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Effect of Some Commonly Used Weedicides on the Parthenium Beetle *Zygogramma bicolorata* Pallister (Coleoptera : Chrysomelidae)

K.P.JAYANTH and GEETHA BALI*
Division of Entomology and Nematology
Indian Institute of Horticultural Research
Hessaraghatta Lake Post, Banagalore - 560 089

The neotropical plant *Parthenium hysterophorus* L. (Asteraceae) is a serious weed of agricultural fields, pastures and waste lands in most parts of India (Krishnamurthy *et al.*, 1977). The mexican beetle *Zygogramma bicolorata* Pallister (Coleoptera : Chrysomelidae), releases of which were initiated in 1984 (Jayanth, 1987), is proving to be a promising biological control agent in and around Bangalore (Jayanth and Geetha Bali, 1990). A number of weedicides have been recommended for the control of *P.hysterophorus* in India (Krishnamurthy *et al.*, 1977 ; Muniappa *et al.*, 1980; Challa, 1987). In situations where chemical methods are preferred, it would be ideal to use weedicides that are least harmful to *Z.bicolorata*. With this in view, the impact of some commonly used weedicides were tested for their safety to the beetle.

A total of 16 weedicides were used in the present studies (Table 1.) Among these, Killer-700, recommended for the control of parthenium in waste lands, is supposed to be a herb-based chemical, the formula of which has not been revealed by the manufacturer. Recommended field doses were chosen for the study and the formulated materials were diluted in water to get the desired concentrations. The weedicides were tested against the egg, larval, pupal and adult stages of the insect. The chemicals were applied with a chromatography sprayer in the form of a fine mist, to give a uniform coating without runoff. Five card strips measuring 5 x 2 cm, with 10 freshly-laid eggs pasted on each, were used for testing the susceptibility of the eggs. The treated eggs were separately placed in 7.5 x 2.5 cm glass vials and closed with cotton plugs and observations were carried out on egg hatching. For tests involving larvae and adults, the weedicides were applied either on the leaves topically or both on insects and leaves. The leaves required for larval and adult feeding were provided in the form of bouquets, with their cut ends introduced into small polythene covers after covering with a layer of moist cotton. This prevented the leaves from drying up during the three day observation period. After the treatment, the insects along with leaves were placed in small perforated polythene covers and their mouths secured with rubber bands to prevent the escape of insects. Observations on mortalities were recorded 1, 2 and 3 days after treatment.

For tests with pupae, dry soil was collected in polythene covers and compressed to a 7 cm column and sufficient quantity of water was added to moisten the whole soil column. Ten fully grown larvae were then released into each of the covers and the openings closed with rubber bands. After 2 days, the number of insects that burrowed into the soil were counted and the remaining ones discarded. On the fifth day the soil surface was uniformly drenched with the weedicide using a chromatography sprayer. The emerging adults, from each of the cages with weedicide-treated pupae, were collected and

* Department of Zoology, Bangalore University Bangalore 560 056.

Table 1. Effect of weedicides on eggs and larvae of *Z.bicolorata*

Chemical name	ppm *	% Mortality			
		Eggs#	Larvae (72h)		
			Leaf treatment	Topical application	Topical + Leaves
Pre-emergent					
Alachlor	2000	12.12	6.00	2.00	10.00
Butachlor	2000	72.74	0.00	2.00	16.00
Fluchloralin	1000	54.55	0.00	4.00	6.00
Fluchloridone	2000	66.67	6.00	2.00	10.00
Oxadiazon	1000	69.70	4.00	8.00	16.00
Pendimethalin	1000	72.73	10.00	4.00	10.00
Trifluralin	2000	90.91	2.00	2.00	8.00
Pre-/Post-emergent					
Atrazine	3000	96.97	30.00	0.00	32.00
Diuron	2500	84.85	10.00	4.00	16.00
Fluazifop-butyl	750	100.00	0.00	32.00	66.00
Glyphosate	4000	63.64	0.00	8.00	18.00
Metribuzin	2000	96.97	2.00	0.00	18.00
Thiobencarb	1000	100.00	4.00	6.00	18.00
Post-emergent					
Killer-700	-	16.67	0.00	18.00	24.00
Na. salt of 2, 4-D	4000	96.97	0.00	0.00	8.00
Paraquat	2000	90.91	52.00	50.00	100.00
	C.D. 1% =	20.89	13.64	13.34	11.79

* 1000 ppm equivalent to 1.00 kg a.i. /ha
# Abbot's correction applied
Means followed by the same letters are not significantly different

placed in separate cages with food and kept under observation. The studies were carried out in the laboratory at 25.51 ± 0.88°C and 65-87% R.H. with five replications, maintaining an untreated check. The data were transformed to arc sine $\sqrt{\text{percent}}$ for statistical scrutiny.

Alachlor and killer-700 were found to be less toxic to the egg stage, causing 12.12% and 16.67% mortality respectively, which were comparable to that obtained in control. All other chemicals induced mortalities above 54% (Table 1). The most toxic chemicals were fluzifop-butyl and thiobencarb, which caused 100% mortality, followed by atrazine and sodium salt of 2,4-D causing 96.97% mortality. No weedicide can, however, be considered safe against the egg stage. Any weedicide that kills the plants will also kill the larvae that hatch from eggs, since the newly hatched larvae cannot migrate in search of food.

Normal feeding by larvae was observed in the case of all pre-emergent weedicides. Feeding was found to be poor in the case of paraquat and moderate in treatments with atrazine, diuron, metribuzin and sodium salt of 2,4-D. As maximum mortality was obtained in most treatments after 72 hours, the percentage mortality obtained after 72 hours alone is presented in Table 2. When non-treated larvae were allow to feed on treated leaves, butachlor, fluazifop-butyl, glyphosate, sodium salt of 2, 4-D and killer-700 were found to be absolutely safe. Atrazine and paraquat were highly toxic, causing 30% and 50% mortality, respectively. Significant differences were not observed bet ween pre- and post-emergent chemicals in their lethal action. In the case of topical application,

Table 2. Effect of weedicides on pupae and adults of *Z.bicolorata*

Chemical name	Treatment of pupae		Treatment of adults		
	Pupal mortality	% Adult emergence	Leaf treatment	Topical application	Topical + Leaves
Pre-emergent					
Alachlor	6.00	0.00	0.00	4.00	8.00
Butachlor	4.00	0.00	0.00	0.00	18.00
Fluchloralin	12.00	63.00	0.00	0.00	6.00
Fluchloridone	6.67	2.23	0.00	0.00	0.00
Oxadiazon	8.45	13.97	0.00	6.00	8.00
Pendimethalin	30.45	69.62	0.00	4.00	6.00
Trifluralin	8.00	17.83	0.00	0.00	2.00
Pre-/Post-emergent					
Atrazine	58.00	41.00	4.00	0.00	2.00
Diuron	7.94	20.07	4.00	0.00	10.00
Fluazifop-butyl	8.00	0.00	0.00	22.00	70.00
Glyphosate	10.00	0.00	0.00	0.00	6.00
Metribuzin	35.45	12.39	4.00	0.00	10.00
Thiobencarb	31.11	70.09	0.00	6.00	28.00
Post-emergent					
Killer-700	15.38	2.00	0.00	0.00	0.00
Na. salt of 2, 4-D	19.11	23.57	0.00	0.00	8.00
Paraquat	16.22	70.95	20.00	100.00	100.00
C.D. 1% =	20.98	11.45	9.06	9.65	14.55

Means followed by the same letters are not significantly different.

all pre-emergent and pre-/post-emergent chemicals, except for fluazifop-butyl and sodium salt of 2, 4-D among post-emergents were found to be safe. All chemicals were found to be significantly toxic to larvae, when applied topically. All the pre-emergent chemicals were only moderately toxic. The most toxic chemical was paraquat, which inflicted 100% mortality, followed in the descending order by fluazifop-butyl (66%), atrazine (32%) and killer-700 (24%).

In the pupal stage butachlor was found to be the safest chemical causing 4% mortality, which was comparable to the natural mortality level (Table 2). The most toxic weedicide was atrazine (58%), followed by metribuzin (35.45%), thiobencarb (31.21%) and pendimethalin (30.45%). Four of the weedicides, *viz.,* alachlor, butachlor, fluazifop-butyl and glyphosate were completely safe to the adults emerging from the treated pupae, while fluchloridone and killer - 700 caused insignificant mortality. The rest of the chemicals caused significantly higher mortality. Paraquat, which caused 70.95% mortality within one week after adult emergence, was found to be the most toxic, followed by thiobencarb (70.09%), pendimethalin (69.62%) and fluchloralin (63%).

As in the case of the larval stage, adult beetles were also found to feed normally on treated leaves. Mating and oviposition were also observed. In the case of diuron and metribuzin, adult feeding was found to be less, while mating and feeding were also not observed in the case of paraquat. All chemicals except atrazine, divron, metributin and paraquat were found to be absolutely safe for the adults in leaf treatment. Among the chemicals that caused mortality, paraquat was the most toxic (20%). By topical application, paraquat was the most toxic (100%) followed by fluazifop-butyl (22%). A combination of topical and leaf application was found to be more potent in killing adults as compared to separate leaf or topical application. The most toxic chemical was again paraquat (100%), followed by fluazifop-butyl (70%) and thiobencarb (28%).

The present studies showed that alachlor, butachlor and fluchloridone can be recommended for use as pre-emergent weedicides without affecting the pupae or diapausing adults within the soil for the control of winter generation plants. Similarly, sodium salt of 2, 4-D and glyphosate followed by killer - 700 are safer chemicals that can be used as post-emergents on parthenium without affecting the insects.

In areas where the insects are only partially effective or have not yet reached their full potential, application of weedicides that are non-toxic to *Z.bicolorata* may be a useful means of bringing down weed densities, so that the insects can act on the low population of the weed present. Reduction in weed density can also be obtained by using weedicides to kill overwintering plants between December and May, when *Z.bicolorata* adults remain under diapause. Application of any of the safer chemicals identified during the present study can prevent mortality to the adults diapausing within the soil.

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KEY-WORDS : *Zygogramma bicolorata, Parthenium hysterophorus,* biological control, weeds, effect of weedicides

REFERENCES

CHALLA, P. 1987. Chemical weed control in grape (*Vitis vinifera* L.) nurseries. *Pesticides*, **21**, 27-29.

JAYANTH, K.P. 1987. Introduction and establishment of *Zygogramma bicolorata* on *Parthenium hysterophorus* at Bangalore, India. *Curr. Sci.*, **56**, 310-311.

JAYANTH, K.P. and GEETHA BALI 1990. Evaluation of the efficacy of *Zygogramma bicolorata* in suppressing *Parthenium hysterophorus* at a field release site in Bangalore. Paper presented at *National Symposium on Conservation and Management of living Resources,* Univ. Agric. Sci., Bangalore.

KRISHNAMURTHY, K., RAMACHANDRA PRASAD, T.V., MUNIYAPPA, T.V. and VENKATA RAO, B.V. 1977. Parthenium, a new pernicious weed in India. Technical Series No. 17, Univ. Agric. Sci., Bangalore.

MUNIYAPPA, T.V., RAMACHANDRA PRASAD, T.V. and KRISHNAMURTHY, K. 1980. Comparative effectiveness and economics of mechanical and chemical methods of weed control of *Parthenium hysterophorus* Linn. *Indian J. Weed Sci.*, **12**, 137-144.