Impacts of selected pesticides on parthenium beetle, *Zygogramma bicolorata* pallister under laboratory conditions in Sri Lanka

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1. Introduction

Parthenium (*Parthenium hysterophorus* L.) is one of the Asteraceae family's most vicious herbaceous weeds. It emerged as the most significant invasive weed of the planet and has invaded 98 countries representing all the continents. Presence of toxic phytochemicals and allelochemicals like parthenon and coronopilin in Parthenium causes severe yield loss on economically important crops as well as poses threat to biodiversity, human and animal health. Among the management practices, chemical, physical, regulatory, fire, mycoherbicides, agronomic practices, competitive displacement, and traditional biological control are the options available for managing parthenium (Dhileepan *et al.*, 2009). Manual and chemical weed control are effective in agricultural fields to control parthenium, but not cost-effective in pastures, vast natural areas, or wastelands. By implementing an integrated pest management practices involving multiple tactics n combination can effectively control Parthenium weed (Dhileepan *et al.*, 2009). Parthenium beetle (*Zygogramma bicolorata*) is found to be a safe biocontrol agent, and its effectiveness has proven in many countries.

Adults and larvae of *Z. bicolorata* feed on parthenium causes meristem damage, resulting in a shorter primary stem and a different branching pattern, defoliation, decreased plant height and flower production. Even when there was no water stress, and plants will die when the plants were defoliated early in their growth cycle (Dhileepan *et al.*, 2000). The success of a biocontrol agent in a natural system is determined over time by biotic and abiotic factors. Recent researches claim that pesticides cause natural enemy mortality which leads to disrupting the equilibrium between pest species and their natural enemies. Therefore, this research study was conducted with the objective of examining the impacts of various pesticides on Parthenium beetle.

2. Materials and Methods

The research was conducted in the quarantine greenhouse at the Department of Agricultural Biology, Faculty of Agriculture, University of Jaffna, situated in dry zone of Sri Lanka (Longitude: 80.4, Latitude: 9.32, Altitude: 46m). Parthenium beetles were detected and collected first time in Northern Sri Lanka and brought to the Biocontrol Laboratory at the Department of Agricultural Biology, and fed with fresh parthenium grown in the insect rearing cages kept in the quarantine greenhouse. Parthenium beetles were adopted well and multiplied quickly under in-vitro condition.

Ten parthenium seeds were sown into 10L pots and the growth of the weed was monitored. At the two leaf-stage, excess weeds were thinned-out and only two parthenium per pot were allowed for further growth. The weed started flowering four weeks after sowing, and at that time, even aged parthenium beetles (10 beetles/plant) and grubs (10 grubs/pant) were released in all 40 cages (10 treatments and three replicates including untreated control) in the late evening (6.00pm) and allowed whole night (14 hours) for settlement.

The pesticides consisting of fungicides, herbicides and insecticides which are commonly used by the small and commercial farmers were selected (Table 1). Pesticides application was done carefully using a hand sprayer at the recommended dosage in an early morning.

Feeding behaviour, mobility and mortality of the beetle and grub population were observed and calculated, respectively. The data were subjected to ANOVA using SAS 9.1. Tukey's HSD multiple comparison test was used to determine the best treatment combination at $P < 0.05$

Table 01. Pesticides used and its rate used for experiment.

Treatments	Pesticide	Chemical name	Recommended dose (for 10 l)
T_1	Fungicide	Mancozeb 80% (w/w) WP	20 g
T_2	Fungicide	Chlorothalonil 500 g/l SC	30 ml
T_3	Fungicide	Propineb 70% (w/w) WP	20 g
T_4	Herbicide	MCPA 600 g	50 ml
T_5	Herbicide	Oxyfluorfen 200 g/l EC	16 ml
T_6	Herbicide	Glufosinate Ammonium 150 g/l SL	94 ml
T_7	Insecticide	Carbosulfan 200 g/l SC	30 ml
T_8	Insecticide	Abamectin 18 g	06 ml
T_9	Insecticide	Pymetrozine 50% (w/w) WG	05 g

3. Results and Discussion

The results of the impact of different types of pesticides on parthenium beetles and their life stages are explained below. Four hours from the application, adult beetles and grubs were found settled but failed to feed for six hours. In the fungicide applied treatments (Fig. 1) adult's and grub's mortality were significantly higher at P <0.05. The grub's mortality was 60% in Chlorothalonil 500 g/l SC treated cages whereas in Mancozeb 80% WP and Propineb 70% WP treated trials, mortality was 40% and 25% respectively. The adult's mortality was 20% in Chlorothalonil 500 g/l SC and Propineb 70% WP treated trials, but no deaths were observed in Mancozeb 80% WP treated trials.

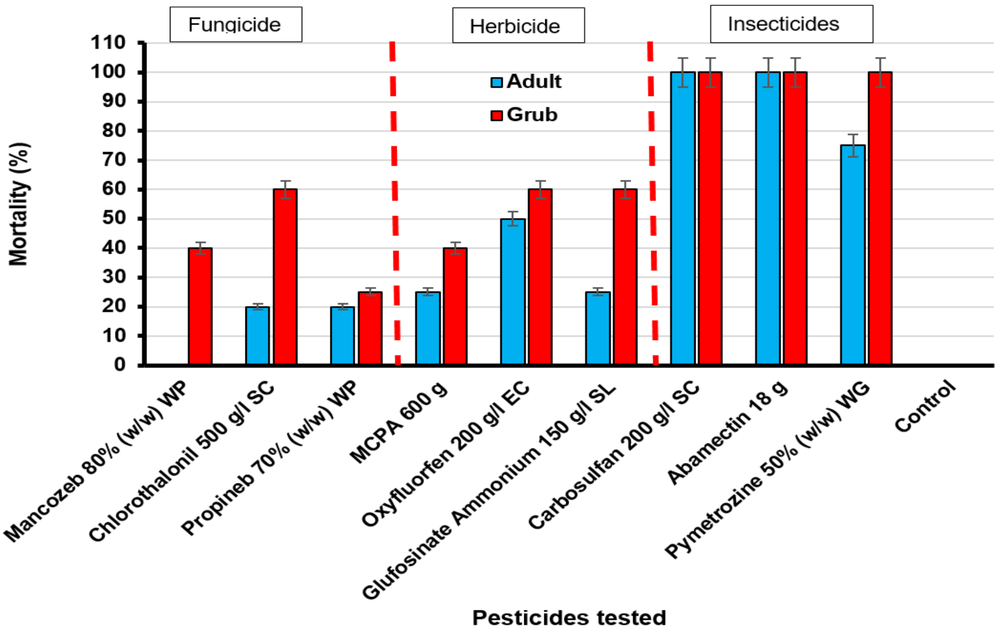

Figure 1. Mortality of life stages of Parthenium beetle due to the application of pesticides

In the herbicide applied trials (Fig. 1) adult's and grub's mortality were significantly higher compared to control at P <0.05. The grub's mortality was 60% in Glufosinate Ammonium 150 g/l SL and Oxyfluorfen 200 g/l EC treated cages whereas in MCPA 600g treated trails, mortality was 40%. The adult's mortality was 50% in Oxyfluorfen 200 g/l EC treated trials, but the death rate was only 25% in MCPA 600g and Glufosinate Ammonium 150 g/l SL treated trials. In the insecticide applied trials (Fig. 1), grub's revealed 100% mortality to all the insecticides tested compared to control at P <0.05. The adult's mortality was only 60% in Pymetrozine 50% (w/w) WG whereas in other two insecticides mortality was 100%.

Overall, insecticides showed an extremely high impact on the survival and existence of the Parthenium beetle population. According to the overall Tukey's HSD multiple comparison test results depicted that insecticides Carbosulfan 200 g/l SC, Abamectin 18 g and Pymetrozine 50% (w/w) WG are highly significant on grub mortality whereas Carbosulfan 200 g/l SC and Abamectin 18 g on adult mortality at P < 0.01.

To control weeds, a compatible combination of biological and pesticide approaches is recommended and not applicable if pesticides are toxic to the biocontrol agent (Hasan and Ansari, 2016). Control of parthenium plants using *Z. bicolorata* under various environmental conditions is being very successful. Due to the indiscriminate use of highly toxic synthetic herbicides and being the major polluting agents of the environment especially soil and water in Sri Lanka, the government has banned two potential herbicides paraquat in 2014 and glyphosate in 2017 (limited use allowed in 2019) (Marambe and Herath, 2020). Therefore, biological control of weed is highly being promoted in Sri Lanka. Parthenium beetle was first time recorded in Sri Lanka in 2019 (Pakeerathan, 2019), and observed that rarely available and eating parthenium in agricultural lands and was abundant in non-cultivated Parthenium grown fields. It was suspected that it may be the reason for the intensive use of pesticides. Therefore, the current study was planned, and it confirmed that the insecticides are highly dangerous to beneficial biocontrol agent *Z. bicolorata*

Hasan and Ansari (2017) reported that acute toxicity of insecticides monocrotophos and imidacloprid caused the highest mortality on third instars and extended the development time of treated larvae of parthenium beetle. Monocrotophos interfered severely on fecundity and egg viability of the Parthenium beetle. Siddhapara *et al.* (2012) reported that insecticide chlorpyriphos 0.05%, atrazine 1 kg per ha, thiomethoxam 0.005%, glyphosate 1 kg per ha, metribuzin 1 kg per ha, and imidacloprid 0.005% per cent were most toxic to the grubs and adults in comparison to Endosulfan 0.075% and dimethoate 0.03% were moderately toxic to the grubs and adults and adults, respectively. Herbicide 2, 4-D sodium salt 1 kg per ha was found to be least toxic to the larvae and adults of *Z. bicolorata*. Moreover, Hasan and Ansari (2016) found that herbicides 2,4-D and alachlor are highly toxic to 3rd instar larva. These findings validate the current findings. Therefore, careful selection of pesticides is extremely important to safeguard the potential biocontrol agents

4. Conclusions

Among the pesticides tested insecticides Carbosulfan 200 g/l SC, Abamectin 18g showed highest mortality to the grubs and adult beetles, even at the recommended dose. In the field there are more chances of beetles to escape from one area to another, therefore to know the real impact of pesticides on various life stages of *Z. bicolorata* Further field trials are needed for recommendation.

5. References

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