speed: High
Flat accumulation[a]	278 b	151 a
Heap[a]	577 d	436 c

[a]Each value is the mean of six replicates. Any two means with the same superscript do not differ significantly at the 5% level for a and b, and 1% for c and d, as determined by the "t" test.

wind; (2) heaps respond similarly with respect to wind conditions, i.e. under moderate wind, the temperature soars to more intense heat than when high wind prevails; and (3) burning efficiency is enhanced by piling combustible matter into heaps.

RECOMMENDATIONS

Recommendations based on the above, to provide for more appropriate and efficient routine burning procedures may be put forward: (1) Light to moderate wind (5 mph), is of greater advantage than brisk wind (12 mph); the former inflicts more destructive action through higher temperatures. Thus, about midday appears to be the appropriate timing for burning. (2) Naturally congested waterhyacinth forming carpets of combustible matter should be piled into heaps prior to the application of routine burning.

CONCLUSIONS

Considering the various aspects of the environmental complex, it seems desirable to recommend shortening of the period (March to July) of routine burning practices. The suggestion is to confine the campaign for routine burning to the months of March and April. Experience has shown that by March both natural accumulations and heaps attain sufficient drying, thus readily combustible matter is, by then, guaranteed. The advantage of burning in March is that it safeguards against prolonging the opportunity for dispersal. On the one hand, early burning would undoubtedly destroy vegetatively dormant forms which might otherwise remain to rejuvenate when moisture requirements are met on the commencement of early rains. On the other hand, burning later than the end of April has its drawbacks. The climatic conditions become favorable with a progressive increase in relative humidity. Dry, spongy-textured waterhyacinth, being readily able to absorb atmospheric moisture, would resist burning or at least render operations less efficient.

The findings of the present studies suggest possible amendments to routine burning practices under Sudan conditions. Practical implications would certainly lead to an improvement of the traditional methods. The accomplishment of higher temperature in routine burning builds up better efficiency in suppressing seed and vegetative regeneration at innumerable potential centers of reinfestation.

LITERATURE CITED

1. Gay, P. A. 1958. *Eichornia crassipes* in the Nile of the Sudan. Nature, Lond. 182:538.

Burning As A Supporting Management In The Control Of Waterhyacinth In The Sudan II - Backburning

B. F. MOHAMED and F. F. BEBAWI

Faculty of Science, University of Khartoum, Sudan

INTRODUCTION

Waterhyacinth *(Eichornia crassipes* (Mart.) Solms.) has acquired great scientific interest in the Sudan since 1958, when it was first declared a notorious weed infesting the White Nile. Its unchallenged invasion as a result of exceedingly rapid multiplication is posing a national problem of immense magnitude. Infestation habitats have provided numerous opportunities for interesting field studies in an entirely new river ecosystem. Despite large scale control efforts involving enormous expense, waterhyacinth presents several problems. A heavy infestation of these plants obstructs navigation, impedes the normal flow of water causing stagnation, hinders fishing practices, and chokes irrigation canals along the greater part of the 600-km stretch of the White Nile. Progress in pursuit of eradicating the weed is yet to be advanced and is presently a much debated topic. Both chemical and mechanical control measures have been adopted. Although the former, spraying with (2,4-dichlorophenoxy) acetic acid (2,4-D) proved fairly satisfactory, by giving rapid temporary relief, certain limitations render the more time-consuming and uneconomical alternative (mechanical removal management) inevitable under various circumstances. Chemical spraying is restricted during the cotton *(Gossypium barbadense* and *G. hirsutum* L.) growing season, July to March. The Fisheries Research Division is exercising strict control over the use of 2,4-D in breeding grounds between January and May. Furthermore, Provincial legislation prohibits the use of 2,4-D in the vicinity of villages as a precaution against harmful pollution of domestic water supplies. Unrestricted mechanical removal campaigns, on the other hand, are conducted throughout the year and wherever heavy infestation creates a serious problem. Mechanical appliances such as forks, rakes, and sawboats are used for the purpose. Masses of mechanically removed waterhyacinth are normally piled into large heaps along the dry river banks. Heaps as well