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Influence on Certain Herbicides for the Control of Water Hyacinth (*Eichhornia Crassipes* (Mart.) Solms) and its Impact on Fish Mortality

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Abstract

An experiment was conducted on the bio-efficacy of certain herbicides for controlling water hyacinth (*Eichhornia crassipes)* and its impact of herbicides on fish mortality. Three herbicides (Fernoxone @ 1.50 kg ha^{-1}, Glycel or Round up @ 2.50 kg ha^{-1} and Gramoxone @ 1.50 kg ha^{-1}) were tried, all are foliage applied herbicides. Three different fishes were tested such as common carp, mrigal and rohu. Among the herbicides applied, round up caused maximum reduction of plant height of 0.50, 1.00 and 1.00 cm; 2.75, 6.98 and 10.00g of biomass were obtained at 50 DAS on small, medium and large statures of *E. crassipes*. The cent percent chlorophyll content was recorded compared to control treatment at 28 DAS, whereas it cent percent mortality of *E. crassipes* at 35 DAS on small, medium and large statures of the weed. Similarly the same herbicides caused the least mortality percent of fishes 23.30, 16.60 and 20.00 on common carp, mrigal and rohu at 32 DAS, respectively compared to other herbicide treatments.

Keywords: *Eichhornia crassipes;* Bio-efficacy; Herbicide control; Fish mortality; Common carp; Mrigal; Rohu

Introduction

The aquatic weed water hyacinth (*Eichhornia crassipes* [Mart.] Solms-laubach: It is considered to be the world's worst aquatic weed [1]. Water hyacinth belongs to the family pontederiaceae and is a native of tropical South America [2]. Aquatic weeds are those unwanted plants, growing in water and complete at least a part of their life cycle in water [3].Water hyacinth is an erect, free-floating and one of the most troublesome weeds all over the world and is most devastating aquatic weeds in India [4]. It is first ranked among the top ten weeds worldwide [5]. In India, the plant was first introduced in Bengal, most probably in early 1890s. It has spread to all types of water bodies through the country [6]. At present it is believed to occupy over 0.2 m ha of water surface in India [7,8]. According to Cornk and Fennesy [2], 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 13 days and 60 g dry weight m^{-2} day, respectively [9]. Excessive infestations of the weed deleteriously affect water traffic, fishing potential, infrastructure for pumping, hydro electricity generation, water used and biodiversity, other damages include water loss due to evapotranspiration which is 1.02 to 9.8 times higher than evaporation from an open surface [10]. The adopted control methods available on mechanical, chemical and biological methods. Frequent mechanical removal of this weed is highly expensive, laborious intensive and time consuming process. Biological control require a minimum of several years, usually 3 to 5 years, for insect population to increase to density that could bring down the weed stand to a substantial decline [4,11]. Herbicides used today have much more environmentally acceptable properties. They are characteristically biodegradable or become biologically inactive [12]. Hence herbicidal control seems to be a better option since it is an effective and fast acting as reported by several studies [12]. Based on the above facts, a pot culture experiment was conducted on bio-efficacy of chemical control as an effective and quick methods are as follow.

Materials and methods

The experiment was conducted at Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamil Nadu, India during 2010-11. Annamalai Nagar is located at 11° 24' N Latitude, 79° 44' E Longitude, and an altitude of +5.79 MSL to study the bio-efficacy of certain herbicides for the control of water hyacinth. The experiment was laid out in a randomized block design with three replications. Water hyacinth was introduced into cement tank of dimension 2'×2.5'×2' having ¾th of water column. Three herbicides (Fernoxone @ 1.50 kg ha^{-1}, Glycel and Round up @ 2.50 kg ha^{-1} and Gramoxone @ 1.50 kg ha^{-1}) were tried. Spray fluid required of 500 lit ha^{-1} was made and applied, through knapsack sprayer fitted with flood jet defector nozzle. In each treatment introduced were ten fish fingerlings of size of 10 cm length, three different species tested viz., common carp, mrigal and rohu in each treatment. The reduction in plant height, biomass, chlorophyll content, and mortality percent was also recorded. Chlorophyll content of *E. crassipes* was estimated 7 Days interval using spectrophotometer [13]. The mortality of *E. crassipes* was calculated based on following formula,

$$\text{Mortality of } E.crassipes\ (\%) = \frac{\text{No.of plant died tank}^{-1}}{\text{Total No.of plant stocked tank}^{-1}} \text{X}100$$

The fish mortality was calculated on 32 DAS using the formula.

$$\text{Mortality of fishes } (\%) = \frac{\text{No.of fishes died tank}^{-1}}{\text{Total No.of fishes stocked tank}^{-1}} \text{X}\,100$$

The experimental data were statistically analyzed using the methods described by Panes and Sukhatme [14]. After subjecting the data to analysis of variance, least significant difference was worked out a 0.05 per cent probability level. The data on percentage values were transformed by angular transformation before analysis.

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Result and discussion

Herbicide Effect on weeds

The data on recorded of herbicide control of water hyacinth, three herbicides were tried for under pot culture experiments, of which gramoxone and round up are of non selective and fernoxone is selective in nature and all are foliage applied herbicides. All the treatments exerted significant influence over the reduction of plant height of *E. crassipes*. Among the herbicides tried, Round up showed (Table 1) highest activity in terms of reducing plant height of 0.50, 1.0 and 1.0cm on small, medium and large of *E. crassipes.* The herbicide fernoxone and gramoxone was next in order. Untreated control showed the normal plant height which was the highest 15.70, 30.35 and 43.69 cm at 50 DAS, respectively. The reduction in plant height was noticed to be gradually increasing with the time lapse after spraying with the herbicides and accordingly 50 DAS showed the greatest height reduction. This is because of time span involved in the mechanism of action of herbicides comprising absorption, translocation and mode of action getting reflected on the visible impacts was reported by Deivasigamani and Kathiresan [15].

Among the treatments exerted significant influence over the biomass of *E. crassipes*. All the herbicides tried, of which Round up recorded a biomass of 2.75, 6.98 and 10.00 g which was the least on small, medium and large of *E. crassipes* (Table 2). The herbicide fernoxone and gramoxone was next in order. Untreated control showed the highest weed biomass of 70.18, 150.86 and 283.46 g at 50 DAS, respectively. Regarding percentage mortality of *E. crassipes,* round up recorded the cent percent mortality of all the growth statures of *E. crassipes* at 35 DAS, (Table 3). The chlorophyll content of *E. crassipes,* round up showed highest activity in terms of reduction in chlorophyll content with 100 per cent reduction of all the growth stages of *E. crassipes* on 28 DAS. The herbicide fernoxone and gramoxone was next in order (Table 4).

Among the herbicides tried, round up was observed to be more efficient in suppressing the growth of the weed plant by virtue of reducing plant height, biomass, chlorophyll reduction and mortality. Round up mode of action is to inhibit an enzyme involved in the synthesis of the aromatic amino acids tyrosine, tryptophan and phenylalanine. It is absorbed through foliage and translocated to growing points. The enzyme that inhibits, EPSPS, is found only in plants and micro-organisms are not present in animals [16]. Though Fernoxone also happens to be a translocated herbicide, the comparatively less efficiency performance is due to comparatively slower process of interruption of protein synthetic mechanism and the ability of water hyacinth to regenerative compensatory growth from vegetative propagules from runners and smaller plant lets. Gramoxone, though very effective in tissue disruption by virtue of free radical and superoxide activity and inhibition of photosystem-I, with the activity being mainly contact and restricted to plant parts of exposure, failed to compare with round up. However, with adequate dose, all the three herbicides achieved complete control with longer time gaps. This is in conformity with the reports of Kannan and Kathiresan and Deivasigamani [17,18].

Treatment	Small		Medium		Large	
	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS
Control (Unsprayed check)	14.34	15.70	28.00	30.35	43.09	43.69
Fernoxone @ 1.50 kg ha^{-1}	4.19	2.00	11.34	2.20	10.49	2.20
Round up @ 2.50 kg ha^{-1}	3.84	0.50	9.46	1.00	4.40	1.00
Gramoxone @1.50kg ha^{-1}	4.71	3.10	13.36	4.15	12.60	4.60
$S.E_D$ CD(p=0.05)	0.17 0.35	0.74 1.49	0.94 1.88	0.60 1.20	3.04 6.02	0.60 1.20

Table 1: Effect of different Herbicide spray on plant height (cm) of small, medium and large *E.crassipes*.

Treatment	Small		Medium		Large	
	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS
Control (Unsprayed check)	67.10	70.18	147.70	150.80	277.65	283.46
Fernoxone @ 1.50 kg ha^{-1}	18.10	4.90	29.17	8.27	58.40	15.60
Round up @ 2.50 kg ha^{-1}	13.70	2.75	31.39	6.98	40.10	10.00
Gramoxone @1.50kg ha^{-1}	27.23	12.10	39.12	20.10	67.00	30.00
$S.E_D$ CD(p=0.05)	2.15 4.38	1.07 2.15	1.1 2.20	0.64 1.29	9.14 18.28	2.80 5.60

Table 2: Effect of different Herbicide spray on biomass (g) of small, medium and large *E.crassipes*.

Treatment	Small		Medium		Large	
	21 DAS	35 DAS	21 DAS	35 DAS	21 DAS	35 DAS
Control (Unsprayed check)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)
Fernoxone @ 1.50 kg ha^{-1}	47.20 (53.80)	67.50 (85.35)	45.40 (50.65)	71.60 (90.00)	42.80 (46.15)	75.90 (94.05)
Round up @ 2.50 kg ha^{-1}	51.30 (60.85)	90.00 (100.00)	56.0 (68.65)	90.00 (100.00)	51.20 (60.65)	90.00 (100.00)
Gramoxone @1.50kg ha^{-1}	40.55 (42.25)	76.6 (94.15)	42.0 (44.75)	75.6 (93.75)	40.40 (42.00)	74.30 (92.60)
$S.E_D$ CD(p=0.05)	0.70 1.41	1.46 2.93	1.80 3.60	10.0 20.0	1.40 2.80	0.59 1.18

Table 3: Effect of different Herbicide spray on mortality percentage of small, medium and large *E.crassipes*. Figures in parenthesis are original values before angular transformation.

Treatment	Small				Medium				Large			
	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total mg/g	Percentage reduction over control	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total mg/g	Percentage reduction over control	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total mg/g	Percentage reduction over control
Control(Unsprayed check)	3.752	3.950	7.702	0.00	4.467	3.870	8.337	0.00	4.463	3.590	8.053	0.00
Fernoxone @1.50 kg ha^{-1}	0.341	0.273	0.614	92.02	0.272	0.131	0.403	95.166	0.251	0.173	0.424	96.63
Round up @2.50 kg ha^{-1}	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.000	0.000	0.000	100.00
Gramoxone @ 1.50kg ha^{-1}	0.263	0.107	0.370	95.19	0.171	0.102	0.273	96.72	0.163	0.108	0.271	94.73
$S.E_D$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*NS-Non significant

Table 4: Effect of different Herbicide Spray on chlorophyll content of small, medium and large of *E.crassipes* at 28 DAS.

Treatments	Mortality Percentage of Fish		
	Common crop	Mrigal	Rohu
T_1 - Fernoxone @ 1.50 kg ha-^{1} -Weed+ Fish	(46.00) 42.70	(33.33) 35.26	(25.00) 30.00
T_2 - Round up @ 2.50 kg ha-^{1} -Weed+ Fish	(23.30) 28.86	(16.60) 24.05	(20.00) 26.57
T_3 - Gramoxone @1.50kg ha-^{1} -Weed + Fish	(42.00) 40.39	(66.66) 54.73	(25.00) 30.00
T_4 - Fish alone	(0.00) 0.01	(0.00) 0.01	(0.00) 0.01
T_5- Control (Unsprayed check with *E. crassipes* + fish)	(14.50) 22.38	(50.00) 45.0	(21.70) 27.30
$S.E_D$	3.16	2.62	0.36
CD (p=0.05)	6.32	5.25	0.73

Table 5: Effect of different Herbicide spray on mortality percentage of fish at 32 DAS. Figures in parenthesis are original values before angular transformation

Herbicides Effect on fishes

Among the herbicide applied gramoxone @ 1.50 kg ha^{-1}, caused the highest mortality percentage of 40.39, 54.73 and 30.00 of common carp, mrigal and rohu on 32 DAS, respectively. Round up @ 2.50 kg ha^{-1} showed significantly lesser lethality over fishes with the mortality percentage of 28.86, 24.05 and 26.04. The fernoxone @ 1.50 kg ha^{-1} has showed highest mortality percentage of 42.70, 35.26 and 30.00 of common carp, mrigal and rohu. The unsprayed check with *E. crassipes* showed mortality of 22.38, 45.0 and 27.30 percent on 32 DAS, respectively. Untreated control fish alone showed no mortality percentage at 32 DAS (Table 5). In studies conducted by Jay et al., (2008) no fish mortality was found in paraquat (0.5 and 1.0 kg ha^{-1}) treated tanks. Similar result ware obtained earlier [19] and their study showed that the gramoxone @ 0.90 kg ha^{-1} was applied 79 per cent mortality of fishes were achieved at 32 DAS.

Conclusion

It could be concluded that, the application of chemical herbicides controlled water hyacinth at all the growth stages of the weed. Among the herbicides applied round up caused 100 per cent mortality of the weed. However all of them significantly affected fish mortality. In all the three treatments, of which fernoxone caused highest mortality per cent of 42.70, 35.26 and 30.00 of common carp, mrigal and rohu fishes on 32 DAS followed by gramoxone. The weed killer round up recorded the lowest mortality per cent of 28.86, 24.05 and 26.57of common carp, mrigal and rohu fishes on 32 DAS, respectively. Among the herbicides applied, round up a broad spectrum, non-selective and systemic foliage applied herbicide has been recommended @ 2.50 kg/ha (500 liter spray fluid) for the efficient control of water hyacinth, is absorbed through foliage. Because of this mode of action, it is only effective on actively growing plants and is safe for non target flora, fauna and retention of water quality and environmental safety.

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