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EFFECTS OF POST-EMERGENCE HERBICIDES ON WATER HYACINTH (*Eichhornia crassipes*) - TANK CULTURE EXPERIMENT

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ABSTRACT

Water hyacinth (Eichhornia crassipes (Mart.) Solms) has become a major weed of rivers and dams, and a problem weed in southern parts of India. Water hyacinth has many adverse impacts on waterways, includes reduced access to water and poor quality of available drinking and irrigation water. Hence, a study was initiated to quantify the characteristics of water hyacinth and to evaluate the effect of post-emergence herbicides management methods on Water Hyacinth in tank culture in the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, during 2007 to 2009. Tank culture experiments were carried out to quantify the characteristics and to evaluate the effects of post emergence herbicides on the management of water hyacinth in a randomized block design with three replications. Water Hyacinth mother plants grew very fast from one week after inoculation up to six weeks, after which the growth rate decreased and it involved in seed maturation, senescence and ramet production. Ramets emerged from the third week onwards and showed fast growth up to six weeks. This continuous growth process and multiplication by ramet production at a very high rate are the main reasons why water hyacinth causes enormous problems to the environment. A tank culture experiment was conducted to evaluate the efficacy of different post emergence herbicides (i.e. paraquat, glyphosate and 2, 4-D Na salt) on both water hyacinth and on the aquatic ecosystem. The results revealed that spraying of glyphosate at 10 mL/L + ammonium sulphate 20g/L + Triton 1mL/L effectively reduced the water hyacinth density as well as Water Hyacinth dry weight considerably.

Keywords: Glyphosate, herbicides, paraquat,, post emergence, tank culture, water hyacinth, 2, 4-D Na salt.

INTRODUCTION

Invasive aquatic weeds have spread throughout the world's waterways as a result of anthropogenic activities. The most problematic species among water body weeds is Water Hyacinth. It is perennial fresh water aquatic plant that doubles its number within four

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weeks under favourable conditions (Akinyemiju and Bewaji, 1990). Originally introduced to India in Bengal as an aquatic ornamental plant, Water Hyacinth has become a major aquatic weed of rivers and dams. Not only does it destroy native habitats, but it also seriously depletes water bodies of oxygen, increases water loss and provides a breeding ground for mosquitoes. Cultural eutrophication of lakes is also a major problem around the world and this can amplify the problem due to Water Hyacinth. Nowadays Water hyacinth becomes a notorious aquatic weed in western parts of Tamil Nadu. Moreover for human population living around such water bodies, it reduces access to and quality of available drinking and irrigation water, prevents fishermen from making a living, clogs water intakes at hydro-electric dams, increases vector-borne diseases, eutrophication and generally leads to an increase in human suffering. This free floating monocotyledous plant obstructs fishing, water transportation and recreation uses in many riverines (Adekoya, 1992).

Considering the gravity of problems posed by the aquatic weed; water hyacinth on human health and on environment, tank culture experiment was conducted with the objectives to quantify the characteristics of water hyacinth and to evaluate the effects of post emergence herbicides on the management of water hyacinth.

MATERIALS AND METHODS

Characteristics of Water hyacinth

Water hyacinth plants were collected uniformly at four leaf stages and inoculated in ten pre-fabricated cement tanks (dimensions- 5 feet x 5 feet x 2 feet) at the rate of twenty plants per tank and watering was done periodically. Then ten plants per tank were tagged for biological studies. Observations on Water hyacinth characteristics were recorded at weekly intervals and up to six weeks after inoculation. Mean data over ten plants each in a tank were arrived and presented in the results and discussion.

Herbicidal management of Water Hyacinth

The experiment was conducted under controlled condition using cement tanks with the size of 10 feet x 5 feet x 4 feet. Water hyacinth plants were collected from local lakes and 75 number of water hyacinth plants have been inoculated in each water filled cement tanks. The tank culture experiment was laid out in randomized block design with treatments replicated thrice. Initial fresh biomass of 75 plants was recorded. Water hyacinth plants were allowed as such to establish in the tanks for a period of one month. Then the calculated quantity of herbicides was sprayed in the respective cement tanks as per the treatment schedule. Plant height, number of leaves, wet weight and dry weight of the water hyacinth plants have been

recorded at weekly intervals. Visual scoring for qualitative assessment of effect of herbicides has been done at weekly intervals after herbicide treatment for three months. Simultaneously visual scoring on regeneration of the water hyacinth has also been done up to four months after treatment. The data on plant dry weight were subjected to logarithmic transformation.

Treatment details

T_1 - Paraquat 6 mL/ L of water
T_2 - Paraquat 8 mL/ L of water
T_3 - Glyphosate 10 mL/ L of water
T_4 – Glyphosate 15 mL/ L of water
T_5 - 2,4-D Na salt 6 g / L of water
T_6 - 2,4-D Na salt 8 g / L of water
T_7 - Coleous plant water extract (1:1 w/w) 300 mL/ L of water
T_8 - Unsprayed control
T_1 to T_6 ammonium sulphate 20 g/L and Triton 10 mL / L of water were tank mixed before spraying.

RESULTS AND DISCUSSION

Characteristics of Water Hyacinth

Plant growth steadily increased and attained the maximum height on six weeks after inoculation, where large number of ramets production also occurred (Table-1). From the day of inoculation, it took 18 days for the initiation of inflorescence. Each plant produced an average of two inflorescences. Root growth also attained its maximum on sixth week of inoculation and declined there after but the rate of decline was low when compared to shoot portion. Number of stolons and leaves increased gradually up to sixth week of inoculation and then decreased. After sixth week small reduction in the ramets production due to the ramets remain attached to the parent plant. Inflorescence initiation in ramets started in fifth week having an average of one inflorescence per ramet and an average of seven flowers per inflorescence. Higher rate of multiplication of Water hyacinth was earlier observed that ten water hyacinth plants could thus produce 600,000 plants covering 0.4 hectare water spread area within months and the individual plant starts to double its number in merely six days (Akinyemiju and Bewaji, 1990). All the characters contributing to dry matter production were at peak on sixth week after inoculation. Total dry weight of the plant reached higher on sixth week after inoculation.

Effect of Herbicides On Water Hyacinth

Plant Height

The height of the plants recorded before herbicide spray did not show any significant variations among the treatments (Table-2).

Lower plant height was observed in glyphosate at 10 mL/L (T_3) and 15mL/L (T_4) treatments followed by 2,4-D at 6g/L(T_5) and 8g/L (T_6). Whereas the unsprayed control (T_8) and *Coleus* sp. plant extract spray (T_7) registered the maximum height (102.4 cm and 91 cm) followed by paraquat at 6mL/L(T_1) and 8mL/L(T_2) treatments at later stages of observation. The reduction in plant height in paraquat spray (T_1 and T_2) might be due to quick knock down effect at initial stages and later stages being a contact herbicide it losses its effect on water hyacinth.

Table-1. Characteristics of mother plant and ramets of Water Hyacinth.

Observations	0 DAT	14 DAT	28 DAT	42 DAT
Plant height (cm)	11.40	22.80	56.60	62.00
Number of leaves / plant	4.00	6.20	9.00	5.00
Number of Inflorescence / plant	0.00	0.00	2.00	2.00
Number of flowers / Inflorescence	0.00	0.00	12.00	12.00
Root length (cm)	7.40	21.40	44.50	45.60
Total dry weight (g)	1.19	26.08	64.20	83.80
Number of ramets	0.00	2.00	7.00	6.00
Number of leaves / ramets	0.00	5.00	7.00	7.00
Number of Inflorescence	0.00	0.00	1.00	1.00
Number of flowers in ramets	0.00	0.00	7.00	7.00

DAT: Days after treatment (inoculation); Data not statistically analysed.

Table-2. Effect of herbicides on plant height of water hyacinth.

Treatments	Plant height (cm)				
	BHT	3 DAT	7 DAT	14 DAT	21 DAT
T_1-Par_6	74.0	58.0	61.0	34.0	57.0
T_2-Par_8	76.0	56.0	60.0	32.0	52.6
T_3-Gly_{10}	72.0	72.0	14.0	5.80	0.00
T_4-Gly_{15}	74.0	74.0	12.5	4.50	0.00
T_5-2,4-D_6	73.0	48.0	12.0	0.00	14.0
T_6-2,4-D_8	70.0	40.0	14.0	0.00	13.5
T_7-Col_{300}	77.0	83.0	87.0	83.0	91.0
T_8-Con	72.0	86.0	91.0	89.0	102.4
SEd	3.21	5.8	4.8	2.01	1.48
$CD_{0.05}$	NS	12.4	10.2	4.32	3.17

BHT: before herbicide treatment; DAT: days after treatment.

Number of Leaves

At the time of spraying, the number of leaves did not show any significant variation among treatments (Table-3). Paraquat spray at 6mL/L(T_1) and 8mL/L(T_2) recorded lower number of leaf during initial stages and started increasing on 7 days after treatment(DAT) and increased up to 21 DAT. This might be due to Paraquat being a contact

non-selective weed killer it might have allowed regeneration of Water Hyacinth at later stages, which was reflected through higher density of Water Hyacinth with more number of leaves recorded at 7 DAT onwards.

Table-3. Effect of herbicides on number of leaves of water hyacinth.

Treatments	Number of leaves/plant				
	BHT	**3 DAT**	**7 DAT**	**14 DAT**	**21 DAT**
T_1-Par_6	9.00	0.00	2.00	6.00	8.00
T_2-Par_8	8.00	0.00	2.00	6.00	8.00
T_3-Gly_{10}	9.00	9.00	4.00	4.00	0.00
T_4-Gly_{15}	8.00	8.00	3.00	4.00	0.00
T_5-2,4-D_6	9.00	2.00	0.00	0.00	3.00
T_6-2,4-D_8	8.00	2.00	0.00	0.00	3.00
T_7-Col_{300}	8.00	9.00	9.00	9.00	11.0
T_8-Con	9.00	11.00	11.0	11.0	12.0
SEd	0.36	0.60	0.50	0.27	0.31
$CD_{0.05}$	NS	1.25	1.01	0.58	0.67

BHT: before herbicide treatment; DAT: days after treatment.

Treatments with glyphosate at 10 mL/L (T_3) and 15mL/L (T_4) initially recorded higher number of leaves (9/plant and 8/plant) and started decreasing from 7 DAT and resulted in lower number of leaves 21 DAT. Glyphosate at 2.38 kg/ha effectively controlled the Water Hyacinth densities at 20 kg/m^2 in 51 days and the second dose of 0.95kg/ha was required for the complete plant control (Eric, 1993). The slower rate of control of water hyacinth with glyphosate might be due to the slow translocation of Glyphosate herbicide which was effective only after 15 DAT. Treatments with 2,4-D at 6g/L(T_5) and 8g/L (T_6) resulted in a gradual decrease in number of leaves from initial stages and recorded lower ratings on 14 DAT and afterwards it showed minimum increase (T_5 and T_6) on 21 DAT. Water hyacinth plants sprayed with 2, 4-D showed epinastic symptoms and brittle stems and leaves. This effect might be due to differential turgidity and unequal rates of cell division and cell enlargement. More number of leaves (12/plant) was observed in unsprayed control (T_8) throughout the experiment followed by coleus plant extract (T_7) from the day of herbicide spraying up to 21 DAT.

Plant Dry Weight

Glyphosate treatments at 10 mL/L (T_3)and 15mL/L (T_4) recorded higher dry weight in the initial stage and have shown gradual reduction and resulted in lower dry weight (2g / plant) at later stages(Table-4). Glyphosate being a non-selective systemic herbicide readily absorbed by leaves and throughout the symplast. All Water

Hyacinth plants can be eliminated after three weeks after Glyphosate application (Gutiérrez *et al.,* 1996). Similarly, Jadhav *et al.* (2007) reported that lower dose of glyphosate 0.8 %(1.36 L/ha) retarded the growth of parent plants of water hyacinth and inhibited the production of daughter plants. Similarly, earlier Singh and Muller (1979) also obtained 100% control of water hyacinth with 2.0 kg/ha Glyphosate within three weeks after application and noted that most plants decayed 56 days after treatment. The herbicide, 2, 4-D at 6g/L (T_5) and 8g/L (T_6) treatments showed epinastic symptoms in the earlier stage and cause death of plants. However, at later stages, there was some evidence of regrowth of Water Hyacinth from partially decaying stolons, which may be due to diluted effects of herbicide. However, Mallya *et al*. (2001) observed that integrated management of water hyacinth was more effective than individual methods. Whereas, untreated control (T_8) and those plants treated with the *Coleus* sp. plant extract (T_7) registered the maximum dry weight of Water Hyacinth at all the stages of observation, followed by the paraquat at 6mL/L(T_1) and 8mL/L(T_2) treated plants at 14 and 21 DAT.

Table-4. Effect of herbicides on dry weight of water hyacinth.

Treatments	Dry weight (g/plant)				
	BHT	3 DAT	7 DAT	14 DAT	21 DAT
T_1-Par_6	1.64(41.4)	1.25(18.0)	1.34(22.0)	1.54(34.8)	1.54(34.6)
T_2-Par_8	1.67(44.6)	1.22(16.5)	1.32(21.0)	1.51(32.4)	1.49(30.9)
T_3-Gly_{10}	1.65(42.8)	1.67(46.4)	0.95(8.90)	0.39(2.45)	0.30(2.00)
T_4-Gly_{15}	1.62(40.2)	1.65(45.2)	0.87(7.50)	0.36(2.30)	0.30(2.00)
T_5-2,4-D_6	1.69(46.8)	1.16(14.5)	0.54(3.50)	0.30(2.00)	0.59(3.90)
T_6-2,4-D_8	1.65(42.6)	1.09(12.3)	0.48(3.00)	0.30(2.00)	0.52(3.30)
T_7-Col_{300}	1.64(41.5)	1.71(51.5)	1.81(64.4)	1.85(71.4)	1.90(79.9)
T_8-Con	1.66(43.6)	1.75(56.4)	1.85(70.8)	1.87(73.9)	1.94(87.5)
Sed	0.01	0.04	0.04	0.04	0.04
CD(5%)	NS	0.08	0.08	0.08	0.08

Figures in parenthesis are original values; BHT: before herbicide treatment; DAT: days after treatment

Summary of results

Mother plants grow very fast from one week after inoculation up to six weeks and then growth rate decreased and involved in seed maturation and senescence and ramet production. Ramets emerged from third week onwards and grow fast up to six weeks because of this continuous growth process the multiplication of water hyacinth resulted in very high rate

The tank culture experiment was conducted to evaluate the effect of different post emergence herbicides on Water Hyacinth plant revealed that spraying of glyphosate at 10 mL/L. + ammonium sulphate 20g/L + Triton 10mL/L as a surfactant effectively controlled

the Water Hyacinth plants. It can be concluded that spraying of glyphosate at 10 mL/L + ammonium sulphate at 20g/L + Triton at10mL/L as a surfactant may be recommended for the control of *Eichhornia crassipes* in large stagnated water bodies.

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