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Allelopathic Effects of *Alternanthera philoxeroides* and *Tilapia* Fish on Growth of Water Hyacinth (*Eichhornia crassipes*) : Pilot Study

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Abstract

Water hyacinth is the most serious aquatic weed in water body causing enormous problems to the economics and the environment. The design of a particular program of water hyacinth control is not an easy task. A strategic plan has to be developed to control the growth of aquatic weed and socio economic constrains, which may prevent the practice of any particular control method. The present paper briefly describes the methodology for controlling the growth of water hyacinth in small scale. Though there are several methods to control water hyacinth which include manual pulling, mechanical harvesting and biological control (introduction of weevils that weaken the water hyacinth root system). Each method has its own economic and environment constrains for which practical advice is needed. Therefore, technically sound programme of control of weed should be rationally developed and implemented. With this background, a pilot study was carried out to use *Alternanthera philoxeroides* - Alligator weed, to control water hyacinth and its impact on growth and development of water hyacinth. Results revealed that the tanks treated with *Alternanthera philoxeroides* stems reduced the stem length of *Eichhornia* gradually which varied from 58.07 to 76.87 per cent when compared to the control, *Eichhornea* (22 %) or application of the water containing leachates of the *Alternanthera philoxeroides* to the *Eichhornea* tanks at 20 days 40 days old leachate there was significant reduction in fresh weight from 65 to 85 per cent implying there was some inhibitory effect on growth of *Eichhornea* due to application of leachates. Similar trend was noticed in reduction of fresh weight of *Eichhornea* (57 to 77%) where *Alternanthera philoxeroides* stems were added. In treatment where All-male genetically improved farmed tilapia (GIFT) fish also showed reduction in fresh weight of *Eichhornea.*

Keywords : Water hyacinth, Alligator weed, Leachates, Fresh weight, Stem length

Water hyacinth is native to the Amazon basin in South America originating in North-Eastern Brazil. Water hyacinth (*Eichhornia crassipes*) has been widely described as one of the world's worst weeds. It is a free-floating and highly invasive aquatic plant that rapidly forms dense and impenetrable floating mats in freshwater systems. This aquatic plant forms large mats in still or slow-moving freshwater, particularly in impounded waterways-potentially threatening the function and ecology of freshwater wetlands and waterways. It is erect and herbaceous, consisting of a cluster of several broad leaves and attractive purple flowers. In India, it has become a serious weed in the aquatic bodies. It depletes water from these habitats due to high rate of evapo-transpiration occurring through its broad and succulent leaves, spoils the water and damage natural flora and fauna of water bodies. It competes with cultivable fishes for space, nutrients and dissolved oxygen; harbors unwanted fishes and other aquatic organisms; causes siltation and hinders harvesting of fish.

The Problem

Aquatic weeds spread very rapidly and have reached alarming proportions in aquatic ecosystems; their invasion into agro-ecosystems and also in water system (Aloo, 2013). Allelopathy in aquatic ecosystems plays an important role. They also influence the competition between different aquatic plants because of their differential allelopathic potential (Abbas, 2015).

Water hyacinth is an aggressive invader and is a weed of national significance. Infestation can double in size every five days under ideal conditions, quickly covering

the water surface and taking over an entire waterway. The ability for this plant to tolerate a large range of temperatures, nutrients and pH levels, gives a superior advantage over other native freshwater plants that generally have slower growth rates and a much lower tolerance to changes in water environments. Several attempts have been made to control this weed biologically using alligator weed (*Alternanthera philoxeroides*), a perennial plant native to South America which often forms very dense strands or mats that make shoreline access difficult. Aquatic stems of Alligator weed are hollow and can be single or branched. Leaves are opposite, long, elliptical or lance-shaped up to 3/4 inch wide and 5 inches long with a prominent midrib. Its roots often develop at leaf nodes. Soft, whitish hairs are found in the leaf axis. Flowers are singular, small (about 1/2 inch in diameter) and white, fragrant clusters of 6 to 10 florets, borne on long branches (to three inches). Their flowers resemble those of white clover. A single seed develops within the fruit. The vegetative parts of the Alligator weed are found to be highly protenaceous (21 % Crude Protein) and is very much relished by the livestock, it has been identified as a fodder plant at the University of Agricultural Sciences, Bangalore (Bhatta, 1990). This plant often forms mats in conjunction with Water-hyacinth (*Eichhornia crassipes*). In the last five to six years, it is found that certain populations of this plant grows profusely on the mat formed by the *Eichhornia* in the aquatic bodies in and around Hebbal, Bengaluru and has given control on spread of water hyacinth. With this background, a pilot study was taken up to study the effect of *Alternenthera philoxeroides* on growth of *Eichhornia crassipes.*

Material and Methods

The experiment was conducted in trapezium shaped cement cisterns with breadth 60.2, length 40.9 cm and height 40.2 cm filled with 105 litres of water during the year 2018 *kharif* season at AICRP Weed Management, Bengaluru. As per the treatments, long rhizome segment each having an average of four nodes were used for alligator weed and a bulb with at least one stolon connection with six branches were used for *Eichhornia crassipes.* Water level in the cistern was maintained by refilling them once in every 15 days, after recording the observations on stem height (cm) and fresh weight of stems (both *Eichhornea* and *Alternanthera philoxeroides*) was recorded at 15, 30, 45 and 60 days after initiation (DAI) of treatments. T1: only *Eichhornia (20 bulbs)* and T2: only *Alternanthera philoxeroides* (80 segments) were maintained in separate cement tanks as control throughout the experiment. 80 segments of *Alternanthera philoxeroides* were maintained separately in another cement tank exclusively for leachate collection, which served as sources of leachates (source tank). Ten litres of leachate from the source tanks was transferred at 20 and 40 days as per the treatment T5: *Eichhornia crassipes 20 Bulbs+20 days old Alligator* Leachate and T6: *Eichhornia crassipes 20 Bulbs+40 days old Alligator* Leachate, respectively. All-male Genetically Improved Farmed Tilapia (GIFT) fish produced by Inland Fisheries Unit, Main Research Station, Hebbal, Bangalore were let in to the cement cistern as per the treatment.

Observations on stem length (cm) and fresh weight (g) was recorded for both *Eichhornea* and *Alternanthera philoxeroides* at 15, 30, 45 and 60 DAI of treatments.

Results and Discussion

Experiment was initiated in Completely Randomised Design (CRD) under two replications. Observations were recorded at 15, 30, 45 and 60 days after initiation on stem length (cm), and fresh weight (g). In treatments T5 and T6 leachates were added according to the treatment schedule.

Effect of *Alternanthera philoxeroides* on Stem Length (cm)

Only *Eichhornia* and *Alternanthera philoxeroides* were maintained in separate tanks as control for comparing the growth over other treatments. *Eichhornia* (T1) exhibited self inhibitive growth after 45 days. *Alternanthera philoxeroides* (T2) continued to grow throughout the study period as evident from the observation recorded on stem length and fresh weight. The growth of *Eichhornia* was significantly

inhibited by the presence of *Alternanthera philoxeroides* potential metabolites. In the cisterns with *Alternanthera philoxeroides* stems, stem length of *Eichhornia* gradually reduced which could clearly be observed from Table 1 and Fig. 1 compared to cisterns with only *Eichhornea*.

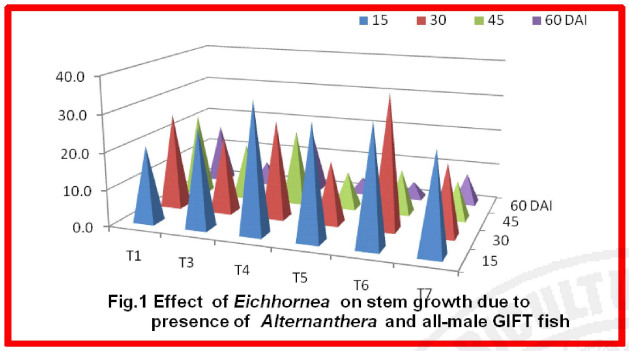

Fig.1 Effect of *Eichhornea* on stem growth due to presence of *Alternanthera* and all-male GIFT fish

In treatments T3 and T4, presence of *Alternanthera philoxeroides* stems affected *Eichhornia*. The leaves of *Eichhornia* turned yellow and the growth affected throughout the experiment. The effect was predominant till 30 DAI (26.8 to 6.2 cm in T3 and 35.3 to 14.8 cm in T4). Application of 20 days old leachates (T5) showed significant reduction of stem length of water hyacinth from 30.7 to 16.9 cm. The same trend was observed when 40 days leachate (T6) was applied, where drastic reduction of stem length was recorded from 36.2 to 12.0 cm. compared to only *Eichhornia* where there was increase in growth till 30 days (20.8 to 26.1 cm) and decreased later. The decrease may be due to overgrowth of *Eichhornia* in the cistern. In treatment where GIFT fish were present (T7), it was noticed that growth of water hyacinth retarded significantly. However, detailed study on cause of reduction in growth due to GIFT fish has to be studied.

Effect of *Alternanthera philoxeroides* on Fresh Weight (g)

Application of 20 days and 40 days old *Alternanthera philoxeroides* leachates to *Eichhornea* tanks or mixture of 15 bulbs of *Eichhornia crassipes* + 45 segments of *Alternanthera philoxeroides* or mixture of 20 bulbs of *Eichhornia crassipes* + 80 segments of *Alternanthera philoxeroides*, there was significant reduction in fresh weight in *Eichhornia* (Table 2, Fig. 2). There was significant and drastic reduction in fresh weight of *Eichhornea* from 28.8 to 16.4 g in

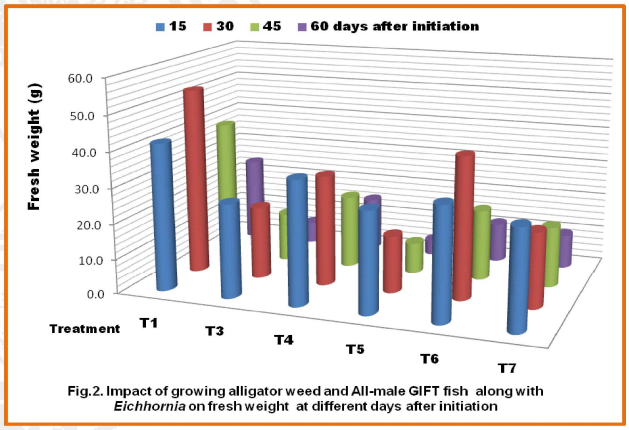

Fig.2. Impact of growing alligator weed and All-male GIFT fish along with *Eichhornia* on fresh weight at different days after initiation

TABLE 1

Stem length (cm) as influenced by *Alternanthera philoxeroides* on *Eichhornea*

Treatments	15	30	45	60
	Days after initiation			
T1: Pure 20 nos. *Eichhornia crassipes* bulbs placed in the water in tanks	20.8	26.1	22.6	16.2
T3: Mixture 15 bulbs of *Eichhornia crassipes* + 45 segments of *Alternanthera philoxeroides* placed in the water in the tank.	26.8	20.8	15.1	6.2
T4: Mixture of 20 bulbs of *Eichhornia crassipes* +80 segments of *Alternanthera philoxeroides* placed in the water in the tank	35.3	26.4	20.4	14.8
T5: *Eichhornia Crassipes 20 Bulbs+ 20 days old Alligator* Leachate	30.7	16.9	9.9	4.2
T6: *Eichhornia Crassipes 20 Bulbs+ 40 days old Alligator* Leachate	32.1	36.2	12.0	4.4
T7: *Eichhornia Crassipes 20 Bulbs* + All-male GIFT fish	26.6	19.3	10.3	8.3
S.Em±	1.8	2.3	0.4	0.4
CD (P=0.05)	3.9	5.0	0.89	0.95

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TABLE 2

Fresh weight (g) as influenced by *Alternanthera philoxeroides* on *Eichhornea*

Treatments	15	30	45	60
	Days after initiation			
T1 : Pure 20 nos. *Eichhornia crassipes* bulbs placed in the water in tanks	41.8	53.0	39.4	23.9
T3 : Mixture 15 bulbs of *Eichhornia crassipes* + 45 segments of *Alternanthera philoxeroides* placed in the water in the tank.	26.8	20.8	13.8	6.0
T4 : Mixture of 20 bulbs of *Eichhornia crassipes* +80 segments of *Alternanthera philoxeroides* placed in the water in the tank.	35.2	31.5	20.7	15.1
T5 : *Eichhornia Crassipes 20 Bulbs+ 20 days old Alligator* Leachates	28.8	16.4	8.8	4.2
T6 : *Eichhornia Crassipes 20 Bulbs+ 40 days old Alligator* Leachate	32.1	40.3	20.4	11.2
T7 : *Eichhornia Crassipes 20 Bulbs* + All-male GIFT fish	28.3	21.5	17.4	9.7
S.Em±	1.9	2.8	2.5	1.4
CD (P=0.05)	4.18	6.16	5.43	3.13

treatments where 20 days leachate was applied, (T5) and 40.3 to 20.4 g when 40 days old leachate was applied (T6). While there was increase in fresh weight in *Eichhornea* alone (T1) (41.8 to 53.0 g) till 30 DAI. In the experiment, within five days after application of leachates, the symptom of drying of *Eichhornea* was more predominant implying that there was some inhibitory effect on growth of *Eichhornea* due to application of leachates. Similar trend was noticed in reduction of fresh weight of *Eichhornea* where *Alternanthera philoxeroides* stems were added in T3 treatment from 26.8 to 20.8 g and from 35.2 to 31.5 in T4 at 30 DAI, This is due to the leachate which is responsible for inhibiting the growth of *Eichhornea*. The exact nature of the chemical accountable for the retard growth of *Eichhornia* is yet to be identified. Dhanapal and Ganeshaiah, 2000 observed similar allelopathic effect of *Alternanthera philoxeroides* on *Eichhornia*.

Treatment where GIFT fish was let into cistern to grow with water hyacinth, significant reduction of fresh weight was noticed in water hyacinth. Thus the experiment suggests a clear potentiality for using alligator weed and GIFT fish as a biological agent to control *Eichhornia* in aquatic bodies. However, further detailed studies are required to identify the metabolite responsible to inhibit the growth of water hyacinth.

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