INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

POST EMERGENCE HERBICIDE COMBINATION ON WATER HYACINTH AND ITS IMPACT ON FISH IN 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 problematic weed in Southern part of India. Water hyacinth has much adverse impact on waterways, which includes reducing species diversity, habitat for insect borne disease vectors, interfere with fishing, change sediment chemistry and reduce water storage capacity in reservoirs. Hence, a study was initiated to quantify the characteristics of water hyacinth and to evaluate the effect of post-emergence herbicides on water hyacinth and its impact on herbivorous fishes in tank culture in the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during 2011-2012. Although the post-emergence herbicides provided effective control on the aquatic weeds in some areas, it could not provide the sustainable inhibition on the aquatic weed population, while it would lead to pollution in water at various levels. Herbicides could be a suitable alternative to discourage or eliminate the regeneration of water hyacinth. However, there is growing need for suitable herbicides with no harmful effects to aquatic life. The result of the experiment showed that the water hyacinth mother plants grew very fast from one week after inoculation upto six weeks, later which the growth rate decreased and it was involved in seed maturation, senescence and ramet production. Application of post-emergence herbicide combination of glyphosate at 10 ml/lit + carfentrazone at 4 mg/lit reduced the wet and dry weight of water hyacinth without any regeneration. There was no mortality of fingerlings were observed with all the tested herbicides with different concentrations except spraying of glyphosate at 10 ml/lit + 2,4-D Na salt at 2.5 g/lit.

KEYWORDS: Water hyacinth, tank culture, biology, herbicides, regeneration, fish growth.

INTRODUCTION

Water hyacinth was first introduced to the United States from South America and is considered as one of the "world's worst weed" (Holm *et al*., 1991) because its presence causes economic losses and affects the ecological interactions. In India, it was invaded in 1886 in West Bengal as an ornament plant and then was introduced throughout the country as a major pest of rivers and dams. Nowadays, water hyacinth becomes a notorious aquatic weed in Western parts of Tamil Nadu. In Tamil Nadu, almost 80% of 39,000 tanks are infested with aquatic weeds mainly Water hyacinth and Hydrilla verticillata. Water hyacinth is a fastest growing broad leaved weed persists in water bodies in abundantly large number. It is a perennial fresh water aquatic plant that doubles its number within four weeks under favorable conditions (Akinyemiju & Bewaji, 1990). The high reproductive capacity and rapid growth of water hyacinth endow it with high vegetative development and productivity rates. A single inflorescence has 20 flowers and each flower produces 3000-4000 seeds. The seeds sink down to the bottom and remain viable at least for 20 years. A pair of plant can multiply upto four thousand times in one season. Under heavy infestation, water bodies are rendered unfit for use by animals and fish farming turns uneconomic. Mechanical or manual weeding is cumbersome and bulbs left in the soil again regenerate (Gopal, 1987). Herbicides could be suitable alternative to discourage or eliminate regeneration. However, there is a growing need for suitable herbicides with no harmful effects to aquatic life. Chemical control is one of the worldwide, most commonly used methods of macrophyte repression. Hence, the present study was undertaken to find out suitable herbicides for effective management of this menace weed. Application need to be undertaken by trained individuals using correct dosage and applied at appropriate stages of growth. In view of this, present study was conducted to manage the growth and regeneration of water hyacinth using different post-emergence herbicides or its combination.

MATERIALS & METHODS

Characteristics of water hyacinth

The tank culture experiments were conducted at the Directorate of Crop Management, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore located at Western Zone of Tamil Nadu. The geographical location of the experimental site is 11º29"N latitude and 77º08"E longitude with an altitude of 256 m above mean sea level. Water hyacinth plants were collected uniformly at four leaf stage and inoculated in ten pre-fabricated cement tanks with the size of 10 feet x 5 feet x 4 feet at the rate of twenty five 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 upto six weeks after inoculation. Mean data for ten plants in each 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 twenty five number of water hyacinth plants have been inoculated in each water filled cement tanks. Fingerlings like roghu and mirgal were released on the same day of inoculation to estimate the herbicide influence over fish. The tank culture experiment was laid out in randomized block design and replicated thrice with nine treatments. Treatments consisted of post-emergence herbicides *viz*., T_1 - Paraquat at 4 ml/lit of water; T_2 - Paraquat at 8 ml/lit of water; T_3 - Glyphosate at 10 ml/lit of water; T_4 - 2,4-D Na salt at 2.5 g/lit of water; T_5 - Glyphosate at 10 ml/lit of water + 2,4-D Na salt at 2.5 ml/lit of water; T_6 - Carfentrazone at 4 mg/lit of water; T_7 - Glyphosate at 10 ml/lit of water + Carfentrazone at 4 mg/lit of water; T_8 - Metsulfuron methyl at 0.05 g/lit of water; T_9 - Unsprayed control. Initial fresh biomass of 15 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. Wet and dry weight of the water hyacinth plants were recorded at weekly intervals. Visual scoring / quantitative assessment have been done at weekly intervals after herbicide treatment for three months. Deaths of fingerlings were also monitored at regular intervals and simultaneously visual scoring on regeneration of the water hyacinth has been done upto 30 days after herbicide spray (DAHS).

Statistical analysis

The data collected for water hyacinth was statistically analyzed following the procedure (Gomez & Gomez, 2010) for randomized block design. The data pertaining to water hyacinth was transformed to square root scale of $\sqrt{(X+2)}$ and analyzed (Snedecor & Cochran, 1967). Whenever significant difference existed, critical difference was constructed at five per cent probability level. Such of those treatments where the difference are not significant were denoted as NS.

RESULTS & DISCUSSION

Biology of water hyacinth

Growth of water hyacinth steadily increased and attained the maximum height on six weeks after inoculation, whereas large number of ramets production also occurred. From the day of inoculation, it took 20 days for the initiation of inflorescence. Each plant produced an average of two inflorescences. Root also attained the maximum growth on sixth week of inoculation and declined thereafter, but the rate of decline was low when compared to shoot portion. Number of stolons and leaves increased gradually upto sixth week of inoculation and then decreased. After six weeks, there was a small reduction in the ramets. Production due to the ramets remains 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 observed in early stage (Table 1). Ten water hyacinth plants could produce 6,00,000 plants covering 0.4 hectare water spread area within months and the individual plant starts to double its number in merely six days (Akinyemiju & 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. By inferring from the above observation of growth characters, it is clear that the growth rate of water hyacinth attained peak on the sixth week after inoculation and decreased gradually as a result of seed maturation and senescence of leaves in mother plants. Whereas, the ramets produced from it results in continued growth and thus resulted in multiplication of water hyacinth.

TABLE 1. Characteristics of mother plant and ramets of water hyacinth

Observations	0 DAI	14 DAI	28 DAI	42 DAI
Plant height (cm)	12.56	24.80	52.60	64.00
Number of leaves / plant	5.00	7.56	8.00	9.00
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)	9.40	24.56	40.50	46.60
Total dry weight (g)	1.26	27.32	65.26	84.80
Number of ramets	0.00	3.00	7.00	7.00
Number of leaves / ramets	0.00	4.00	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

DAI - Days after Inoculation

Effect of herbicides on dry weight of water hyacinth

Application of paraquat at 8 ml/lit of water recorded lower dry weight of water hyacinth and it was closely followed by glyphosate at 10 ml/lit + carfentrazone at 4 mg/lit and glyphosate at 10 ml/litre + 2, 4 D Na salt at 2.5 g/lit (Table 2). In case of submerged weeds, herbicide application before the plants reach full maturity is advised preventing de oxygenation of water through the rapid breakdown of dying plant material resulting was reported by Gupta, 2001. Application of lower dose of glyphosate at 1.36 lit/ha retarded the growth of parent plants of water hyacinth and inhibited the production of daughter plants (Jadhav, 2007). At 7 DAHS, significantly lower dry weight was observed with application of glyphosate at 10

ml/lit + 2,4-D Na salt at 2.5 g/lit than all other treatments. At 14 DAHS, dry weight was lowered with glyphosate at 10 ml/lit + carfentrazone at 4 mg/lit and glyphosate at 10 ml/lit + 2,4-D Na salt at 2.5 g/lit application of water. Similarly, the 100% control of water hyacinth with glyphosate at 2.0 kg/ha within three weeks after application and noted that most plants decayed 56 days after treatment (Singh & Muller, 1979). Unsprayed control has recorded higher dry biomass of water hyacinth than all other herbicidal management. At 30, 45 and 60 DAHS, glyphosate at 10 ml/lit + carfentrazone 4 g/lit sprayed had effectively controlled the water hyacinth and had consistent effect on water hyacinth. Chemical weed control with glyphosate, 2,4-D, diaquat and paraquat are reduced the dry weight of water hyacinth and also cause relatively rapid decline in water hyacinth mat (Sushilkumar *et al*., 2008).

TABLE 2: Effect of herbicides on dry weight of water hyacinth at different intervals

Treatments	Initial weight	3 DAHS	7 DAHS	14 DAHS	30 DAHS	45 DAHS	60 DAHS
T_1 - Paraquat at 4 ml/lit	65.0	5.60 (31.53)	5.30 (28.37)	5.45 (30.00)	6.41 (41.33)	7.76 (60.45)	8.37 (70.47)
T_2 - Paraquat at 8 ml/lit	57.0	4.61 (21.35)	5.20 (27.15)	6.16 (38.35)	6.13 (37.72)	6.89 (47.74)	7.69 (59.41)
T_3 - Glyphosate at 10 ml/lit	60.0	7.89 (62.53)	7.43 (55.75)	6.47 (42.50)	5.60 (31.52)	4.81 (23.25)	4.08 (16.74)
T_4 - 2,4-D Na salt at 2.5 ml/lit	65.0	6.84 (47.12)	6.44 (41.85)	6.17 (38.40)	7.05 (49.91)	7.27 (53.13)	7.75 (60.45)
T_5 - Glyphosate at 10 ml/lit + 2,4-D Na salt at 2.5 ml/lit	76.0	5.60 (31.51)	5.15 (26.72)	4.54 (20.56)	3.90 (15.21)	5.22 (27.38)	5.60 (31.51)
T_6 - Carfentrazone at 4 ml	60.0	6.45 (41.85)	5.75 (35.66)	5.50 (30.50)	6.77 (45.98)	7.78 (60.76)	8.14 (66.65)
T_7 - Glyphosate at 10 ml/lit + Carfentrazone at 4 ml	58.0	5.10 (26.16)	4.96 (24.82)	4.50 (20.50)	3.96 (15.75)	2.91 (8.53)	2.15 (4.68)
T_8 - Metsulfuron at 0.05 ml/lit	60.0	6.91 (48.05)	6.30 (40.02)	4.16 (17.50)	5.20 (27.18)	5.78 (33.58)	6.051 (36.78)
T_9 - Unsprayed control	73.0	9.21 (85.26)	9.33 (87.65)	20.41 (420.00)	22.90 (527.00)	23.85 (571.00)	24.42 (599.33)
SEd	0.16	0.15	0.16	0.58	0.38	6.48	0.53
CD (P=0.05)	0.33	0.32	0.34	1.07	0.94	1.02	1.12

Figures in parenthesis are original values; DAHS - Days after herbicide spraying

Regeneration of water hyacinth

The regeneration of water hyacinth was observed with application of paraquat at 4 or 8 ml/litre, and metsulfuron methyl at 0.05 g/lit (Table 2). Spraying of glyphosate at 4 ml/lit + carfentrazone at 4 mg/lit and 2, 4-D Na salt at 2.5 g/lit showed complete control of water hyacinth without regeneration and the control sustained up to 90 DAHS. There was no regeneration of water hyacinth in the application of post-emergence 2, 4-D Na salt (Yadav & Yadav, 2010).

Effect of herbicide combination on fish

Aquatic herbicides are not toxic to fish when applied according to label directions. Not following label directions can result in fish kills. Aquatic weeds killed by the herbicides often decompose rapidly. The decomposition process consumes oxygen and can reduce the amount of dissolved oxygen (DO) available to fish, particularly at night. If the dissolved oxygen concentration drops too low, fish kills can occur. No fish mortality in first week after herbicide treated tank was observed except only 10% mortality after 25 days which may be correlated with the decaying of weeds due to herbicide action. The pH increased 7.4 to 8.5 after herbicide treatment corresponding to area of glyphosate treatment. No change in dissolved oxygen (DO) was observed upto 5 days in tanks treated with herbicide but onwards it was decreased in herbicide treated tanks. Maximum decrease in DO was observed between 25 to 45 days in tanks where 100% area of water hyacinth surface was treated with herbicide. Generally, there was no mortality of fish with all the tested herbicides at various concentrations except spraying of glyphosate at 10 ml/lit + 2,4-D Na salt at 2.5 g/lit. In tanks having no weeds by treated with higher doses of paraquat at 8 ml/lit of water, glyphosate at 10 ml/lit + 2, 4-D Na salt at 2.5 g/lit, glyphosate at 10 ml/lit of water + carfentrazone at 4 mg/lit of water, metsulfuron methyl at 0.05 g/lit of water caused 0%, 10%, 0% and 0% fish mortality, respectively. This indicated reduction in water quality could be attributed to metabolic process and to the decomposing organic matter after water hyacinth death instead of direct effect of herbicides. No fish mortality was observed in ponds at Jabalpur when treated in larger area with recommended dose of glyphosate, 2,4-D and metsulfuron methyl to control lotus infestation (Sushilkumar *et al*., 2005). There afterwards there was no mortality of fish in this particular treatment. Metsulfuron methyl emerged as safest herbicides to control alligator weed in terms of weed control, fish and insect mortality and water quality (Sushilkumar *et al*., 2008). Dissolved oxygen levels can reach dangerously low concentrations for fish when large water hyacinth mats limit oxygen exchange decrease oxygen production by other plants and algae or when a relatively large area of plants decompose at the same time. Dissolved oxygen concentration less than 4.8 mg L^{-1} are considered detrimental to fish growth and concentrations less than 2.3 mg L^{-1} threaten juvenile and adult survival according to the US EPA water quality criteria for dissolved oxygen was reported by Cowx, 2003. In addition, weed mass killed by the herbicides may also

decrease oxygen in water and cause a secondary pollution harmful to fish (Kannan & Kathiresan 2002).

CONCLUSION

From the detailed documentation of various biological characters of water hyacinth it is clearly indicated that the mother plants grow very fastly from one week after inoculation upto six weeks after that the growth rate was decreased. Therefore it involved in seed maturation, senescence and ramet production but in case of ramets they emerged from third week onwards and also involved in fast growth up to six weeks because of this continuous growth process the multiplication of water hyacinth resulted in very high rate and cause enormous problems to environment. Tank culture experiment was conducted to evaluated the effect of different post-emergence herbicides and its combination on water hyacinth revealed that spraying of herbicide combination of glyphosate at 10 ml/lit + carfentrazone at 4 mg/lit reduced the dry weight of water hyacinth and had complete control on water hyacinth without any regeneration. There was no mortality of fish was observed with all the tested herhicides with different concentrations except spraying of glyphosate at 10 ml/lit + 2,4-D Na salt at 2.5 g/lit.

REFERENCES

Akinyemiju, O.A. and Bewaji, F.A. (1990) Chemical control of water hyacinth and associated aquatic weeds at Itoikin near Lagos. Proceedings of 8th EWRS Symposium on Aquatic Weeds, 1990: pp. 3-8**.**

Cowx, I.G. (2003) Interaction between Fish and Birds: Implication for Management Oxford. Fishing New Books, Malden.

Gomez, K.A. and Gomez, A.A. (2010) Statistical procedures for Agricultural Research, Wiley India Pvt. Ltd., New Delhi, India.

Gopal, B. (1987) Water hyacinth, Aquatic Plant. Elsevier Science Publishers, The Netherlands.

Gupta, O.P. (2001) Weed aquatic plants: their utility menace and management. Agrobios (India): 273.Holm LG, Pluckuett DL, Pancho JV, Herberger JP. 1991. The world's worst weeds; Distribution and biology. Krieger Publishing Company, Malabar, FL. 609.

Jadhav, A., King, A., Brudvig, R., Hill, M. and Byrne, M. (2007) Integrated weed control using a retardant dose of Glypjhosate: A new management tool for water hyacinth? Outlook on Pest Management-October 2007: pp 213-216.

Kannan, C. and Kathiresan, R.M. (2002) Herbicide control of water hyacinth and its impact on fish growth and water quality. Indian Journal of Weed Sci., 34 (1 & 2): pp. 92 - 95.

Singh, P.S and F. Muller. (1979) Efficacy, uptake and distribution different herbicides in the water hyacinth. Weed Sci., 23: 235-240.

Snedecor, G.W. and Cochran, W.G. Statistical Methods, Oxford and IBH Publ. Co., New Delhi, 1967, P. 593.

Sushilkumar, Kamlesh Vishwakarma, Puja Ray. (2008) Non target effect of herbicides on Neochetina spp., biological control agents of water hyacinth. Ind. J. of Weed Sci., 40 (3 & 4): pp. 200 - 202.

Sushilkumar, K., Vishwakarma. and Yaduraju, N.T. (2005) Chemical control of lotus (Nelumbo nucifera Gartn.) in fish culture pond and its impact on water quality. Ind. J. of Weed Sci., 37 (3 & 4): pp. 293 - 295.

Yadav, B. and Yadav. (2010) Chemical control of water hyacinth (*Eichhornia crassipes*) in Natural Water Bodies. Ind. J. of Weed Sci., 42 (3 & 4): pp. 246-248.