Indian J. Weed Sci. 37 (3 & 4) : 293-295 (2005) *Short Communication*

Chemical Control of Lotus (*Nelumbo nucifera* Gaertn) in Fish Culture Pond and its Impact on Water Quality

Sushilkumar, K. Vishwakarma and N. T. Yaduraju
National Research Centre for Weed Science
Maharajpur, Adhartal, Jabalpur-482 004 (M. P.), India

Lotus (*Nelumbo nucifera*) of family Nymphaceae is a rooted emerged weed, grown in ponds from India to Japan and also in Hawaii for ornamental and edible purpose. But in some other aquatic situations like fish culture ponds, lotus may act as a problematic weed. Ticku and Zutshi (1991) reported aquatic weed problem including lotus in Dal lake in Srinagar (Jammu & Kashmir). They recorded about 500 g of fish loss for every 100 kg of weeds due to removal by large scale non-selective weed harvesting using mechanical devices. Control of this weed by conventional, manual or mechanical method has limitations in addition to expensive cost. Herbicides may provide effective control but such studies have not been conducted in India in relation to effect on water quality and fish mortality.

The experiment was carried out during May to June 2002 in fish culture pond located at Jawaharlal Nehru Krishi Viswavidyalya (JNKVV), Jabalpur. The pond was used to culture fishes like *Labio rohita, Cirrhina mrigalla* and *Cyprinus carpio*. Initially, screening of three herbicides was done. The pond was divided at the surface into strips of dimension of 10 x 30 m at sufficient distance with each other with the help of thermocoal pads inserted in a nylon rope and fixed with the bamboo poles at the end. 2, 4-D (ethyl ester), glyphosate and metsulfuron-methyl were tested at 2.0, 2.0 and 0.012 kg ha^{-1}, respectively. The experiment was conducted in randomized block design with three replications. Spraying of herbicide was done with the help of pre-calibrated power fitted with adjustable nozzle mounted on the boat. By nature, lotus leaves are very smooth hence to enhance the efficacy of herbicides, 1% surfactant (Triton-20) was added into 2, 4-D and glyphosate, while ready-made surfactant supplied with metsulfuron-methyl was used. The data pertaining to weed count were recorded using 1 m^2 quadrate and per cent mortality data were subjected to arc sign transformation before statistical analysis. The water samples were taken randomly from treated and control area at 15 days after herbicides application. Glyphosate which was emerged as an effective herbicide in initial screening was sprayed in rest of the area of about one hectare and detailed study of its effect on water quality was done by taking water samples from treated and untreated area at 0, 1, 2, 3, 4, 7 and 15 days interval. The water quality parameters were determined by following A. O. A. C. methods (1970). In the treated area, regular observations were also taken on fish mortality.

Glyphosate and 2, 4-D being at par were significantly superior to metsulfuron-methyl. The effect of 2, 4-D was quick and was evidenced with the folding of lotus leaves 8 h after the treatment. Leaves became yellow, dried and fell on water at 1, 3 and 8 DAA and killed within 12-14 days, respectively. In glyphosate and metsulfuron-methyl treated lotus, yellowing, drying, felling and killing of lotus were observed at 3, 8, 12 and 15 and 8, 12, 16 and 20 DAA, respectively (Table 1). Glyphosate also killed about 98% lotus population when sprayed in large area.

All herbicides influenced the water quality in the pond (Table 1). The pH was significantly reduced in all the treatments over control but it was least affected by metsulfuron-methyl and maximum affected by glyphosate which was at par with 2,4-D. The dissolved oxygen (DO) was also affected significantly in all the treatments over control but it was greatly reduced by 2, 4-D followed by glyphosate and metsulfuron-methyl. Hardness of water was significantly reduced by metsulfuron-methyl but was not significantly affected by glyphosate and 2, 4-D than the control. The chloride

Table 1. Effect of different herbicides on lotus control (%) and on different parameters of water quality at 15 days

Herbicide	% Control and water quality parameters at 15 DAA					
	% Control	pH	Alkalinity	Hardness	Chloride	DO
Glyphosate (2.0 kg ha^{-1})	82.7 (97.8)	7.1	251	110	112.4	6.4
2, 4-D (2.0 kg ha^{-1})	77.52 (93.5)	7.3	249	120	132.9	5.6
Metsulfuron-methyl (12 g ha^{-1})	59.6 (73.9)	7.4	245	114	115.8	7.2
Control	-	7.8	255	116	105.6	8.6
LSD (P=0.05)	13.2	0.2	6.7	2.9	1.8	0.4

DAA–Days after application, Unit–Alkalinity, Hardness, Chloride, DO in ppm.
% Control values are transformed by arc sign. Original values are given in parentheses.

was significantly increased in 2, 4-D and glyphosate but was at par in metsulfuron-methyl with the control. It was found that most important parameters like pH and DO were least influenced by metsulfuron-methyl but it could not control the weed effectively at 12 g ha^{-1} dose. No fish mortality was observed in any of the area treated with different herbicides.

Detailed water quality study done after the glyphosate spray in large area revealed that pH was reduced at 0 day and did not change significantly upto seven days but it was increased and became at par with untreated area at 15 DAA. The DO was also reduced from 0 to 7 days but it was maximum at seven days, however, it was restored near to control at 15 DAA. The reduction in DO content in untreated area was also recorded at 7 DAA. The COD was increased in the treated area at 0 day and reached maximum at 7 DAA but afterwards it declined. The COD in control area also increased significantly at 4 DAA and afterwards (Table 2). This reduction in DO and increase in COD in untreated area might be because of disintegration of lotus in large area which would have also influenced the DO and COD due to mixing of water as there was no such barrier to check the flow of water from treated to untreated area.

Kannan and Kathiresan (2002) also observed reduction in pH and DO by paraquat (0.90 kg ha^{-1}), 2,4-D (1.00 kg ha^{-1}) and glyphosate (2.20 kg ha^{-1}) compared to the untreated control. Sushilkumar *et al.* (2004) also repoted more decrease in DO in 2,4-D treated tanks followed by glyphosate and metsulfuron-methyl. They found that water quality parameters were least influenced by metsulfuron-methyl while giving maximum control of alligator weed. In the present study, metsulfuron-methyl also least affected water quality than 2,4-D and glyphosate but the control of lotus was not satisfactory. They also noticed significantly high fish mortality in the tanks sprayed with glyphosate on alligator weed over the tanks having no weed and concluded that the fish mortality was not due

Table 2. Effect of glyphosate on different water quality parameters at different days after application

Water quality parameters	Water sampling at different days after application													
	0 day		1 day		2 days		3 days		4 days		7 days		15 days	
	T	C	T	C	T	C	T	C	T	C	T	C	T	C
pH	7.4	9.5	6.6	8.5	6.8	8.2	6.4	7.5	6.5	7.6	6.9	7.5	7.2	7.3
Alkalinity	293	295	290	290	295	296.6	295.6	303	295	306	296.6	296.6	296.6	296.6
Hardness	110	100	122	104	104.6	100	134	112	108	107	103.3	99.3	101.3	102
Chloride	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3	102.3
DO	3	5.8	2	3	2.1	3.9	2.0	3.0	1.8	3.6	1.3	2.6	5.3	5.6
COD	108	100	104	100	135	88	132	97	124	116	138.6	128.6	118.6	11.8

Given values are means of three replications, T–Treatment, C–Control.
Unit–Alkalinity, Hardness, Chloride, Dissolved oxygen (DO) and Chemical Oxygen Demand (COD) in ppm.

to direct effect of herbicide but it was due to the deterioration of weed biomass which severely affected DO of water owing to which fish death was high. In the present study, the reason of no mortality of fish in spite of spray of herbicide in large area may be that more than 60% area of the pond was still untreated. On deterioration of weed biomass, the fishes might have migrated to untreated area on declining of DO. This also suggests that in a severely infested aquatic body, spray of herbicides should be done in different pockets at different time intervals leaving sufficient untreated area.

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