Indian Journal of Weed Science **49**(1): 105–107, 2017
DOI: 10.5958/0974-8164.2017.00029.6

Short communication

Chemical control of duck weed and its effect on water quality and residue

Sushilkumar* and Shobha Sondhia
ICAR-Directorate of Weed Research, Maharajpur, Jabalpur, Madhya Pradesh 482 004

Received: 11 December 2016; Revised: 4 February 2017

Key words: Chemical control, Duckweed Glyphosate, Herbicides, Paraquat, Metsulfuron-methyl, Water quality

Aquatic plants are necessary in aquatic ecosystem for survival of various aquatic lives (fish, crustacean *etc*.) to satisfy their respiration need. Aquatic vegetation helps in reducing the pollution load of water bodies by absorbing several pollutants. But excessive growth of these plants may cause several problems also that are mainly related to hindering transportation, water supply, lowering in water quality, fishing, energy production besides proliferation of disease. *Lemna minor* L. commonly called duck weed refers to a group of lentil shaped, free floating plants of the family Lemnaceae, which forms green carpet on the water surface. Duckweed is commonly used for toxicity testing of pollutants in waste waters (Soukupova and Beklova 2010). Duckweed plants are fast growing and widely distributed. They are easy to culture and to test. Some reports suggest that duckweed plants are tolerant to environmental toxicity (Verma 2007**)**. *Lemna minor* represents a high growth rate and have been used for removal of heavy metals from polluted water bodies (Maine *et al.* 2001, Cardwell *et al.* 2002). In spite of beneficial aspects, it creates severe problems in respiration by clogging gills of fishes during fish culture. Small stagnated water bodies are favorite habitats of *L. minor*. Control of this weed by conventional manual and mechanical methods is most laborious, uneconomical and not suited for large water bodies, whereas biological control method has many limitations like lack of suitable natural enemies, culturing of agents, host specificity *etc*. Hence the chemical method appears quite suitable and cost effective to control duckweed. Although, no label claim is acclaimed for control of *Lemna minor* in India, application of oxadiargyl 450 mg/liter of water was found effective for controlling *L. minor* without showing any sign of harm to non-target organisms (Mandal and Nag 2014). Present study was conducted to evaluate most commonly used herbicides to control *L. minor* in wataer bodies in relation to its residue persistence and water quality.

***Corresponding author:** sknrcws@gmail.com

Experiment was carried out at ICAR-Directorate of Weed Research, Jabalpur during summer season of 2009 in 0.63 m^2 water tank. A 25 cm soil layer was maintained in the bottom of the water tank. FYM was added in the soil to increase soil fertility. Culture of *Lemna minor* was added in the tank. It was allowed to establish well for one month to form a mat over the water surface. The experiment was laid out in complete randomized design with three replications and consisted of 10 treatments, *viz*. paraquat 0.25, 0.50, 1.0 kg/ha, glyphosate 0.50, 1.0, 1.5 kg/ha and metsufuron-methyl (MSM) 0,008, 0.012, 0.016 kg/ha with unsprayed control. Spraying of herbicides was done on mat of *L. minor* with the help of knapsack sprayer fitted with flat fat nozzle using water 500 L/ha. Water samples were taken from treated and untreated water tanks before treatment and at 0, 1, 15 and 30 and 60 days after application. Water samples were filtered prior to extraction.

Metsulfuron-methyl residues were determined by high performance liquid chromatographic method using photodiode array detector. The method makes use of Phenomenex C–18 (ODS) column (250 x 4.6 mm) and acetonitrile: water (70 : 30 v/v) as mobile phase at a flow rate of 2 ml/min (Juhler *et al. 2001;* Sondhia 2009**).** Using these conditions, metsulfuron–methyl was eluted at Rt 2.08 minutes at wavelength of 220 nm. Water sample were extracted thrice by shaking in a horizontal shaker with 100 ml of dichloromethane for 2 hours. After extraction with dichloromethane, samples were subjected to florisil cleanup and passed through anhydrous sodium sulphate and makeup final volume in 5 ml (Bhattacherjee and Dureja 1998, Sondhia 2009). The recovery ranged of this method was between 63.4 to 85.6% in water.

Paraquat residues in water samples were determined by spectrophotometer following method of Sondhia and Gogoi 2005). Water samples were filtered (50 ml) through Whatman No.1filter paper. Pipetted 10 ml of water sample in to a test tube and added two ml of 0.2% sodium dithionite and mixed the solution by gently inverting the tube once or twice. The solution was placed in a 1.0 cm cell and recorded the absorbance at 396 nm **(**Kuntom *et al.* 1999**).**

For glyphosate residue determination, trifluroacetic acid (2 ml) and trifluroacetic anhydride (2 ml) were added to the residual material and refluxed in a water bath for 8 hours at 50-60 ^{0}C. Constituted final residue in 2 ml of methanol. Residues were subjected to cleanup by chromatographic column packed with 5 g of activated silica gel in between two layer of 2 g sodium sulphate. The sample was transferred to column and eluted with 50 ml of methanol. Elutes were collected and concentrated to 2 ml in a rotary vacuum evaporator and analyzed using photodiode array detector coupled with HPLC. A phenomenex C–18 (ODS) column (250 x 4.6 mm) and methanol: water (80 : 20 v/v) as mobile phase at a flow rate of 0.5 ml/min was used (Sondhia and Gogoi 2005**).** Using these conditions, glyphosate was eluted at Rt 2.3 at 215 nm. Recovery ranged between 60.2 to 78.5.6 in water. The physico-chemical analysis of water i.e. pH, DO, alkalinity etc. were measured as the methods developed by APHA, 2005 with appreciable degree of accuracy.

Effect of herbicides on weed

Application of paraquat 0.50 kg/ha, glyphosate 1.0 kg/ha and metsulfuron-methyl 0.008 kg/ha resulted in 100% control of *L. minor* in 15, 30 and 30 days, respectively. Paraquat (0.25 kg/ha) and glyphosate (0.5 kg/ha) reduced the growth of *L. minor* by 15th day but did not control the weed completely up to 30 days. The weed reoccupied the whole tank due to regrowth. Metsulfuron-methyl did not show effectiveness in all doses till 15 days but killed all the weed mat by 30 days in all the doses. Paraquat (0.5 and 1.0 kg/ha) controlled the maximum weed in seven days but completely cleared the water in 15 days. Glyphosate and metsullfuraon-methyl showed such effect in 25 to 30 days (**Table 1**).

Table 1. Control of duckweed (%), days after spray (DAS) of herbicides

Herbicide	Dose (kg/ha)	*Lemna minor* control efficiency (%) 7 DAS	15 DAS	30 DAS
Metsulfiron-methyl	0.008	40	60	100
	0.012	45	65	100
	0.016	45	70	100
Glyphosate	0.50	50	65	80
	1.00	50	80	100
	1.50	60	80	100
Paraquat	0.25	50	60	80
	0.50	90	100	-
	1.00	90	100	-

Effect on water quality

Water quality parameters like pH and dissolved oxygen were influenced with various treatment (**Table 2**). All treatments influenced the pH of treated water and also affected dissolved oxygen content. The pH of the water treated with paraquat, glyphosate and metsulfuron-methyl was slightly reduced after one day of spray, however, it was restored in due course. Before spray of herbicides, initial dissolved oxygen was low (4.0- 4.7) in all the tanks. Dissolved oxygen was decreased at 7, 15, 30 days in paraquat, metsulfuron-methyl and glyphosate treated tanks, respectively. This reduction in DO was observed when the weed was in decomposing process due to the effect of herbicides. Similar findings on the effect of herbicides on reduced water quality and fish mortality have been reported by Olaleye *et al.* (1993). Kannan and Kathiresan (2002) also observed reduction in pH and DO by paraquat (0.90 kg/ha), 2,4-D (1.00 kg/ha) and glyphosate (2.20 kg/ha) compared to the untreated control.

Table 2. Effect of herbicides on pH and dissolved oxygen after spray

Herbicide	Dose	pH Initial	pH 1 DAS	pH 15 DAS	pH 30 DAS	DO (ppm) Initial	DO 7 DAS	DO 15 DAS	DO 30 DAS
Metsulfiron-methyl	0.008	7.3	7.0	7.6	7.3	4.0	4.1	3.9	6.2
	0.012	7.2	6.9	7.5	7.2	4.3	4.2	348	6.9
	0.016	7.1	7.3	7.6	7.0	4.2	4.5	3.9	6.8
Glyphosate	0.5	7.2	6.9	7.0	6.6	4.3	4.3	4.2	6.6
	1.00	7.3	6.8	7.2	6.6	4.5	4.7	3.8	6.9
	1.50	7.3	7.0	6.8	6.5	4.5	4.1	3.9	6.8
Paraquat	0.25	7.5	7.2	7.3	7.0	4.4	4.2	6.5	7.2
	0.50	7.4	7.1	7.2	6.9	4.6	3.6	6.6	7.0
	1.00	7.4	7.1	7.0	6.8	4.3	3.8	6.4	6.7
	Control	7.3	7.2	7.2	7.1	4.7	6.7	6.8	6.6
LSD (p=0.05)	-	0.17	0.19	0.17	0.16	0.17	0.20	0.17	0.18

Residues of paraquat were found 0.11, 0.15 and 0.39 ppm at 0.25, 0.50 and 1.0 kg/ha applied dose at 0 day, which reduced to 0.001, 0.003 and 0.006 ppm, respectively at 60 DAS. Residue of MSM in higher dose (0.016 kg/ha) ranged from 0.56 at 0 day to 0.070 ppb at 60 DAS, but it could not be detected in lower dose at 0.008 kg/ha at 60 DAS. Glyphosate residues in higher dose (1.5 kg/ha) were ranged from 0.14 at 0 day to 0.017 ppm at 60 DAS, but it could be detected upto 60 DAS. Similar findings have also been reported by Sanyal (2006**).** Their study revealed that the half-lives of metsulfuron-methyl and chlorimuron-methyl ranged from 10.75 to 13.94 days irrespective of soils and doses applied. Field trials with rice, wheat and soybean also revealed that these two herbicides could safely be recommended for application as no residues were detected in the harvest samples.

Table 3. Detection of herbicides residues in water

Herbicide	Dose (kg/ha)	Herbicide residues* (days after spray)				
		0 DAS	1 DAS	15 DAS	30 DAS	60 DAS
Metsulfiron-methyl	0.008	0.330	0.230	0.110	0.039	ND
	0.012	0.550	0.390	0.120	0.081	0.05
	0.016	0.560	0.410	0.180	0.090	0.07
Glyphosate	0.5	0.035	0.024	0.017	0.013	0.004
	1.00	0.055	0.044	0.029	0.022	0.011
	1.50	0.140	0.120	0.083	0.057	0.017
Paraquat	0.25	0.110	0.800	0.300	0.090	0.001
	0.50	0.150	0.120	0.050	0.010	0.003
	1.00	0.390	0.31	0.150	0.110	0.006
LSD (p=0.05)	-	0.016	0.059	0.084	0.064	0.010

* Unit – All units in ppm except metsulfuron-methyl which are expressed in ppb

SUMMARY

An experiment was conducted to evaluate chemical control of duckweed (*Lemna minor*) and its effect on water quality and herbicide residue. Paraquat, glyphosate and metsulfuron-methyl (MSM) were applied in different doses on *Lemna minor* mat in water tank. Paraquat 0.5 kg/ha resulted in 100% control of *Lemna minor* in 15 days while metsulfuron-methyl (MSM) and glyphosate resulted 100% control in 30 days. Water quality in relation to dissolve oxygen and pH were affected by all treatments as compared to the untreated control. Low pH was found in all treated water tanks compared to untreated control. Residues of paraquat in water were 0.11 to 0.39 ppm at 0.25 to 1.0 kg/ha application rate at 0 day, which was reduced to 0.001 to 0.006 ppm at 60 days after application (DAA). Residues of MSM in higher dose (0.016 kg/ha) ranged from 0.56 at 0 day to 0.070 ppm at 60 DAA, but it could not be detected in lower dose at 0.008 kg/ha at 60 DAA. Glyphosate residue in higher dose (1.5 kg/ha) ranged from 0.14 ppm at 0 day to 0.017 ppm at 60 DAA.

REFERENCES

APHA [American Public Health Association]. 2005. *Standard methods for the examination of water and waste water*. Washington DC.

Cardwell A, Hawker D and Greenway M. 2002. Metal accumulation in aquatic macrophytes from south-east Qeensland, Australia. *Chemosphere* **48**: 653-663.

Juhler RK, Sorensen SR and Larsen L. 2001. Analyzing transformation products of herbicide residues in environmental samples. *Water Research and Application* **35**(6): 1371-1378.

Kannan C and R and Kathiresen M. 2002. Herbicidal control of water hyacinth and its impact on fish growth and water quality. *Indian Journal of Weed Science* **34**(1&2): 92-95.

Kuntom A, Kifli H and Tan YA. 1999. Method for determination of paraquat residue in oil matrix. *Journal of Oil Palm Research* **2**: 57-62.

Michel A, Johnson RD, Duke SO and Scheffler BE. 2003. Dose–response relationships between herbicides with different modes of action and growth of *Lemna paucicostata*: an improved ecotoxicological method. *Environmental Toxicology and Chemistry* **23**(4): 1074-1079.

Mandal B and Nag TS. 2014. Application of oxadiargyl solutions for control of duckweed (*Llemna* minor) in freshwater aquaculture ponds. *Indian Journal of Biological Sciences* **20**: 8-12.

Olaleye VF, Akintunde EA, Akintunde and Ahinyemiju A. 1993. Effect of herbicidal control of water hyacinth on fish composition and abundance in Kofawei Creek, Ondo State. *Journal of Environment Management* **38**: 85-97.

Sondhia S and Gogoi AK. 2005. *Methods for Herbicides Residue Analysis in Soil, Water and Food chain.* National Research Centre for Weed Science, 69 p.

Sondhia S. 2009. Persistence of metsulfuron-methyl in paddy field and detection of its residues in crop produce. *Bulletin of Environmental Contamination and Toxicology* **83**(6): 799-802.

Soukupova I and Beklova M. 2010. Validation of duckweed microbiological test for assessing hazardous substances. *Journal of Biochemical Technology* **2**(5): S60-S61.

Verma Y. 2007. Toxicity assessment of industrial effluents using duckweed bioassay. *Journal of Environmental Protection* **27**: 260-263.