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RESEARCH ARTICLE

EFFECTIVENESS OF CERTAIN ESSENTIAL OILS ON SPODOPTERA LITTORALIS (BOISD)

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S. littoralis, eucalyptus oil, clove oil, LC50s, antifeedant effects.

Abstract

The results revealed that the lowest concentrations (1%) of eucalyptus and clove oils caused 36.66 & 13.3 % mortality, respectively while the highest conc. 5% of the same oils caused 83.83 & 73.33% mortality, respectively against 4th instar larvae. Moreover, mortality was a concentration-dependent response. While LC50 values of eucalyptus and clove oils were 1.9859 and 3.378 %, respectively indicating that eucalyptus was more toxic than clove oil against 4th larval instar. The antifeeding percentage values were significant different between eucalyptus and clove oil-treatments either at low or high concentrations of both oils. Whereas, the maximum AF% was in the eucalyptus and clove oils (at 5% conc.) were 73.52 and 65.73%, respectively. Therefore, the tested EOs effectiveness was shown from acting either as biocides or antifeeding agents against S. littoralis larvae.

Introduction:-

The cotton leafworm S. littoralis is considered as a destructive phytophagous pest causing great losses in yield (Lanzoni et al., 2012). Essential oils (EOs) extracted from plants are a good alternative source to synthetic pesticides (Pathak et al., 2022; Ngegba et al., 2022). Essential oils have been demonstrated to have repellent, insecticidal and growth inhibitory effects on insects as evaluated by fumigation, contact and ingestion (Isman, 2020; Chaudhari et al., 2021). EOs proved to have efficient against an enormous number of pests (Fabres et al., 2014; Liang et al., 2017; Benelli & Pavela, 2018; Isman, 2005, 2006; Kanda et al., 2017). The present work aims to determine the toxicity and antifeedant effects of both eucalyptus EO and clove EO on S. littoralis 4th larval instar.

Materials and Methods:-

Insects:-

From the cotton leafworm division, Plant Protection Research Institute, Dokki, Egypt,S. littoralis larvae were obtained. At 27±2° C and 65±5 % R.H., larvae were reared on castor bean leaves as described by (El-Dafrawi et al., 1964).

Chemicals:-

From El-Captain Company, Cairo, Egypt, the commercial EOs of eucalyptus, Eucalyptus camaldulensis and clove, Syzygium aromaticum were obtained.

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Experiments:-

Toxicity bioassay:-

The preparation of conc. (1, 2, 3, 4 and 5%) from stock solutions of the tested EOs was done and leaf dip method was adopted in this study. Fresh castor leaves dipped in different concentrations for treating 4^{th} S. littoralis larval instar with EOs. The treated leaves were applied to the 4^{th} instar larvae as a mere feeding source for 48 hours. After that the larvae were fed on the non-treated castor leaf discs. After 24 hours of treatment, larval mortality was recorded. 3 replicates/ treatment were done with 10 larvae/ replicate.

Antifeedant assay (non-choice test):-

Ten larvae/replicate of 4th instar were placed in each petri dish and introduced for them the different conc. EOs - treated caster leaf. The leaves of all treatments were dipped in each proposed concentrations and the control leaf discs were dipped in distilled water. After 24 hrs. amount of leaf discs eaten by the larvae treated with EOs and control were recorded. From the formula of Singh and Pant (1980), the % antifeedant activity was calculated.

Statistical analysis:-

Probit analysis was adopted according to Finney (1971) using a software computer program (2002). By using one-way analysis of variance (ANOVA), the resulted data were statistically analyzed supported by Duncan's multiple range test (1955) running on Co Stat statistical software (1990).

Results and Discussion:-

In table (1) and figure (1), the results revealed that the low concentrations (1, 2 & 3%) of eucalyptus oil caused 36.66, 46.66 & 63.33% mortality, respectively while 4 & 5% conc. of this oil caused 76.66 & 83.83% mortality. Also, it was observed that as the oil concentrations increased the mortality percentages were increased. These results are in agreement with those of Barboucha et al. (2024) who showed that concentration-dependence of E. camaldulensis EO effects on Tribolium castaneum mortality. Also, Obembe et al. (2024) showed that bioactive compounds, isopulegol, citronellol and citronella within different species of Eucalyptus sp. have insecticidal activity on A. gambiae. While Nurdjannah & Bermawie, 2012; Tian et al., 2015; Rismayani & Laba, 2015; Martínez et al., 2018; Armijos et al., 2019; Vargas-méndez et al. (2019) showed that the main active ingredient in clove leave oil is eugenol (80–88%), eugenol acetate and caryophylene which was effective on different insect pests.

Table (1): Mortality % against S. littoralis larvae after treatment with clove and eucalyptus oils.

Concentrations %	Treatments	Mortality %
Control	-----	$6.66^{p}\pm0.069$
1	**Clove**	$13.3^{o}\pm0.83$
	Eucalyptus	$36.66^{l}\pm0.842$
2	**Clove**	$33.33^{m}\pm1.09$
	Eucalyptus	$46.66^{j}\pm0.956$
3	**Clove**	$43.33^{j}\pm1.27$
	Eucalyptus	$63.33^{g}\pm1.228$
4	**Clove**	$60.00^{h}\pm1.63$
	Eucalyptus	$76.66^{c}\pm1.238$
5	**Clove**	$73.33^{d}\pm1.44$
	Eucalyptus	$83.83^{a}\pm1.342$
$L.S.D_{0.05\%}$		1.402

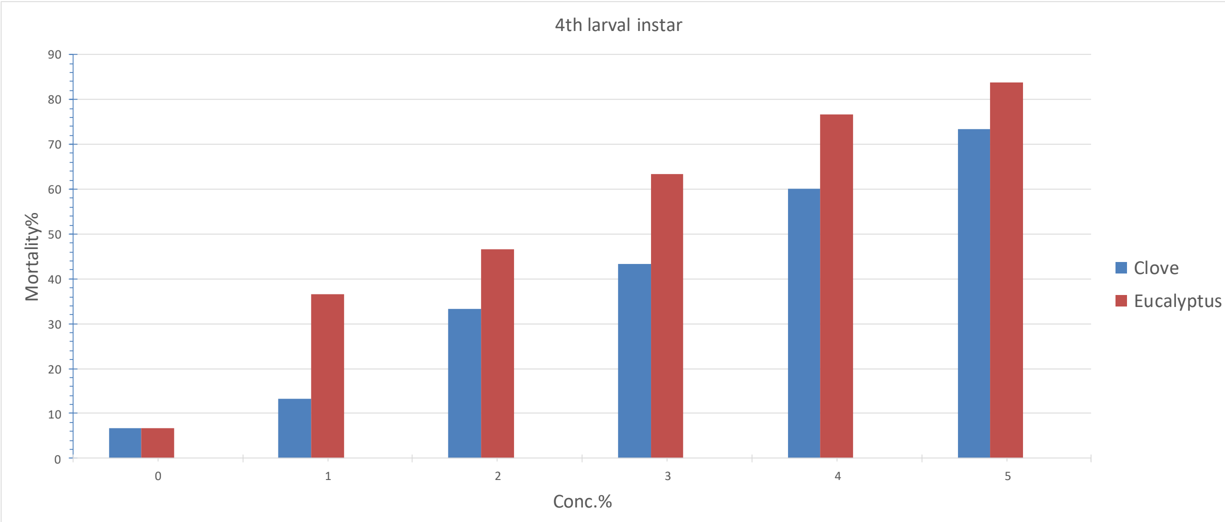

Figure 1: Mortality % against S. littoralis larvae after treatment with clove and eucalyptus oils.

Table (2) showed that the sublethal concentration to kill 25% (LC25) and lethal concentration to kill 50% (LC50) of eucalyptus oil were 0.9214 and 1.9859 %, respectively against S. littoralis 4th larval instar. While LC25 and LC50 of clove oil were 1.9407 and 3.378 %, respectively against 4th larval instar. Eucalyptus essential oil is rich in monoterpenes and sesquiterpenes. On 4th S. littoralis larval instar, Eucalyptus and clove EOs possess toxic effect against it (Yassin, 2013; Ibrahim & Abd El-Kareem, 2018).

Table 2: Toxicity indices (LC25 and LC50) of the essential oils (eucalyptus and clove oils) on S. littoralis 4th larval instar.

Treatments	LC%	Conc.%	95% Fiducial limits		Slope	Chi^2
			Lower	Upper		
Eucalyptus oil	25%	**0.9214**	**0.6478**	**1.1595**	**2.0223±0.2454**	**4.8066**
Clove oil		**1.9407**	**1.6663**	**2.1799**	**2.8021±0.291**	**1.7893**
Eucalyptus oil	50%	**1.9859**	**1.6833**	**2.2731**	**2.0223±0.2454**	**4.8066**
Clove oil		**3.378**	**3.0599**	**3.7732**	**2.8021±0.291**	**1.7893**

* LC_{25} and LC_{50} values are significant (P< 0.05) whenever confidence intervals do not overlap.

Barboucha et al. (2024) noticed that Eucalyptus camaldulensis oil contains spathulenol, cryptone and p-cymene as the major compounds (Barboucha et al., 2024). Pectinophora gossypiella adults were tested with E. globulus EO rich in 1,8-cineole (61.60%), p-cymene (12.40%), limonene (11.50%) for insecticidal activity using in contact assay (Kobenan et al., 2022). The phytochemical spectra of E. pyrocarpa, E. andrewsii and E. siderophloia reveal the presence of α-eudesmol, p-cymene, α-pinene, α-phellandrene and β-phellandrene (Filomeno et al., 2017). While Ribeiro et al., 2018 when applied eucalyptus EOs against Ascia monuste larvae found that after 72 h of the topical exposure at dose 30 µg/ mg of insect with E. sphaerocarpa EO rich in α-phellandrene (15.1%), p-cymene (16.7%),1.8-cineole (37.9%) and E. tindaliae EO rich in α-pinene (40.6%) and 1.8-cineole (48.2%) caused ~50% mortality rate. In clove EO, the major compounds were humulene oxide (4.84%), γ-cadinene (5.01%), α-humulene (10.8%), 2-propenoic acid (12.2%), caryophyllene oxide (18.3%), caryophyllene (24.5%) caryophyllene (24.5%) and eugenol (27.1%) (Plata-Ruedaa et al., 2018). Vargas-Méndez et al. (2019) showed that (iso)eugenols and clove oil are a good choice as models for developing new insecticides against Spodoptera frugiperda.

While the effect of different concentrations of eucalyptus and clove oils on the antifeeding percentage (AF%) of S. littoralis 4th instar was presented in table (3) and figure (2). The percentage antifeeding indices of S. littoralis 4th instar treated with lower conc. (1, 2 & 3%) of eucalyptus oil were 38.95, 49.61 and 59.27%, respectively whereas those of clove oil at the same conc. were 22.48, 40.15 and 50.77%, respectively. In connection with high conc. (4 and 5%), the feeding deterrence index values of eucalyptus oil were 68.29 and 73.52%, respectively whereas those of clove oil were 57.76 and 65.73%, respectively at the same concentrations. The maximum AF% was in the eucalyptus oil (at 5% conc.) and the least AF% was at the 1% concentration and it was 38.95 and 73.52%, respectively. The feeding deterrence percentage (AF%) was increased with increasing the concentrations, so at the lowest conc. (1%) of clove oil the AF% was 22.48% and at the highest conc. (5%) the AF% was 65.73%. Meanwhile, data clearly indicate that both EOs have high feeding deterrence activity at high concentrations. Also, the same trend was noticed by Selvam & Ramakrishnan (2014) who mentioned that the antifeedant activity is directly proportional to the increase in the concentration of EOs. Clove oil has potential larvicidal and antifeedant effects on S. litura 3rd larval instar (Fateha et al., 2021). Also, Karemu et al. 2013, showed the high repellent effect of E. camaldulensis oil against Sitophilus zeamais. Certain major compound found within Eucalyptus oil had a high antifeedant index on S. frugiperda larvae at conc. 1000 mg/Ml (Vargas-Méndez et al., 2019). Ebadollahi & Setzer (2020) showed that E. camaldulensis oil has repellent effect when applied on T. confusum adults. The insecticidal or repellent properties of EO from E. camaldulensis against Sitophilus spp., are related to their chemical composition (Ahouandjinou et al., 2021).

Table (3): Antifeeding index % against S. littoralis larvae after treatment with clove and eucalyptus oils.

Concentrations %	Treatments	Antifeeding index %
Control	-----	0^{r}±0.00
1	**Clove**	22.48^{q}±0.81
	Eucalyptus	38.95^{o}±0.825
2	**Clove**	40.15^{n}±0.951
	Eucalyptus	49.61^{k}±0.919
3	**Clove**	50.77^{j}±0.985
	Eucalyptus	59.27^{f}±0.970
4	**Clove**	57.76^{g}±1.0326
	Eucalyptus	68.29^{c}±1.024
5	**Clove**	65.73^{d}1.089
	Eucalyptus	73.52^{a}±1.048
L.S.D$_{0.05\%}$		1.052

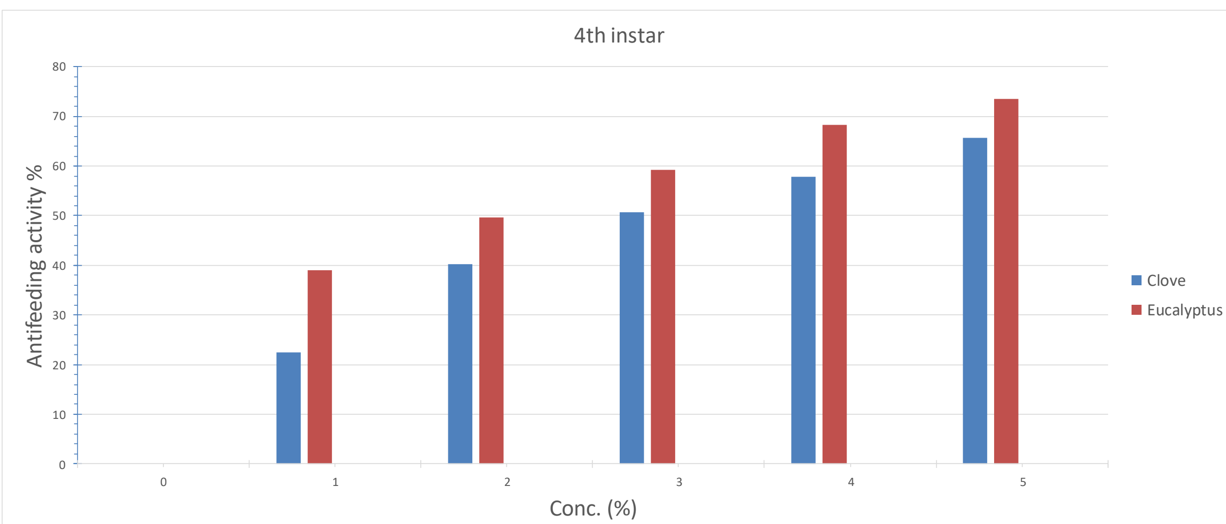

Figure 2: Antifeeding index % against S. littoralis larvae after treatment with clove and eucalyptus oils.

Conclusion:-

The EOs of eucalyptus as well as clove acted as larvicidal and antifeeding agents against S. littoralis larvae and have potential to be exploited as botanical insecticides used as a part of IPM of this pest and its related species.

Competing interests:

No competing of interests was obtained.

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