Chemical control method as a management approach to water hyacinth infestation in Nigeria

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ABSTRACT

Water hyacinth is threat to Nigerian inland waters. Several methods of control have been used with the exception of chemical control methods. This paper showcases the potential and effectiveness of chemical control method in the control of this obnoxious aquatic weed.

INTRODUCTION

Water hyacinth (*Eichhornia crassippes*) belongs to the family *Pontederiaceae* and is a native of tropical South America (Cronk and Fennessy, 2001).New individuals arise through asexual reproduction when daughter rosettes formed on modes along stolons detach from the parent plant (Barette 1980; Harley *et al* 1996).*Eichhornia crassippes* forms dense floating mats. According to Cronk and Fennesy, 2001 leaves make up 60 to 70% of the plant biomass and the leaf turnover rate is high with about 60 to 70% of leaves being replaced each month. The average doubling rate and biomass accumulation is 13days and 60g dry weight m^{-2} day^{-1} respectively (Cook, 1993).

Water hyacinth infestation leads to increased evapotranspiration, blockage of water, thus a decrease in water availability for Agricultural, human and industrial purposes. The worst effect of *Eichhornia crassippes* may be felt by people in the developing countries who depend on fisheries for their diet and livelihood (Hill *et al*, 1997).Its infestation also creates conducive atmosphere for human and animal diseases, thus reduced fish biomass implies reduction in nutrition and health.

The occurrence of high prolific water hyacinth in Nigerian water ways has greatly affected the lives of the riverine people of Nigeria and hence the urgent need for its control. Emphasis has been laid on the Physical, Mechanical and Biological control of water hyacinth, leaving out chemical control measures. This paper is therefore proposing the use of chemical as a management strategy for water hyacinth infestation.

Water Hyacinth Invasion in Nigeria

Water hyacinth was first observed in the Badagry Creek in September, 1984.It enters the country via Port Novo which is connected to and close to Badagry Creek. As it drifted into Lagos in January, 1985 enroute the Sea, the weed encountered high salinity, lost its greenness and died (Kusemiju *et al*, 1985). In order to effectively and efficiently control this weed, some aspects of its biology and ecology that needs to be known are

- Its tolerance to salinity
- Temperature
- Light
- Nutrient availability
- Plant density
- Interaction with other organism
- Its biology and autecology

Akinyemiju (1987) reviewed the water hyacinth invasion in Nigerian waterbodies.Since the reported invasion and the publicity created by the press, government has embarked on manual and mechanical harvest for the weed control. However, government efforts have not yielded sufficient success. The recent incident in which seven commercial boats transporting 500 traders and goods were trapped by a thick mat of Water hyacinth (*Eichornia crassipes*) off the creeks of Ejirin-Maroko in Lagos State, Nigeria brings to the fore the nuisance caused by this aquatic weed that has invaded much of the creeks of Nigeria's coastal waters. Most likely, several of such incidents may have occurred elsewhere in the past without much publicity. Lives and property may have been lost in minor incidents without anyone knowing. The latest incident probably received wide publicity because it involved as many as seven boats in a convoy with 500 people comprising men, women, children and merchandise. Certainly, the traders and fishermen are contending with a serious problem that is taking toll on their source of livelihood. How to deal with this problem should be a matter of policy for poverty alleviation in the riverine areas. Obviously, the weeds have put most traders and fishermen out of business, thereby subjecting their families to untold economic hardship. It therefore becomes necessary to find other control measures that will achieve the desired level of control. The choice of any control measure(s) to be adapted is to be based on a detailed economic analysis in order to use the Nations scarce resources judiciously most especially when the Nation is weak in economic situation like most developing country. With this in view chemical control seem to have a control although with a lot of caution. Since most of the riverine people get their domestic water (s) from these water sources. Alimi and Akinyemiju (1988) reported that mechanized control is labour intensive and labour accounts for 75% of the total cost involved in mechanical control.

Chemical control as a method of choice

To forestall the invasion of this world worst and obnoxious aquatic weed, government established a number of structural measures signaling a new attitude to governance. These measures resulted in the establishment of National Committee on Water hyacinth control. Presently, Government of Nigeria through the Ministry of Environment has received financial support from the African Development Bank to execute Integrated Management of Invasive Aquatic weeds project for the year 2008/2011.The objective of this is to ensure the sustainable management of natural resources especially water resources, to optimize their contribution to social economic and environment development.

The use of chemical control method has always faced stiff opposition as environmentalists always kick against its use. According to Schmidt 1983, Scientists role is to separate fact fact from fiction to assure that decision be based upon valid evidence rather emotions and misinformation. The use of chemicals for aquatic vegetation control is one issue commonly surrounded with fear and uncertainty by general public, environmental groups, and politicians. Scientists and environmentalist argue that chemical control of aquatic plants treats the symptom rather than the source of the problem. The impact of chemical control on the environment is always raised when this method is mentioned. This is an important issue. However, the eradication of vegetative growth in water body may affect the populations of fish.

Chemical control allows the flexibility to control plants on a selective basis as to species and area. Moreso, the localized impact of controlling portions of aquatic plant populations with chemicals does not compare with some of the major impacts resulting from dredging, drawdown, nutrient deactivation, diversion and other lake management techniques. Although, these latter techniques are to improve water quality, what is the effect of total habitat change upon the fishery in these productive waters? Manipulation of this balanced aquatic ecosystem will have some impact. Pesticide scares and groundwater contamination have made the general public quite wary when plans are proposed to put chemical into water. The Scientists have a role to play in the sensitization and education of the public to pacify them of unfounded concerns.

Herbicides use today has much more environmentally acceptable properties. They are characteristically biodegradable or become biologically inactive. These products include endothall compounds, Diquat and 2,4D esters and amines among others. The table 1 below provides information on chemicals used to control some aquatic weeds. Chemical control of aquatic weeds has become of increasing importance due to greater awareness of the need for efficient and effective weed control. In addition, the value placed on irrigation as well as fishing and amenity requirement plus increased cost of labour has created substantial interest in weed control by chemicals.

Chemicals such as Diquat, Paraquat (these are Dichlorides) are extremely soluble in water and acts as contact weed killer, killing all green growth. These are quickly absorbed through all leaf cuticles and act by interfering with photosynthesis. Although they are translocated to some extent, the speed of their action depend largely on light conditions, in bright sunlight, leaf kills is usually complete within few hours or days. The control a wide purge of submerged free floating and emergent aquatic weeds and are non-toxic to fish (es) at concentration well above those rates used for terrestrial weed control.

Chemicals such as Paraquat and Diquat are degraded rapidly by photochemical degradation on exposure to sunlight, the amount of degradation is being dependent on the intensity and quality of the light.Paraquat and Diquat are extremely rain fast due to their rapid uptake with plant tissues. Rain falling within a few minutes after application does not reduce the overall effect.

Effect of chemical control on aquatic biodiversity

A pilot demonstration on the chemical control of water hyacinth was undertaken in Ere fishing village on the outlets of Yewa River to the Lagoon waters of Badagry Creek (OGADEP, 1991) South –west, Nigeria because of financed unsuccessful manual clearing of water hyacinth. The study revealed the effectiveness of the herbicide (glyphosate) to control the menace of water hyacinth (Table 2)

The Chemical control did not affect the fish species in Ere channel, rather there was an increase in the number of fish species from eighteen species (18) prior to treatment, to twenty-six (26) post-application of herbicide, the total number of fish caught, as well as the catch per unit effort, is a clear indication of an enhanced fisheries production after the application of the herbicide (Ezeri, 2002). Table 3

According to Ezeri,2002 Pathological studies revealed that of the total number of fishes examined prior to the chemical application, 334 (5%) had ulcerations, 2,541 (36%) abrasion, 4,147 (5%) lesions, fin-rots 1,805 (27%) sloughing of their body slimc. None had tumours or nodules. The post application examination revealed that 5806 (7%) had finrots, 8294 (10%) abrasions, 4147 (5%) lesions, 1244 (1.5%) ulcerations, 4145 (5%) sloughing of body slime. None had tumors or nodules. The total number of fish showing signs of infection before herbicidal application was 5816 (86.9%) but in the post-application period it was 23,636 (28.49%). The observation for fish mortality revealed no mortalities in the Ere channel both before and after herbicidal application. (Table 4).

The application of the chemicals did not affect the physical and chemical composition of Ere waterbody.The physico-chemical parameters in Ere channel before and after herbicidal treatment is presented as Table 5.

According to Adekoya 2000 reported that residue analysis of the glyphosphate revealed that it was undetectable in the open water treated within only the first four hours application rather only traces of (<1.0ul/L) were detectable in the mudfish and that public health assessments also revealed that glyphosphate had no adverse effect on the Ere population throughout the period of the herbicidal treatment and afterwards. He concluded that glyphosphate is safe and cost effective when properly used under specialist supervision.

In conclusion, the highest economic efficiency is achieved with chemicals that are able to eradicate the weed within the stipulated time period at the least possible cost. The economic efficiency of chemical in controlling water hyacinth is a function of its percentage active ingredient (AI), rate of application within the chemical is effective and unit price of the chemical. It is therefore important water resource managers, environmentalists and the public should support the use of chemicals for aquatic vegetation.

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Table 1. Chemicals used to control some aquatic weeds.

Species	Chemical Ingredient	Rate of Application
Typha spp	Paraquat	0.5kg/ha
	Glyphosate	1 – 2 kg/ha
Nymphaea sp	2,4-D (20%G)	2.26kg/A
Eichhornia crassipes	2,4-D Ester	0.5 – 1kg/ha
	2,4-D Amine	0.5 - 1kg/ha
	Paraquat	0.5kg/ha
Ceratophyllum demersum	2,4-D ester(20%G)	2ppm

Table 2. Species abundance of floating aquatic plant in Ere Channel.

	Pre-treatment				Post-treatment			
Month	E.crassipes	P.stratiotes	A.indica	Others	E.crassipes	P.stratiotes	A.indica	Others
Sept,91	89.5	6.9	2.5	1.4	0.00	0.00	0.00	0.00
Oct, 91	89.5	6.5	2.7	1.5	0.00	0.00	0.00	0.00
Nov, 91	89.5	6.0	2.8	1.7	0.00	0.00	0.00	2.70
Dec,91	90	5.0	2.8	1.8	0.00	2.80	0.00	3.20
Average total %	89.5%	6.2%	2.7%	1.6%	0.00	2.65	0.00	2.95

Table 3. Abundance, species diversity and length weight relationships of fish in Ere channel Pre and Post application of herbicide

		Pre-application samples				**Post-application samples**			
No	Fish species	**Total fish caught**	**Average weight (kg)**	**Average Weight (mm)**	**Catch per unit effort**	**Total fish caught**	**Average weight (kg)**	**Average Weight (mm)**	**Catch per unit effort**
1	*Oreochromis niloticus*	166	0.40	202	5.53	1875	0.48	2.34	75.0
2	*Tilapia guineensis*	183	0.43	228	6.56	1735	0.52	336	75.2
3	*Tilapia melanopleura*	0	0	0	0	3605	0.25	200	75.1
4	*Hemichromis fasciatus*	297	0.21	176	5.20	359.2	0.25	189	74.8
5	*Hemichromis bimaculatus*	0	0	0	0	4500	0.20	101	75
6	*Auchenoglamis occidentalis*	0	0	0	0	3197	0.28	224	74.6
7	*Chrysichthys nigrodigitatus*	212	0.35	244	6.18	2343	0.38	258	74.2
8	*Clarias gariepinus*	220	0.32	258	5.87	2186	0.41	281	74.7
9	*Clarias angullaris*	0	0	0	0	4090	0.22	206	75
10	*Hepsetus odoe*	0	0	0	0	2308	0.39	264	75
11	*Heterotis niloticus*	170	0.52	234	7.37	1599	0.56	240	74.6
12	*Gymmarchus niloticus*	176	0.45	272	6.60	576	1.52	508	73
13	*Momyrus rume*	193	0.36	214	5.80	2029	0.42	262	71
14	*Parachana obscura*	153	0.44	257	5.61	1698	0.48	269	67.9
15	*Guathonemus tomandua*	186	0.38	238	5.90	2070	0.43	241	74.2
16	*Schilbe mystus*	0	0	0	0	2875	0.28	203	67.1
17	*Bagrus bayad*	0	0	0	0	2349	0.35	196	69
18	*Notopterus afer*	0	0	0	0	2358	0.38	205	74.7
19	*Polypterus senegalensis*	109	0.61	252	5.54	1261	0.67	259	70.4
20	*Mugil cephalus*	188	0.35	206	5.48	1970	0.44	211	72.2
21	*Synodontis clarias*	155	0.43	203	5.60	1724	0.51	209	73.3
22	*Alestes nurse*	407	0.17	128	5.76	3739	0.23	136	71.7
23	*Petrocephalus bane*	145	0.48	206	5.80	1686	0.50	212	70.3
24	*Barbus nigeriensis*	2162	0.03	166	5.41	20500	0.04	169	66.8
25	*Calamoichthys calabaricus*	725	0.10	281	5.44	5367	0.15	288	67.1
26	*Dictichodus rostatus*	239	0.26	194	5.18	2161	0.38	204	68.4
	Total	6,686 7.46%			104.8	82,943 92.54%	10.72		1.880

Total number of species (Pre- treatment) = 18%
Total number of species (Post-treatment) = 26%

Table 4. External clinical symptoms of examined fish from Ere channel (Pre and Post herbicidal application.

Pre-Treatment				Post-Treatment		
Parameters examined	**Total number of fish examined**	**Number of observed diseased fish**	**% observed of diseased fish**	**Total number of fish examined**	**Number of diseased fish**	**% observed of diseased fish**
Fin rot	6686	334	5	82,943	5806	7
Abrasion	6686	2541	38	82,943	8294	10
Lesions (LS)	6686	802	12	82,943	4147	5
Ulcerations (UL)	6686	334	5	82,943	1244	1.5
Sloughing Slime (SS)	6686	1805	27	82,943	4145	5
Tumour/Nodules (TM/N)	6686	0	0	82,943	0	0
Total		5816	87		23636	28.5

* Two or more clinical symptoms can occur in the same fish
Source : Ezeri,2002

Table 5. Physicochemical parameters of Ere channel (before and after herbicidal treatment) all values are mg/l unless otherwise stated

	Station*		Station**		Station***	
Parameters	**Pre-treatment**	**Post treatment**	**Pre-treatment**	**Post-treatment**	**Pre-treatment**	**Post-treatment**
Conductivity (µs)	85.9 -114.5	107.2- 38.4	90.3-103.0	91.0-562	103.7-106.0	90.30-164.5
$_pH$	6.2 – 7.8	7.3- 7.9	6.5-7.5	6.6- 7.0	6.5-7.7	6.6-7.2
Sodium	4.2 – 9.7	9.1-11.7	8.7-76.8	8.0-47.8	8.8-9.0	12.0-76.8
Potassium	3.4 – 9.0	8.5- 10.9	8.1-71.3	7.5-44.4	8.2-8.4	11.1-71.3
Calcium	4.7 – 7.2	6.8- 24.2	6.5-56.9	6.2-35.4	6.5-6.7	8.9- 56.9
Magnesium	3.2 – 5.8	5.5-19.6	5.3-46.1	5.4-25.0	5.3-5.4	7.2-46.1
Bicarbonate	24.4- 36.6	24.4- 32.6	24.5-45.7	24.4-25.0	42.7-48.0	18.3-24.4
Chloride	8.4- 36.6	17.7-63.6	16.7-150.0	16.3-92.7	17.1-17.5	23.3-149.0
Sulphate	3.5- 4.7	4.4-15.7	4.2-37.0	4.5-23.0	4.2-4.4	5.8-37.0
Nitrate	1.0 – 2.7	2.6-9.2	2.4-21.7	2.0-13.5	2.5-2.5	3.4-21.7
Dissolved Silica	15.0-17.0	25.7-96.0	25.5-220.0	26.2-140.5	25.9-26.5	35.3-335.7
Biochemical Oxygen Demand	2.50 – 3.65	1.10- 3.90	2.0-4.62	2.30-4.45	1.10-3.50	2.30-3.40
Dissolved Oxygen	4.8- 5.5	2.2-4.2	3.0-4.0	3.2- 3.8	0.7-2.8	1.5-3.8
Chemical Oxygen Demand	1.4 – 3.2	0.8- 4.8	2.0-3.2	2.4-4.6	2.0-3.5	2.3- 3.3
Temperature °C	28.5 – 29.9	28.5- 32.0	29.0- 31.0	29.0-31.0	27.9-30.5	28.7- 30.8

* Station 1 : Ere channel treated with glyphosate on 17th Dec,1999
** Station 2 : Untreated open water Yewa lagoon free of water hyacinth.
*** Station 3 : Untreated Soki channel infested with water hyacinth adjacent to Ere Channel.
Source: Ezeri,2002