Indian Journal of Weed Science 40 (3&4) : 200 - 202, 2008

Non-target effect of herbicides on *Neochetina* spp, a biological control agent of waterhyacinth

Sushilkumar, Kamlesh Vishwakarma and Puja Ray
National Research Centre for Weed Science, Maharajpur, Adhartal, Jabalpur (Madhya Pradesh)
E-mail : sknecws@gmail.com

ABSTRACT

Water hycienth is one of the worst weeds of water bodies in India. It is responsible for causing great loss to water by evapotranspiration besides blockage of water, loss to fish production and responsible for creating breeding sites for mosquitoes and other disease causing organisms. The host specific waterhyacinth weevils, *Neochetina bruchi* Hustache and *N. eichhorniae* Warner (Coleoptera: Curculionidae) are the most important biocontrol agents used against waterhyacinth with notable success in India. Bioagent if used alone takes longer time, hence integration of herbicide in the area of 15 to 25% of the weed mats at suitable interval is recommended. These herbicides may cause harmful effects on bioagent. Significant impact of herbicides was observed on the mortality of the weevils. When herbicide was sprayed on both the leaves and weevils, 3.3 % mortality was seen on all doses of glyphosate, paraquat and the lower (0.5x) dose of 2,4-D while higher dose (x) caused significantly high mortality of 20% by 24 hours. 2,4-D at a higher concentration caused 53% mortality followed by paraquat (50%) when herbicide was sprayed directly on weevils. Glyphosate caused the lowest mortality among the three herbicides tested.

Keywords: Non-target organism, Bioagent, Herbicides

Eichornia crassipes (waterhyacinth), a floating, aquatic weed of Neotropical origin disseminated very quickly to various parts of the world and is now one of the major problems of water bodies of tropics and subtropics. Its explosive growth rate and absence of its natural enemies contributed to its rapid proliferation as weed. Among various control measures there are physical, chemical, biological and utilization methods. Chemical methods have some one or other serious concern for implementation in water bodies in India. Integration of biological and herbicidal methods has been widely recommended (Haags 1986, Center, *et al*. 1999). The host specific waterhyacinth weevils, *Neochetina bruchi* Hustache and *N. eichhorniae* Warner (Coleoptera: Curculionidae) are the most important biocontrol agents used against waterhyacinth (Corodo 1999, Julien 2001) with notable success in India, Australia, South Africa and USA. Similarly chemical control which typically involves spray application of herbicides like glyphosate, 2,4-D, diaquat and paraquat are widely in use and cause relatively rapid decline in waterhyacinth weed mat. Some of the chemical formulations may have harmful effect on non-target organisms including the waterhyacinth weevils especially if integrated management of waterhyacinth is being attempted. Keeping this point in view, the present investigation was undertaken to find out the effect of commonly used herbicides on the *Neochetina* spp.

MATERIALS AND METHODS

Three of the most effective herbicides studied against waterhyacinth, i.e. glyphosate, 2,4-D and paraquat were selected to study their effect on the weevils of *Neochetina* spp. Each of the three herbicides were taken in two doses (0.5x and x where x is the normal recommended dose). The herbicides were sprayed in two ways, 1, the direct spray in which herbicide was sprayed only on the weevils and then they were fed on fresh unsprayed leaves, 2 and herbicide was sprayed on both leaves and weevils. 10 weevils were taken in each spray and all the treatments were replicated thrice. Control consisted of weevils and waterhyacinth leaves sprayed with tap water . The observations were taken at an interval of every 24 hours

for 96 hours to study the average mortality of the weevils due to the effect of herbicide.

RESULTS AND DISCUSSION

Significant impact of herbicides was observed on the mortality of the weevils. Highest mortality was found when the herbicides were sprayed on the weevils directly. When herbicide were sprayed on both the leaves and weevils (Table 1), 3.3 % mortality was seen on all doses of glyphosate, paraquat and the lower (0.5x) dose of 2,4-D while higher dose (x) caused significantly high mortality of 20% by 24 hours. At 96 hours highest mortality of 46.6% was seen in paraquat treated weevils followed by 2,4-D and glyphosate (20%). When herbicide was sprayed directly on weevils alone (Table 2), 2,4-D at a higher concentration caused 53% mortality followed by paraquat (50%). Glyphosate caused the lowest mortality among the three herbicides tested. Further it was noted that the weevils fed on paraquat treated waterhyacinth leaves showed a significant decrease in feeding followed by 2,4-D and glyphosate. This showed that the herbicides caused a decline in food quality and palatability of waterhyacinth tissue.

A similar study made on turtle beetle (*Cassida* sp. Nr *enervis* Boh), a biocontrol agent of alligator weed (*Alternanthera philoxerodies*) showed that the herbicides caused a significant mortality of the beetles in all concentration of herbicides. 2, 4-D caused higher mortality of adults while glyphosate caused the highest mortality of larvae corresponding with increase in concentration (Sushilkumar *et al*. 2003). Similarly paraquat was found to be highly toxic to the beetles *Zygogramma bicolorata*, a biocontrol agent of *Parthenium hysterophorus* (Jayanth and Bali 1993).

The present study showed that glyphosate is comparatively safer than the other two herbicides Even if the herbicide is not directly harmful to the weevils, damage may be caused particularly to eggs, larvae and pupae which live within the waterhyacinth plant tissue and cannot migrate away from plants that die and decay. The adult weevils which live on the surface of the plants appear to be capable of flight and migration only at certain time during their life span. Therefore, weevil population may be reduced drastically under field conditions as a secondary effect of spray programs. However, if choice of herbicide is there in waterhyacinth management program, glyphosate may be preferred over 2,4-D and paraquat.

Table 1. Percentage mortality of the weevils due to herbicide spray on leaves and weevils together

Herbicide	Dose (kg/ha)	% Average mortality of weevils at			
		24 hour	48 hour	72 hour	96 hour
2,4-D	1.5	3.3(8.8)	6.6(11.6)	10(1.8)	20(26.1)
	2.5	20(22.4)	23.3(27.3)	23.3(2.9)	30(32.2)
Glyphosate	1.5	3.3(8.8)	3.3(8.8)	13.3(1.9)	20(26.1)
	2.5	3.3(4.1)	3.3 (8.8)	16.6(2.8)	23.3(28.8)
Paraquat	0.5	3.3(8.8)	6.6(13.6)	26.3(3.1)	43.3(41.1)
	1.0	3.3(4.1)	13.3(18.6)	33.3(3.5)	46.6(42.9)
Control		0(4.1)	0(4.1)	3.3(0.8)	3.3(8.8)
LSD (P=0.05)		17.6	18.9	2.0	14.8

Values in the parenthesis are the arc sin transformed values of the original mean values.

Table 2. Percentage mortality of the weevils due to direct herbicide spray on weevils.

Herbicides	Dose (kg/ha)	% Average mortality of weevils at			
		24 hour	48 hour	72 hour	96 hour
2,4-D	1.5	3.3(8.8)	3.3(8.8)	16.6(21.3)	46.6(40.2)
	2.5	16.6(17.7)	23.3(25.2)	26.6(30.0)	53.3(47.7)
Glyphosate	1.5	0(4.1)	0(4.1)	10(16.3)	10(16.4)
	2.5	3.3(8.8)	3.3(8.8)	20(26.1)	20(26.7)
Paraquat	0.5	6.6(11.6)	6.6(11.6)	6.6(11.6)	6.6(11.6)
	1.0	10(16.4)	13.3(28.8)	50(45.0)	50(45.0)
Control		0(4.1)	0(4.1)	0(4.1)	3.3(8.8)
LSD (P=0.05)		20.9	18.0	18.8	30.5

Values in the parenthesis are the arc sin transformed values of the original mean values.

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