Research Journal of Agriculture and Biological Sciences, 3(1): 21-23, 2007

Impact of Integrated Biological Control of Water Hyacinth (Eichhonnia Crassipes (Mart.) Solms) on Water Quality and Fish Mortality

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Abstract: The short-term control measures of water hyacinth including physical and chemical control have serious constraints for implementation in water bodies of developing countries of the tropical and sub tropical region. Classical biological control using insects agents *Neochetina spp.* is constrained in many tropical watershed environs with interrupted host range due to season water flow and complete drying of water during the hot summer months. Integrated control of *Eichhornia crassipes* has been achieved by integrating bio-control agents *Neochetina* spp. with a plant product *Coleus amboinicus/aromaticus.* Integrated approach involving releasing the insect agents @ two plant^{-1} first followed by spraying the plant product @ 25 per cent on 10 days after releasing the insects showed synergistic interaction in controlling water hyacinth and the same did not affect the water quality in terms of pH and dissolved oxygen and fish survival. The untreated *E. crassipes* infested system recorded a pH of 7.42, dissolved oxygen of 2.56 ppm and fish mortality of 42 per cent on 30 days after spraying whereas pH of 7.28, dissolved oxygen of 5.42 ppm and fish mortality of 4 per cent were recorded in system subjected to integrated approach.

Key words: *Eichhornia crassipes,* Iintegrated biological control, Water quality, Fish mortality

INTRODUCTION

The aquatic weed, Water hyacinth (*Eichhornia crassipes* (Mart.) Solms - Laubach: Pontederiaceae) is one of the most troublesome weeds all over the world. In India, it has spread to all types of water bodies throughout the country and is believed to occupy over 200000 ha of water surface. Excessive infestations of the weed deleteriously affect water traffic, fishing potential, infrastructure for pumping, hydro electricity generation, water use and biodiversity. Other damages include water loss due to evapotranspiration and an increased population of vectors of human diseases like malaria, encephalitis, schistosomiasis, filariasis, etc.[5]. *E. crassipes* also affects the water quality by reducing water temperature, pH, bicarbonate content, dissolved oxygen and increasing biological oxygen demand, free carbon dioxide and nutrient level that ultimately makes water unfit for livestock and human use[4]. In the state of Tamilnadu, India the Veeranum Lake and its distributaries form the major irrigation source that covers a large proportion of the rice tract of the state with a command area of 18,000 ha. This lake and its distributaries in recent days have been infested with *E. crassipes*. Frequent mechanical removal of this weed is highly expensive, labour intensive, and time consuming process. Chemical herbicides, even though effective, are not popular because of their high cost and pollution hazards. Biological control using insect agents, though accepted to be the only sustainable option does not eliminate the weed and even after its implementation, large quantities of water hyacinth biomass frequently remain in water bodies. Biological control requires a minimum of several years, usually 3 to 5 years, for insect population to increase to a density that could bring down the weed stand to a substantial decline[2]. Based on the above facts, the preliminary study was conducted to determine the interaction between botanical herbicide *Coleus amboinicus/aromaticus* and insect bio-control agent *Neochetina eichhorniae/bruchi*. The results revealed that releasing the insect agents @ two insects plant^{-1} first and spraying the plant product as 25 per cent foliar spray over the weed after 10 days proved effective in controlling the weed with a higher degree of inhibition in fresh weight and chlorophyll content of the water hyacinth. Further, a pot culture experiment was conducted based on the results obtained from the preliminary experiment, to trace the impact of integrated bio-control on water quality and fish.

MATERIALS AND METHODS

The experiment was conducted at Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamilnadu, India, to study the impact of integrated approach involving release of insects and plant product spray on water quality and fish survival. The experiment was laid out in a randomized block design in concrete cement tanks of dimension 120 cm diameter, 65 cm height and 5 cm thickness. After

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Table 1: Impact of integrated biological control on *E. crassipes*

Treatments	Percentage reduction in fresh weight					Percentage reduction in chlorophyll content				
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS
Insects + 25 % plant product spray	34.33 (31.80)	46.56 (52.73)	56.79 (70.00)	68.03 (86.00)	90.00 (100.00)	37.35 (36.80)	57.06 (60.50)	60.83 (76.25)	75.82 (94.00)	90.00 (100.00)
Insects alone	16.43 (8.00)	22.79 (15.00)	28.73 (23.10)	33.10 (29.80)	36.75 (35.80)	18.95 (10.54)	27.63 (21.50)	32.21 (28.41)	35.10 (33.00)	38.10 (38.00)
Unsprayed check with *E. crassipes*	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)
Fishes without *E. crassipes*	-	-	-	-	-	-	-	-	-	-
SE_D	2.80	3.01	2.90	3.40	3.60	2.98	3.38	3.10	3.80	4.00
CD (p=0.05)	5.63	6.15	6.10	6.80	7.30	6.00	6.81	6.20	7.60	8.01

Figures in parentheses are original values before angular transformation.
DAS- days after spraying

clogging the drainage holes, the water was let into three fourth of height of the tanks. The *E.crassipes* plants were collected and grown in concrete cement tanks. These plants were released with insect agents *N.eichhorniae* / *bruchi* @ two plant^{-1} in treatments involving insect bio-control. The plant product *C.amboinicus* / *aromaticus* was sprayed in respective treatments (Table 1), 10 days later, on the foliage of the weed with a concentration of 25 per cent using a spray fluid of 500 l ha^{-1} through hand compression sprayer fitted with flood jet deflector nozzle. In each treatment pot, ten fish fingerlings of size 15 cm length or 50 g weight from five different species *viz*., Rohu, Mrigal, Catla, Common carp and Grass carp (two from each species, representing an ideal mixture for polyculture) were released, right at the start of the experiment. The observation recorded were reduction in fresh weight and chlorophyll content, water quality in terms of pH and dissolved oxygen and fish mortality. The reduction in fresh weight of E.crassipes was recorded at 15 days intervals (in comparision with initial fresh weight of plants in the same treatments). Chlorophyll content of *E. crassipes* was estimated at 15 days interval by extracting the leaf tissue using dimethyl sulphoxide (DMSO)[3]. The pH and dissolved oxygen content of water were measured and recorded at 10 days interval by using water quality analyzer. The mortality of fishes was calculated based on the number of fishes died per tank to the total number of fishes let into the tank. Fish mortality were observed on 30 days after spraying of plant product on the weed.

Mortality of fishes (%) =

$$\frac{\text{No. of fishes died per tank}}{\text{Total no. of fishes stocked per tank}} \times 100$$

RESULTS AND DISCUSSIONS

All the treatments influenced the reduction in fresh weight and chlorophyll content of *E. crassipes*, pH and dissolved oxygen of water and fish mortality. Among the treatments, spraying of plant product at 25 per cent after releasing the insects @ two plant^{-1} was exhibiting a higher degree of inhibition with cent per cent reduction in fresh weight and chlorophyll content of *E. crassipes* on 75 DAS (days after spraying) (Table 2). This might be due to better absorption of allelochemicals in plant product by the weed host

Table 2: Impact of integrated biological control on water quality and fish mortality

Treatments	pH			Dissolved oxygen in ppm			Fish mortality on 30 DAS
	10 DAS	20 DAS	30 DAS	10 DAS	20 DAS	30 DAS	
Insects + 25 % plant product spray	7.4	7.31	7.28	6.2	5.8	5.41 (4.00)	11.54
Insects alone	7.46	7.37	7.31	5.24	4.47	4.21 (18.00)	25.10
Unsprayed check with *E. crassipes*	7.64	7.51	7.42	4.24	3.18	2.56 (42.00)	40.40
Fishes without *E. crassipes*	8.81	8.68	8.61	10.98	10.31	8.25 (0.00)	0.01
SE_D	NS	NS	NS	0.09	0.08	0.08	3.22
CD (p=0.05)	NS	NS	NS	0.171	0.171	0.16	6.41

Figures in parentheses are original values before angular transformation.
DAS- days after spraying

through the spots scrapped by the insect agents. The same integrated approach did not affect the water quality in terms of pH and dissolved oxygen. The untreated *E. crassipes* infested system recorded a pH of 7.42 and dissolved oxygen of 2.56 ppm on 30 DAS whereas pH of 7.28 and dissolved oxygen 5.41 ppm were recorded in system subjected to the integrated approach. Even though no significant difference was observed among the treatments, integrated approach recorded lesser pH compared to other treatments. This could be attributed to the electrolyte leakage and decomposition of the treated *E. crassipes* producing organic acids with an ultimate increase in the pH of water. The lowest dissolved oxygen was recorded in treatments with the weed alone without either the insect agent or the foliar spray of the plant product. This might be due to higher longevity of weed host in aquatic system causing depletion of oxygen in water. This is in conformity with the earlier results of[1].

Fish mortality of 4 per cent was recorded in aquatic system wherein integrated bio-control approach was followed as against 42 per cent in aquatic system with untreated *E.crassipes* infestation. Considerable mortality of fishes observed in treatments involving the weed alone without either the insect agent or the foliar spray of the plant product indicate that the impact is due to declining water quality resulting from the weeds inhabitation, and decaying organic matter. Integrated approach was imparting a rapid and more disruptive action on the weed leaving very little or negligible weed biomass for degradation and ultimately recorded the lesser morality over fishes with more dissolved oxygen by less oxygen starvation compared to other treatments.

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