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MANAGEMENT OF MAIZE STEM BORER *CHILO PARTELLUS* SWINHOE (LEPIDOPTERA: PYRALIDAE) USING SELECTED PLANT POWDERS WITH INSECTICIDAL PROPERTIES

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ABSTRACT

Stem borer (*Chilo partellus)* is one of the serious pests of maize in Sri Lanka. At present, this pest is managed through foliar application of liquid or granular formulations of recommended insecticides. The use of insecticides can be environmentally disruptive and can result in reducing beneficial insects and accumulation of residues in the harvested produce. In order to develop safer control methods, field studies were conducted during *Maha* 2014/15 and *Yala* 2015 to evaluate the efficacy of crude powders of locally available plants against maize stem borer. Experiments were laid out in a randomized complete block design with four replicates. The treatments tested were leaf powder of *Ocimum* spp., *Lantana camara*, *Tagetes* spp. and seed powder of *Azadirachta indica.* These treatments were compared with the recommended Diazinon 5G and an untreated control. The variety MI maize hybrid 1 was used. Plant powders and Diazinon were applied twice as whorl applications at 3 and 5 weeks after planting at a rate of 15 kg/ha (except neem at 5 kg/ha). During *Maha* 2014/15, at 8 weeks after planting, the percentage damaged plants in the plots treated with plant powders ranged from 17 to 27 % while the damaged plants in the untreated plot was 40 %. During *Yala* 2015, at 8 weeks after planting, all the plants treated with plant powders except those treated with *Tagetes* spp. showed significantly lower percentage of damage (21-23 %) compared to untreated control (36 %). Diazinon 5G was superior in reducing stem borer damage during both seasons. Larval population and severity of stem borer damage were also significantly lower in *Ocimum* spp., L.

***camara*, A. *indica* and Diazinon treated plots compared to the untreated control during both seasons. Results also showed that application of crude powders of these three plants increased the maize grain yields by 43-45 % and 24-27 % compared to the untreated control during *Maha* 2014/15 and *Yala* 2015, respectively.**

Keywords: *Azadirachta indica*, *Chilo partellus*, *Lantana camara*, maize stem borer, *Ocimum* spp.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops grown in Sri Lanka. The area under maize in Sri Lanka is about 67,219 ha and annual production was about 240,588 t in 2014 (Agstat, 2015). Maize is used directly as food, livestock feeds and raw material for numerous industrial purposes. However, maize stem borer (MSB), *Chilo partellus* (Swinhoe) causes a serious damage to maize production. Severe infestation of MSB at seedling stage may result a total failure of the crop (Khan *et al*., 1999). Maize stem borer starts to infest the crop at 3 to 4 weeks after planting and continue up to maturity stage (Subasinghe and Amarasena, 1988). Larvae attack all parts of the maize plant except roots. It feeds on young leaves and later bore into the stem, tassels, stalks and ears of the maize plants (Alejandro, 1987; Khan and Amjad, 2000).

The management of this pest mainly rely on insecticides applied as foliar spray (Novaluron 10EC, Thiodicarb 375SC, Etofenprox 10EC) as well as granular formulations (Diazinon 5G, Fipronil 0.3G) (Anon, 2015). The use of insecticides can be environmentally disruptive and can result in reducing beneficial insects and accumulation of residues in the harvested produce. Therefore, it is necessary to find alternative control methods which are as effective as pesticides, and without causing harmful impacts to environment. Use of natural products from plant origin is progressively becoming recognized as a potential option. Certain plant families are rich in natural substances with insecticidal properties that could be utilized in the development of safe and alternative methods for pest control (Wheeler and Isman, 2001).

Various field studies conducted have identified several bio-intensive pest management options including ashes, crude plant powders and plant extracts that can be used for the control of different species of field and storage insect pests of maize (Ogendo *et al.*, 2003; Maribet and Aurea, 2008; Yacoub, 2011; Shiberu, 2013). However, information on the local research conducted on botanicals used for MSB control is not available. Therefore, considering the importance of eco-friendly approaches to manage MSB, field studies were conducted at the Field Crops Research and Development Institute (FCRDI), Mahailluppallama during Maha 2014/15 and Yala 2015 to evaluate the efficacy of plant powders from locally available plant species, *Ocimum* spp., *Lantana camara*, *Tagetes* spp. and *Azadirachta indica* against MSB.

MATERIALS AND METHODS

The experiment was conducted in *Maha* 2014/15 and *Yala* 2015 adopting randomized complete block design with 4 replicates. Seeds of variety "MI maize Hybrid 01" were sown at a spacing of 60 × 30 cm in plots measuring 4.2 × 3 m. All the cultural practices recommended by the Department of Agriculture for maize cultivation were followed. The following plant powders were tested at the given rates along with the treated (Diazinon 5G - @15 kg/ha) and untreated control (Table 1).

Table 1. Tested plant powders against maize stem borer during *Maha* 2014/15 and *Yala* 2015 and their rate of application

Common name	Scientific Name and family	Parts used	Rate of application
Basil	*Ocimum spp* (Lamiaceae)	Leaves	15 kg/ha
Lantana	*Lantana camara* (Verbenaceae)	Leaves	15kg/ha
Marigold	*Tagetes spp.* (Asteraceae)	leaves	15 kg/ha
Neem	*Azadirachta indica* (Meliaceae)	Seeds	5 kg/ha

The plant samples were collected from research fields at Mahailluppallama and dried under shade for one week. The dried leaves and seeds were ground using a grinder and were sieved through a 0.5 mm pore size mesh to obtain uniform particles. Plant

powders and insecticides were applied twice as whorl applications at 3 and 5 weeks after planting.

Percentages of MSB damaged plants were recorded before the application of plant powders and insecticides and at 4 and 8 weeks after planting. Number of stem borer larvae and pupae in 10 randomly selected plant stems was recorded at 8 weeks after planting. Severity of leaf damage was rated using the following scale developed by Guthrie *et al*. (1960) (Table 2).

Table 2. Severity scale of leaf feeding damage by MSB

Scale	Description
1	No visible leaf injury or a small amount of pin or fine shot hole type injury on a few leaves
2	Small amount of shot hole type lesions on a few leaves
3	Shot hole injury common on several leaves
4	Several leaves with shot hole & elongated lesions
5	Several leaves with elongated lesions
6	Several leaves with elongated lesions about 2.5cm long
7	Long lesions common on about half of the leaves
8	Long lesions common on about 2/3 of leaves
9	Long lesions in more than 2/3 of leaves

Severity index was calculated by using the following equation and the grain yield was recorded at the harvesting stage.

$$P = \Sigma (v. n) / N.Z \times 100$$

P = Severity index v = Score value n = Number of plants having same score

N = Total number of plants observed Z = Maximum scale number

Data analysis was done using Analysis of Variance and means were compared using the Duncan's Multiple Range Test. Data on percentages and counts were subjected to appropriate transformation before performing the Analysis of Variance.

RESULTS AND DISCUSSION

The percentage of stem borer damaged plants was not significantly different among the treatments before application of plant powders and insecticides (Table 3). The percentage of stem borer damaged plants in the plots treated with different plant powders and untreated control varied from 14 to 20 % while the damage in the Diazinon 5G treated plots was 1.8 % at 4 weeks after planting during *Maha* 2014/15. At 8 weeks after planting, the percentage damaged plants in the plots treated with different plant powders varied from 17 to 27 % while the damaged plants in the untreated plot was 40 %. The lowest damage (4 %) was recorded in the plots treated with Diazinon 5G.

During *Yala* 2015, at 8 weeks after planting all the plots treated with plant powders except *Tagetes* spp. (Marigold) and Diazinon treated plots showed significantly lower percentage of damaged plants compared to untreated control (36 %). Diazinon 5 G found to be superior in reducing stem borer damage during both seasons.

Table 3. Percentage of maize stem borer damaged plants treated with indicated plant powders and Diazinon 5G during *Maha* 2014/15 and *Yala* 2015 at Mahailluppallama

Treatment	% Damaged plants*					
	Maha 2014/15			Yala 2015		
	Before app.	4 WAP	8WAP	Before app.	4 WAP	8WAP
Basil	1.79	19.9a	21.5bc	1.4	16.8c	24.0b
Lantana	1.43	14.9a	17.4c	1.8	17.9bc	21.5c
Marigold	1.79	23.0a	27.8b	1.4	24.0ab	32.1ab
Neem	1.43	15.8a	21.2bc	1.8	21.2bc	21.2c
Diazinon 5G	1.79	1.8b	4.3d	1.4	7.8d	7.8d
Untreated Control	1.43	20.5a	40.4a	1.4	30.7a	36.5a
CV %	ns	20	14	ns	10	12

*Means in a column followed by the same letter are not significantly different at α=0.05, ns – not significant

The larval and pupal populations in 10 plants stems were significantly lower in *Ocimum* spp., L. *camara*, *A. indica* and Diazinon 5G treated plots compared to that in the untreated control in both seasons (Table 4). This could be because of the insecticidal effect, repellent or anti-feedant activity of these plant powders. The percentage reduction of stem borer population ranged from 28-59 % and 38-51 % in plant powders treated plots and 77 % and 74 % in Diazinon 5G treated plots over the control plot during *Maha* 2014/15 and *Yala* 2015, respectively.

Table 4. Effect of different plant powders and Diazinon 5G on number of larvae and pupae in 10 plant stems during *Maha* 2014/15 and *Yala* 2015 at Mahailluppallama

Treatment	Number of larvae and pupae in 10 plant stems *	
	***Maha* 2014/15**	***Yala* 2015**
Basil	13.7bc	.29.0b
Lantana	11.2cd	26.5b
Marigold	19.7ab	34.0b
Neem	12.2cd	28.2b
Diazinon 5G	6.25d	14.0c
Untreated Control	27.7a	54.5a
CV%	16	10

*Means in a column followed by the same letter are not significantly different at α=0.05

The severity of stem borer damage was significantly low in plant powders of *Ocimum* spp., *L. camara*, *A. indica* and Diazinon 5G treated plots compared to the untreated plot during both seasons (Table 5).

Table 5. Efficacy of different plant powders and Diazinon 5G on severity of stem borer damage during *Maha* 2014/15 and *Yala* 2015 at Mahailluppallama

Treatment	Severity Index*	
	***Maha* 2014/15**	***Yala* 2015**
Basil	20.80b	22.65bc
Lantana	20.00b	20.75c
Marigold	37.73a	30.50ab
Neem	18.08b	20.28c
Diazinon 5G	13.03b	13.33c
Untreated Control	43.08a	38.80a
CV%	24	24

*Means in a column followed by the same letter are not significantly different at α=0.05

All the plant powders except *Tagetes* spp. (Marigold) treated plots and Diazinon 5G treated plots gave significantly higher yields than the untreated control plots during Maha 2013/14. However, there was no significant difference in yield between plant powders treated plots and untreated control during Yala 2015. Application of crude powders of *Ocimum* spp., L. *camara*, *A. indica* increased the maize grain yields by 43-45 % and 24-27 % compared to the untreated control during *Maha* 2014/15 and *Yala* 2015, respectively. The diazinon 5G applied plots increased the grain yield by 63 % and 51 % compared to the untreated control during *Maha* 2014/15 and *Yala* 2015, respectively (Table 6).

Table 6. Efficacy of different plant powders and Diazinon 5G on seed yield of maize during *Maha* 2014/15 and *Yala* 2015 at Mahailluppallama

	***Maha* 2014/15**		***Yala* 2015**	
Treatment	**Seed yield* (t/ha)**	**% yield increase over the control**	**Seed yield (t/ha)**	**% yield increase over the control**
Basil	3.13a	43	3.49ab	27
Lantana	3.15a	44	3.41ab	24
Marigold	2.85ab	30	3.26ab	19
Neem	3.18a	45	3.43ab	25
Diazinon 5G	3.59a	63	4.16a	51
Untreated Control	2.19b	-	2.74b	-
CV%	16		18	

*Means in a column followed by the same letter are not significantly different at α=0.05

CONCLUSIONS

Maize plants treated with crude, dry powders of *Ocimum* spp. (@15 kg/ha), L. *camara* (@15 kg/ha) and *A. indica* (@5kg/ha) showed significantly low stem borer incidences, pest populations and higher yields as compared to those received no treatment. The plants treated with Diazinon 5G had the lowest stem borer damage and highest yield. Therefore, crude powders of these plants can be used as alternative crop protectants to synthetic insecticides in integrated pest management programs for the control of C. *partellus* in maize. Further research is needed to determine the mode(s) of action of these plant powders and to validate these results under farmer field conditions.

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