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Assessment of selected botanical extracts against *Liriomyza* species (Diptera: Agromyzidae) on tomato under glasshouse condition

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Abstract
An evaluation of fresh extracts from three locally available and two commercial pesticidal plants and its combinations in Ethiopia was carried out against important tomato leaf miner, *Liriomyza* species in the glasshouse in order to assess their potency for pesticidal application. Significant differences ($P<0.001$) were observed with respect to efficacy percent and total yield of tomato fruits per plant. At 7th day after treatment application Prosuler oxymetrin (Levo 2.4 SL™) and *Azadirachta indica* had the highest efficacy percentage and no significance differences from the standard check. It was concluded that Prosuler oxymetrin (Levo 2.4 SL™), Emamectin benzoate (Prove 1.9 E. C™) and *Azadirachta indica* could be used as a management measure against *Liriomyza* species.

Keywords: Botanicals, Extracts, *Liriomyza*, *Lycopersicon esculentum*

1. Introduction
Tomato (*Lycopersicon esculentum* Mill.) is an important vegetable crop, cultivated widely in the Ethiopia. Among the various insect-pests responsible for reducing the yield of tomato crop, the tomato leaf miner, *Liriomyza* species, are a highly destructive pest causing serious damage of tomato leaves [1, 2].

More than 300 *Liriomyza* species have been described to date, including 24 species of economic importance, and many important polyphagous species of agricultural and horticultural plants [3] like *Liriomyza sativae* (Branchard), *Liriomyza trifolii* (Burgess), *Liriomyza huidobrensis* (Branchard), *Liriomyza bryoniae* (Kaltenbach), *Liriomyza strigata* (Meigen) and *Liriomyza longei* Frick [4]. In the past two decades, the occurrence and distribution of certain *Liriomyza* species have changed dramatically. Numerous research work have been undertaken worldwide owing to the economic importance of some *Liriomyza* species, and an extensive body of research papers has been published.

The management of Agromyzidae continues to be a topic of extensive research and scientific debate. Synthetic and natural insecticides for *Liriomyza* species control have been extensively worked and are commonly used by farmers and producers regardless of production scale and crop [5]. The effectiveness of these insecticides has been reduced by their indiscriminate use, which has adversely impacted natural enemies and resulted in the development of resistance to several groups of insecticides [6].

Larval feeding not only reduces the marketability of plants because of the aesthetic damage but it also reduces the photosynthetic capacity of plants causing reduction in plant vigor, growth and yield [7]. *Liriomyza huidobrensis* has the most significant effect on host plants because it creates large mines in the spongy mesophyll of foliage and in petioles [8]. Satti [9] found the peak of *Liriomyza* spp. to be 6.9-8.6 infested leaves/50 leaves.

Under conventional production conditions, leaf miners were primarily controlled by the use of synthetic insecticides such as cyromazine, cypermethrin, permethrin or fenvalerate. Moreover, the biorationale compounds azadirachtin, Spinosad and Abamectin are described as efficient insecticides [5]. However, frequent applications bear a high risk of selecting pesticide-resistant strains and adverse effects on non-target organisms [10, 11].

Integrated pest management (IPM) seeks to provide an effective and economical control strategy that minimizes the disturbance of anthropogenic control measures on the natural components of the agro-ecosystems. Most plant derived products are supposed to be less toxic to non-target organisms, easily biodegradable and therefore do not persist in the environment as opposed to synthetic products which often end up being pollutants. Plant products are also cheap especially if they are locally available [12]. Therefore, the present studies were undertaken to study the efficacy of locally available botanicals against *Liriomyza* species under glasshouse conditions on tomato.

2. Materials and Methods

2.1 Description of the study area

The experiment was carried out at Ambo University glasshouse conditions during the main cropping season of 2015. Ambo is112 km from Addis Ababa and found on latitude 08° 59′.078′ North and longitude 037° 50.704′ East, with an altitude of 2072 m.a.s.l. and located in Oromia Regional State Western Shoa Zone, Ethiopia.

The experiment was conducted between January-May, 2015. The experiment was consist of ten treatments with three replications. Five botanical extracts and three combinations were used: Green pepper (*Capsicum* sp.), Garlic (*Allium sativum*), Prosuler oxymatrin (Levo 2.4 SLTM), Emamactin benzoate (Prove 1.9 E.CTM) *Azadirachta indica* seed, Garlic + Levo 2.4 SLTM, Garlic + Prove 1.9 E.CTM, Garlic + Green pepper, Lambda Cyhalothrin (Triger 5% E.C^{TM}) as standard check and control.

2.2 Crop establishment

The experimental pots were irrigated every day for the first three weeks and twice thereafter. The pots were fertilized with Di-ammonium phosphate (DAP) and urea at the recommended rates. Other agronomic practices were carried out as required.

Tomato (*Lycopersicon esculentum* Mill.) plant used was a "Coshoro" cultivar that are popular in the study area. Seeds were bought from Melkasa Agricultural Research Center, Ethiopia and germinated in a nursery bed.

The experiments were arranged in a Randomized Complete Block Design with three replications. Purposefully the door and windows of the glasshouse were kept open for 24 hours for the entrance of flies. Hence, plants were infested under natural conditions. Planted tomato plants were sprayed with botanicals at recommended rates. Each potted plant was covered with nylon cloth to avoid escape of larvae. Mortality data were recorded after application at 1st, 3rd, 5th and 7th days of treatments.

2.3 Preparation of botanicals and insecticides

Botanicals extracts were prepared in the following manner. Fresh garlic bulb, green pepper fruit were bought from Ambo local market, and seeds of *Azadirachta indica* were collected from Melka Werer Agricultural research center subjected to dry in shade. Dried seeds were grinded and afterward mixed with water at 5% concentration level (w/v) i.e. 20 g of powder per 100ml of water and filtered through Muslim cloth. A total of three times extract suspension was sprayed at vegetative, flowering and fruit setting stages by using hand sprayer at the rate of 150 liters per hectare against tomato leaf miner, *Liriomyza* species. The two commercial botanical insecticides namely: Prosuler oxymetrin (Levo 2.4 SL^{TM}) and Emamectin benzoate (Prove 1.9 E.C^{TM}) mixed with 100 liter of water and sprayed at the rate of 0.5 liter per hectare.

Fresh garlic bulb and green pepper were cut into small pieces and grinded with grinding machine, afterward mixed with water at 5% concentration (v/v). 20 ml of aqua extracts/100ml of water was filtered through Muslim cloth. The extracted botanicals were collected in sample bottles and taken directly for spray against *Liriomyza* species.

2.4 Data collection

Data was collected for the number of leaf infested/damaged by *Liriomyza* species, number of fruit infested/bored by insect pests per plant, number of primary branches, number of fruit per plant, marketable and unmarketable fruit yield per plant were taken.

2.5 Data analysis

Data obtained was subjected to one way analysis of variance by ranks (t-test) to establish the trend of infestation between treatments. The mean comparisons were carried out using Duncan's Multiple Range Test (DMRT) through SAS Statistical software. Results with P≤ 0.05% were considered statistically significant. Data for leaf damaged and yield per plant was calculated in percentage along with the efficacy of botanicals against *Liriomyza* species by using the following formula:

$$\text{Efficacy (\%)} = \frac{\Pr SC - PoSC}{\Pr SC}(100)$$

Where: PrSC = Pre Spray Count

PoSC = Post Spray Count

All calculations and graphic presentations were carried out using Microsoft office Excel 2007.

3. Results and Discussion

The experiment studies revealed that all the insecticidal treatments found significantly different compared to standard check and control. Amongst the botanicals, Prosuler oxymetrin (Levo 2.4 SL^{TM}) and *Azadirachta indica* were non-significantly different from the standard check. Lambda Cyhalothrin (Triger 5% E. C^{TM}) was significantly reduced larval population of *Liriomyza* species by 61.13 and 56.67 percent mortality on 7th day after application of each spray, respectively. The other treatments such as Emamectin benzoate (Prove 1.9 E. C^{TM}), the combination of Garlic and Prosuler oxymetrin (Levo 2.4 SL^{TM}), and Garlic and Emamectin benzoate (Prove 1.9 E. C^{TM}) (48.9, 46.67 and 44.30%) were significantly different from the standard check while the combination of Garlic and Pepper, Pepper alone and Garlic alone gave low percent mortality (30.0, 24.53 and 24.43%), respectively (Table 1).

Mean of percent mortality of larvae due to dates of mortality after treatment application ranged from 1st day to 7th day showed increased percent mortality from 6.67 to 75.47% in different treatments. The highest mortality 75.47 of larva was recorded with Lambda Cyhalothrin (Triger 5% E. C^{TM}) which was at par with Prosuler oxymetrin (Levo 2.4 SL^{TM}) and *Azadirachta indica* (neem seed) (50.0 after 1st day to 56.67% at 7th day of applications).

Table 1: Efficacy of different botanicals against *Liriomyza* species on tomato under glasshouse conditions.

Treatments	Percent Mortality			
	1st day	3rd day	5th day	7th day
T_1-Pepper (*Capsicum* sp.)	6.67^{fg}	19.77^{d}	32.87^{cde}	24.53^{d}
T_2-Garlic (*Allium sativum*)	18.9^{def}	18.98^{d}	18.90^{e}	24.43^{d}
T_3-Prosuler oxymetrin (Levo 2.4 SL™)	46.67^{a}	46.67^{b}	46.67^{bcd}	61.13^{ab}
T_4-Emamectin benzoate (Prove 1.9 E. C™)	36.10abc	46.23^{b}	48.90^{bc}	48.90^{bc}
T_5-Neem seed (*Azadirachta indica*)	50^{a}	52.23^{b}	56.67^{ab}	56.67^{ab}
T_6-Garlic + Levo 2.4 SL™	31.10^{bcd}	31.10^{c}	41.10^{bcd}	46.67^{bc}
T_7-Garlic + Prove 1.9 E. C™	24.53^{cde}	24.53^{cd}	44.30^{de}	44.30^{bcd}
T_8-Garlic (*Allium sativum*) + Pepper	12.23^{efg}	15.57^{d}	30.00^{de}	30.00^{cd}
T_9-Lambda Cyhalothrin (Triger 5% E. C™)	42.63^{ab}	65.70^{a}	68.80^{a}	75.47^{a}
T_{10}-Control	0.00^{g}	0.00^{e}	0.00^{f}	0.00^{e}
MSE	5.72	4.58	7.85	8.50
LSD at 0.01%	14.5	10.76	18.46	19.96
CV (%)	21.20	14.27	20.23	20.60

Note: Means in the same column followed by the same letter(s) are not significantly different for each other.

The data of mean percent in damaged leaves of tomato influenced by various insecticidal treatments are presented in Table 1. The results revealed that all the treatments gave significantly lower percent in damaged leaves over untreated control. It was ranged from (10.67 to 32.33%).

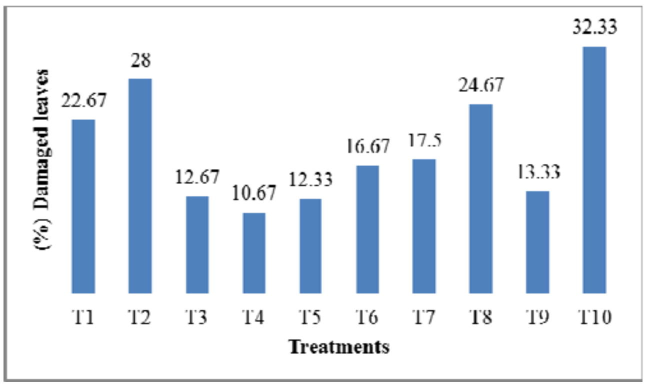
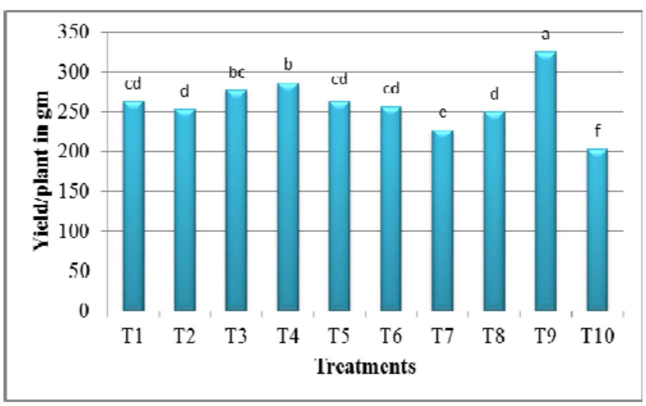


Fig 1: Mean percentage of damaged leaves by *Liriomyza* species under glasshouse conditions.



LSD at 0.01 CV (%) MSE

Fig 2: Mean effect of *Liriomyza* species on yield of tomato per plant in gram

The higher percent in damaged leaves (32.33%) was recorded in control followed by Garlic (24.67%) (Figure1). The next subsequent better insecticides were Emamectin benzoate (Prove 1.9 E. C™) (10.67), *Azadirachta indica* (12.33) and Prosuler oxymetrin (Levo 2.4 SL™) (12.67). The rest of the insecticides *viz*., Pepper, Garlic + Emamectin benzoate ™, Garlic + Prosuler oxymetrin, were (22.67, 17.5 and, 16.67) intermediate in damaged leaves of tomato, respectively. The lowest percent decline in damaged leaves (10.67%) was observed in Emamectin benzoate (Prove 1.9 E. C™). On the other hand, the relationship between efficacy percent and date of reaction is relatively increased when post application date prolonged, efficacy percent relatively at some points increased (Figure 3).

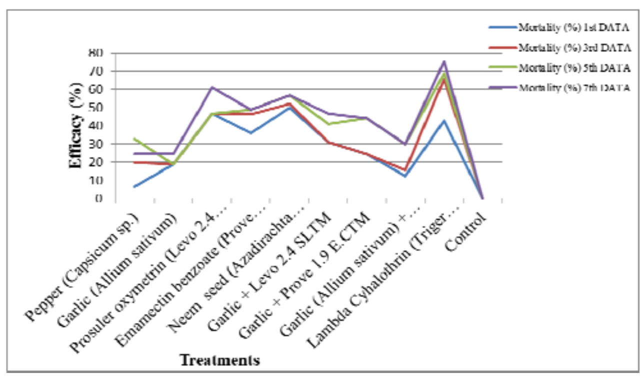


Fig 3: Relationship between efficacy percentage and date of reaction

The yield data revealed that all the treatments gave significantly higher yield over untreated control (Figure 2). Amongst the insecticides, Lambda Cyhalothrin (Triger 5% E. C™) recorded significantly higher yield (325 g/plant) followed by Emamectin benzoate (Prove 1.9 E. C™) (286 g/plant) and Prosuler oxymetrin (Levo 2.4 SL™) (277 g/plant) than the untreated control (203 g/plant). The next subsequent better yield were *Azadirachta indica* (263 g/plant) and Garlic + Prosuler oxymetrin (256 g/plant), respectively over control.

The present studies are in conformity with several researchers who reported that these insecticides reduce the infestation of *Liriomyza* species on various horticultural crops. Mousa *et al.* [13] reported efficacy of garlic oil is the best efficient in reducing the population of leafhoppers and plant hoppers by a mean reduction percentage of 68.09%. Similarly, the efficacy of garlic (*Allium sativum*) and red chilli (*Capsicum frutescens*) have potential to control red spider mite (*Tetranychus evansi*) in tomato production [14]. Adult emergence of unparasitized *L.*

sativae was almost completely inhibited by NeemAzal-U, indicating a high, direct toxicity [15]. These reports lend support to the present findings.

A general analysis of aqueous botanical extract and commercial insecticides on the *Liriomyza* species revealed an increase in toxicity rate from first day to second day and generally stabilized from the third to the seventh day, with most of the survived insects being weak and less motile.

4. Conclusion and Recommendations

Selected botanical extracts exhibited some degrees of insecticidal properties and have great potential to be used in management option of *Liriomyza* species. Among the tested materials, Prosuler oxymetrin (Levo 2.4 SL™), *Azadirachta indica* (seed) and Emamectin benzoate (Prove 1.9 E. C™) were the most effective. There is some direct correlation between efficacy percentage and date of reaction.

Further study of field efficacy of the promising botanicals under different ecosystem in various economically important vegetable crops, the doses of botanical extracts, frequency of application and identification of *Liriomyza* species in Ethiopia is needed.

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