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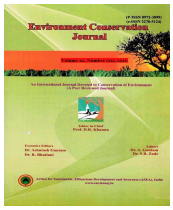

Assessment of certain plant products toxixity against *Sitophilus oryzae* in milled rice grains in coastal Odisha

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ABSTRACT

The rice variety, Jyotirmayee was treated with plant products for the assessment of toxicity towards rice weevil *Sitophilus oryzae* in milled rice grains in the laboratory of Department of Entomology of College of Agriculture under Odisha University of agriculture and technology, Bhubaneswar in coastal climatic condition of Odisha. The toxicity assessment revealed that the average rate of mortality over the time and doses was significantly highest in black pepper with 81.86% mortality which was statistically at par with tobacco (80.37%), turmeric (70.00%) and chilli (68.51%). Theprobit analysis data revealed that at 24 HAT and 48 HAT the lowest LC_{50} value of 0.02 and 0.06% was recorded respectively in black pepper. But at 72 HAT the lowest LC_{50} value of 0.08% was recorded with chilli followed by turmeric (0.14%), black pepper (0.21%), eucalyptus (0.71%) and tobacco (0.95%).

Introduction

The rice weevil *Sitophilus oryzae* has been reported to develop resistance to synthetic insecticides (Benhalima*et al.,* 2004). The increasing serious problems of resistance and residue to pesticides and contamination of the biosphere associated with large-scale use of broad spectrum synthetic pesticides have led to the need of effective biodegradable pesticides with greater selectivity. The plant derived chemicals have been used as potential seed protectant (insecticides and antifeedants) often begins with the screening of plant extracts (Pavela, 2007). Plants are rich source of compounds having insecticidal activity (Arnason*et al.,* 1989) and its extracts contain compounds that show ovicidal, repellent, antifeedant, sterilization and toxic effects in insects (Isman, 2006). The plant derived materials are more readily biodegradable, less likely to contaminate the environment and may be less toxic to mammals. Therefore, today researchers are seeking new classes of naturally occurring insecticides that might be compatible with newer pest control approaches.

Material and Methods

For the toxicity test of plant products, 10g of treated rice was taken in each petridish as food materials of rice weevil. Each treatment was replicated thrice. Ten insects per replication were taken in each petridish. In the untreated check (control) same number of insects was tested without treated materials. These petridishes were kept in an incubator at 30 $\pm$ 5° C. Insect mortalities were recorded at 24, 48, and 72 hours after treatment (HAT). Observed mortalities of the insects were corrected by Abbott's formula (1987) and then analyzed by Analysis of Variance (ANOVA). The mean values were separated by DMRT test (Duncan, 1951). LC_{50} values were calculated by Probit analysis in MS excel through Data Analysis Tool Pack. According to Abbott's formula;
Corrected mortality =

$$\text{Corrected mortality} = \frac{\text{(Portion of control group survived)- (Portion of treatment group survived)}}{\text{(Portion of control group survived)}}$$

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Results and Discussion

The toxic effect of the plant products revealed that after 24 HAT highest mortality of *S. oryzae* of 70.00, 76.70 and 83.30 % was recorded with tobacco @ 1.5, 2.0 and 2.5% doses and 73.30, 73.30 and 80.00% with black pepper @ 0.5, 1.0 and 1.5% doses respectively. It was followed by chilli (56.70, 63.30 and 70.00%) and turmeric (60.00, 63.30 and 66.70 %) @ 0.5, 1.0 and 1.5% doses respectively. With fenugreek (6.70, 10.00 and 13.30% respectively) and coriander (3.30, 6.70 and 10.00% respectively) the lowest mortality rates were observed. Same trend was observed at 42 HAT. (Table 1)However Ivbijaro and Agbaje (1986) reported that admixture of dried chilli powder @1.5 g/20 g cowpea caused 46 percent mortality of adult *C. maculatus* within 48h and reduced F1 production by 45 percent which is in support of our results. At 72 HAT highest mortality of 80.00, 86.70 and 96.70% was recorded in black pepper @ 0.5, 1.0 and 1.5% doses respectively which was followed by tobacco with 76.70, 83.30 and 93.30 % at 1.5, 2.0 and 2.5% doses respectively. With turmeric 70.00, 73.30 and 83.30 %; with chilli 70.00, 73.30 and 80.00% and with eucalyptus 43.30, 56.70 and 63.30% mortality were recorded at 0.5, 1.0 and 1.5% doses respectively.

The average rate of mortality over the time and doses was significantly highest in black pepper with 81.86% which was statistically at par with tobacco (80.37%), turmeric (70.00%) and chilli (68.51%). It was followed by Eucalyptus oil (48.89%), castor oil (43.70%), karanja oil (42.98%), chrysanthemum (42.60%), clove (36.68%), cinnamon (32.22%), garlic (28.52%), Tulsi (21.48%) and Bael (20.00%) which was at par with each other. The lowest average mortality was recorded with fenugreek (10.73%) and coriander (7.03%) and was at par with each other.The average mortality of *S. oryzae* was 36.67, 43.33 and 51.10% at 0.5, 1.0 and 1.5% doses. However Yahiya (2004) during his investigation on the efficacy of castor oil at dosages of 0.5 ml, 1.0 ml, 2.0 ml, 3.0 ml and 4 ml/50 g seeds against the longevity of rice weevils (*S. oryzae*) found that longevity of weevils was inversely proportional to the dosages of oils used which is supports our findings.The average rate of mortality over the time and doses was significantly highest in black pepper with 81.86% which was statistically at par with tobacco (80.37%), turmeric (70.00%) and chilli (68.51%). Ntonifor *et al.,* (2010) found that using a dose of 2g/100g of grain of stored cowpea, *P. guineense* caused 97.5% mortality of *C. chinensis* at 3 and 5 DAI. Moreover, Asawalam and Chukwuekezie (2012) evaluated the significant mortality effect (90%) of *S. zeamais* assessed by petroleum ether extract of *C. longa* after 42 days of treatment. These reports further strengthen our findings.

Further Eucalyptus oil (48.89%), castor oil (43.70%), karanja oil (42.98%), chrysanthemum (42.60%), clove (36.68%), cinnamon (32.22%), garlic (28.52%), Tulsi (21.48%) and Bael (20.00%) were at par with each other. Dhakshinamoorty and Selvanarayana (2002) studied the efficacy of some plant materials on the survival of *C. maculatus* infesting stored green gram and reported that at 7 days after treatment the mortality was highest (100%) in castor oil which contradicts from the present findings. The lowest average mortality was recorded with fenugreek (10.73%) and coriander (7.03%) and was at par with each other. Soon *et al.,*(2003) reported that an extract from *Cinnamon umsieboldii* (cinnamon)root bark when used against *S. oryzae* resulted in 100% mortality at 2 days after treatment which contradicts the present findings.

Probit analysis

The calculated probit regression analysis of plant products have been made at 24, 48 and 72HAT. The results of the probit analysis for the estimation of LC_{50} values and their 95% fiducial limits and the slope of the regression lines at 24, 48 and 72HAT for the mortality of *S. oryzae* have also been presented in the Table. The probit analysis data revealed that 24 HAT the lowest LC_{50} value of 0.02% was recorded in black pepper followed by turmeric (0.10%), chilli (0.31%), tobacco (0.83%) and eucalyptus (1.79%). The highest LC_{50} value was reported in garlic (37.86%) and fenugreek (38.06%)(Table 2). After 48 HAT the lowest LC_{50} value was recorded with black pepper (0.06%) followed by turmeric (0.10%), chilli (0.13%), tobacco (0.79%). The LC_{50} value fenugreek was remained down to 25.16% but was still highest among the others (Table 3). But at 72 HAT the lowest LC_{50} value of 0.08% was recorded with chilli followed by turmeric (0.14%), black pepper (0.21%), eucalyptus (0.71%) and tobacco (0.95%).

Table 1: Toxicity test of plant products against rice weevil, *S. oryzae* at 24, 48 and 72 HAT in milled rice grains at different concentrations

Treatment	Conc. (%)	Mortality rate (%)			Average mortality rate	Mortality rate (%) over conc. and time
		24 HAT	48 HAT	72 HAT		
T1 (Bael)	1.5	13.30	16.70	20.00	16.67	20.00[bc]
	2.0	16.70	20.00	23.30	20.00	
	2.5	20.00	23.30	26.70	23.33	
T2 (Chrysanthemum)	1.5	33.30	36.70	40.00	36.67	42.60[b]
	2.0	40.00	46.70	50.00	45.57	
	2.5	40.00	46.70	50.00	45.56	
T3 (Tulsi)	1.5	13.30	16.70	20.00	16.67	21.48[b]
	2.0	16.70	20.00	23.30	20.00	
	2.5	23.30	26.70	33.30	27.77	
T4 (Garlic)	0.5	20.00	23.30	26.70	23.33	28.52[b]
	1.0	23.30	26.70	30.00	26.67	
	1.5	26.70	36.70	43.30	35.57	
T5 (Karanj)	0.5	33.30	36.70	40.00	36.67	42.98[b]
	1.0	36.70	40.00	46.70	41.13	
	1.5	46.70	50.00	56.70	51.13	
T6 (Castor)	0.5	33.30	36.70	40.00	36.67	43.70[b]
	1.0	40.00	43.30	46.70	43.33	
	1.5	43.30	53.30	56.70	51.10	
T7 (Fenugreek)	0.5	6.70	6.70	6.70	6.70	10.73[c]
	1.0	10.00	13.30	13.30	12.20	
	1.5	13.30	13.30	13.30	13.30	
T8 (Turmeric)	0.5	60.00	66.70	70.00	65.57	70.00[a]
	1.0	63.30	70.00	73.30	68.87	
	1.5	66.70	76.70	83.30	75.57	
T9 (Chilli)	0.5	56.70	63.30	70.00	63.33	68.51[a]
	1.0	63.30	66.70	73.30	67.77	
	1.5	70.00	73.30	80.00	74.43	
T10 (Cinammom)	0.5	20.00	26.70	33.30	26.67	32.22[b]
	1.0	26.70	33.30	36.70	32.23	
	1.5	33.30	36.70	43.30	37.77	
T11 (Clove)	0.5	26.70	30.00	30.00	28.90	36.68[b]
	1.0	36.70	36.70	40.00	37.80	
	1.5	40.00	43.30	46.70	43.33	
T12 (Black pepper)	0.5	73.30	76.70	80.00	76.67	81.86[a]
	1.0	73.30	83.30	86.70	81.10	
	1.5	80.00	86.70	96.70	87.80	
T13 (Tobacco)	1.5	70.00	73.30	76.70	73.33	80.37[a]
	2.0	76.70	80.00	83.30	80.00	
	2.5	83.30	86.70	93.30	87.77	
T14 (Coriander)	0.5	3.30	3.30	3.30	3.30	7.03[c]
	1.0	6.70	6.70	6.70	6.70	
	1.5	10.00	10.00	13.30	11.10	
T15 (Eucalyptus)	0.5	36.70	40.00	43.30	40.00	48.89[ab]
	1.0	46.70	53.30	56.70	52.23	
	1.5	46.70	53.30	63.30	54.43	
SEm	-	-	-	-	-	11.77
CD $_{0.05}$	-	-	-	-	-	34.00

HAT – Hours after treatment

Table 2: Relative toxicity (Probit analysis) of plant products treated against rice weevil, *S. oryzae* at 24 HAT in milled rice grains

Plant products	Conc. applied (%)	Regression equations	LC50 value (%)	95% Fiducial limit		Slope ± SE
				Lower limit	Upper limit	
T1 (Bael)	1.5, 2.0, 2.5	y = 1.217x + 3.671	12.33	0.81	1.63	1.22 ± 0.03
T2 (Chrysanthemum)	1.5, 2.0, 2.5	y = 0.833x + 4.444	4.65	-4.29	5.96	0.83 ± 0.40
T3 (Tulsi)	1.5, 2.0, 2.5	y = 1.701x + 3.567	6.94	-2.88	6.28	1.70 ± 0.36
T4 (Garlic)	0.5, 1.0, 1.5	y = 0.451x + 4.287	37.86	-0.33	1.23	0.45 ± 0.06
T5 (Karanj)	0.5, 1.0, 1.5	y = 0.685x + 4.743	2.37	-3.17	4.54	0.68 ± 0.30
T6 (Castor)	0.5, 1.0, 1.5	y = 0.555x + 4.738	2.96	0.18	0.93	0.56 ± 0.029
T7 (Fenugreek)	0.5, 1.0, 1.5	y = 0.799x + 3.735	38.06	-0.002	1.60	0.79 ± 0.06
T8 (Turmeric)	0.5, 1.0, 1.5	y = 0.364x + 5.356	0.10	-0.42	1.15	0.36 ± 0.06
T9 (Chilli)	0.5, 1.0, 1.5	y = 0.726x + 5.374	0.31	-0.88	2.33	0.73 ± 0.13
T10 (Cinnamon)	0.5, 1.0, 1.5	y = 0.845x + 4.403	5.08	-0.33	2.02	0.85 ± 0.09
T11 (Clove)	0.5, 1.0, 1.5	y = 0.790x + 4.627	2.96	-0.69	2.28	0.79 ± 0.12
T12 (Black pepper)	0.5, 1.0, 1.5	y = 0.410x + 5.712	0.02	-3.75	4.58	0.41 ± 0.33
T13(Tobacco)	1.5, 2.0, 2.5	y = 1.974x + 5.164	0.83	-0.93	4.88	1.97 ± 0.23
T14 (Coriander)	0.5, 1.0, 1.5	y = 1.163x + 3.508	19.14	0.82	1.51	1.16 ± 0.03
T15 (Eucalyptus)	0.5, 1.0, 1.5	y = 0.572x + 4.855	1.79	-2.28	3.42	0.57 ±0.22

Table 3: Relative toxicity (Probit analysis) of plant products treated against rice weevil *S. oryzae* at 48 HAT in milled rice grains

Plant products	Conc. applied (%)	Regression equations	LC50 value (%)	95% Fiducial limit		Slope ± SE
				Lower limit	Upper limit	
T1 (Bael)	1.5, 2.0, 2.5	y = 1.065x + 3.843	12.17	0.47	1.66	1.07 ± 0.05
T2 (Chrysanthemum)	1.5, 2.0, 2.5	y = 1.200x + 4.481	2.70	-6.18	8.59	1.20 ± 0.58
T3 (Tulsi)	1.5, 2.0, 2.5	y = 1.525x + 3.745	6.65	-3.04	6.09	1.53 ± 0.36
T4 (Garlic)	0.5, 1.0, 1.5	y = 0.766x + 4.468	4.94	-3.40	4.93	0.77 ± 0.33
T5 (Karanj)	0.5, 1.0, 1.5	y = 0.666x + 4.83	1.80	-3.18	4.51	0.67 ± 0.30
T6 (Castor)	0.5, 1.0, 1.5	y = 0.851x + 4.893	1.33	-2.02	3.72	0.85 ± 0.23
T7 (Fenugreek)	0.5, 1.0, 1.5	y = 0.860x + 3.794	25.16	-3.42	5.15	0.86 ± 0.34
T8 (Turmeric)	0.5, 1.0, 1.5	y = 0.589x + 5.586	0.10	-2.26	3.44	0.59 ± 0.22
T9 (Chilli)	0.5, 1.0, 1.5	y = 0.560x + 5.487	0.13	-2.03	3.15	0.56 ± 0.20
T10 (Cinnamon)	0.5, 1.0, 1.5	y = 0.595x + 4.560	5.47	0.23	0.96	0.59 ± 0.03
T11 (Clove)	0.5, 1.0, 1.5	y = 0.731x + 4.686	2.69	-0.47	1.93	0.73 ± 0.09
T12 (Black pepper)	0.5, 1.0, 1.5	y = 0.801x + 5.969	0.06	0.66	0.94	0.80 ± 0.01
T13(Tobacco)	1.5, 2.0, 2.5	y = 2.189x + 5.22	0.79	-1.53	5.90	2.19 ± 0.29
T14 (Coriander)	0.5, 1.0, 1.5	y = 1.163x + 3.508	19.14	0.82	1.51	1.16 ± 0.03
T15 (Eucalyptus)	0.5, 1.0, 1.5	y = 0.748x + 5.002	0.99	-2.98	4.48	0.75 ± 0.29

Table 4 : Relative toxicity (Probit analysis) of plant products treated against rice weevil *S. oryzae* at 72 HAT in milled rice grains

Plant products	Conc. applied (%)	Regression equations	LC50 value (%)	95% Fiducial limit		Slope ± SE
				Lower limit	Upper limit	
T1 (Bael)	1.5, 2.0, 2.5	y = 0.986x + 3.981	10.78	0.70	1.15	0.97 ± 0.08
T2 (Chrysanthemum)	1.5, 2.0, 2.5	y = 1.183x + 4.570	2.31	-2.25	3.38	1.18 ± 0.22
T3 (Tulsi)	1.5, 2.0, 2.5	y = 1.803x + 3.806	4.59	-5.98	9.58	1.8 ± 0.61
T4 (Garlic)	0.5, 1.0, 1.5	y = 0.882x + 4.598	2.85	-4.78	6.55	0.88 ± 0.44
T5 (Karanj)	0.5, 1.0, 1.5	y = 0.850x + 4.979	1.06	-2.03	3.73	0.85 ± 0.23
T6 (Castor)	0.5, 1.0, 1.5	y = 0.850x + 4.979	1.06	-2.03	3.73	0.85 ± 0.23
T7 (Fenugreek)	0.5, 1.0, 1.5	y = 0.860x + 3.794	25.16	-3.42	5.15	0.86 ± 0.34
T8 (Turmeric)	0.5, 1.0, 1.5	y = 0.860x + 5.74	0.14	-4.59	6.31	0.86 ± 0.43
T9 (Chilli)	0.5, 1.0, 1.5	y = 0.628x + 5.688	0.08	-2.46	3.71	0.63 ± 0.24
T10 (Cinnamon)	0.5, 1.0, 1.5	y = 0.524x + 4.708	3.60	-1.70	2.75	0.52 ± 0.18
T11 (Clove)	0.5, 1.0, 1.5	y = 0.922x + 4.751	1.86	0.70	1.15	0.92 ± 0.02
T12 (Black pepper)	0.5, 1.0, 1.5	y = 1.961x + 6.345	0.21	-8.81	12.73	1.96 ± 0.85
T13(Tobacco)	1.5, 2.0, 2.5	y = 3.394x + 5.074	0.95	-9.52	16.31	3.39 ± 1.016
T14 (Coriander)	0.5, 1.0, 1.5	y = 1.479x + 3.578	9.14	-2.07	5.03	1.48 ± 0.28
T15 (Eucalyptus)	0.5, 1.0, 1.5	y = 1.071x + 5.157	0.71	0.57	1.57	1.07 ± 0.04

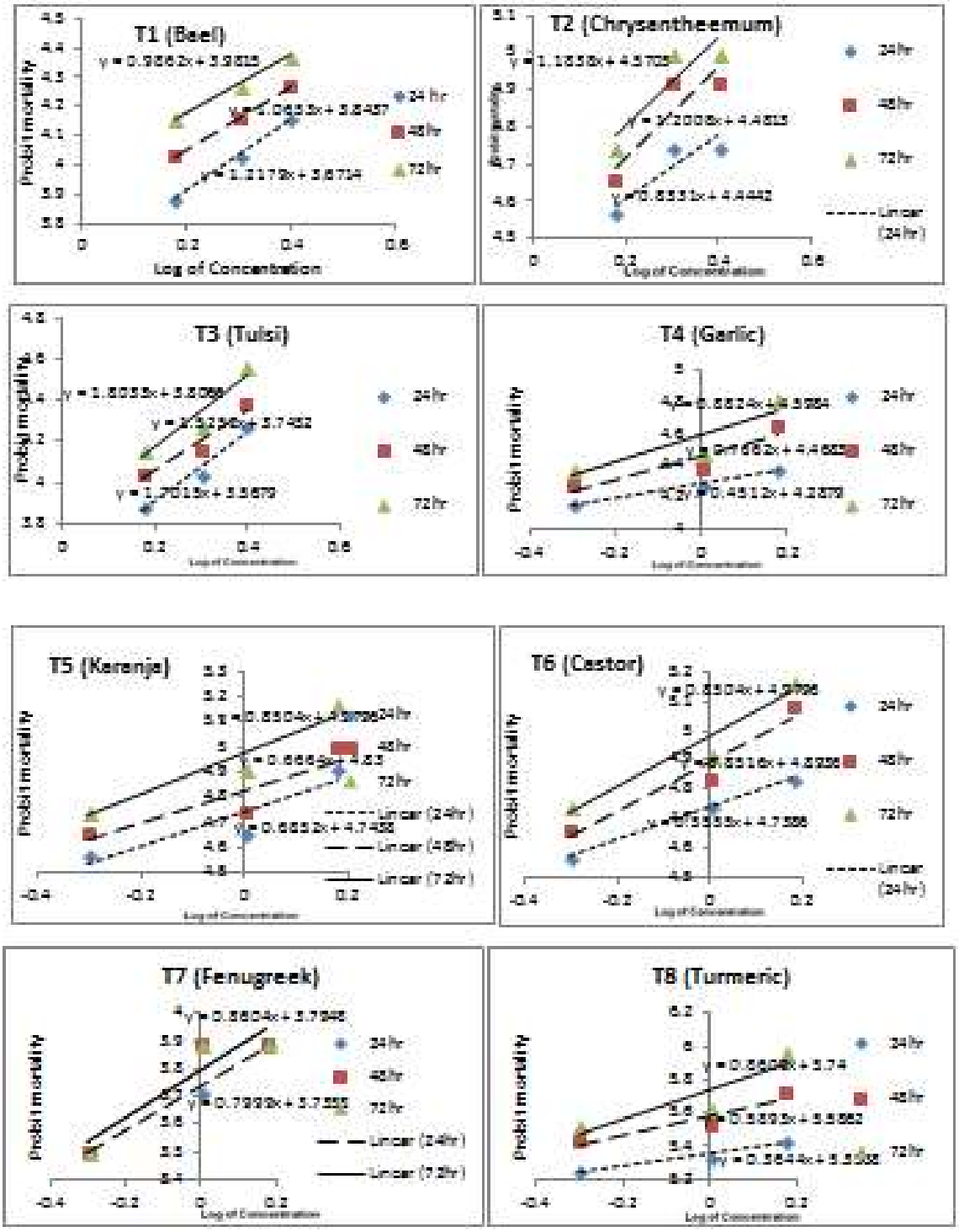

Figure 1: Relative toxicity of plant products (Tobacco, Coriander, Eucalyptus, Garlic, Karanj, Castor, fenugreek, turmeric) against *S. oryzae*at24, 48 and 72 HAT.

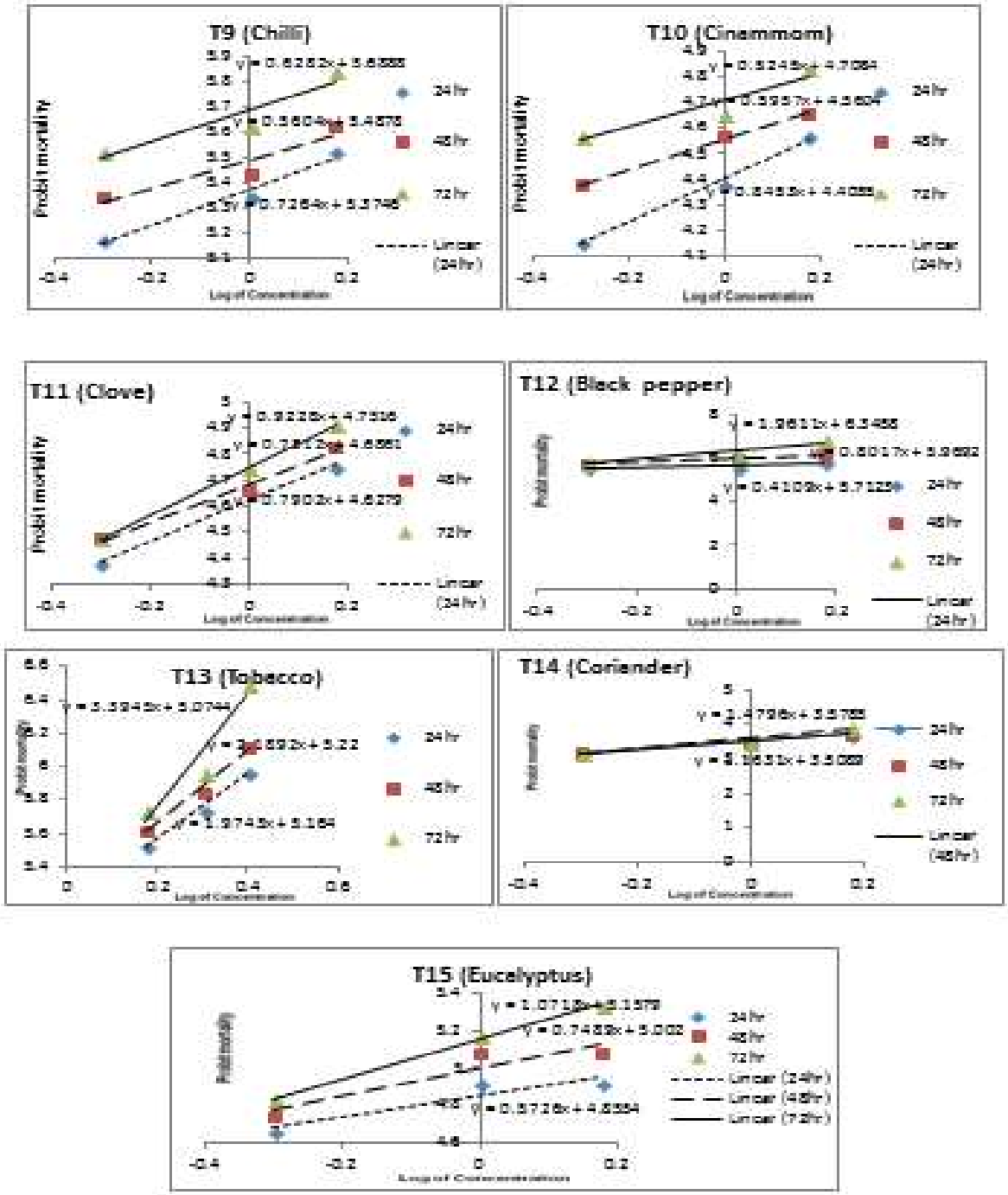

Figure 2: Relative toxicity of plant products (Chilli, Cinnamon, Clove, Black pepper,Tobacco, Coriander and Eucalyptus) against *S. oryzae*at24, 48 and 72 HAT.

Karaj and castor oil had the same LC_{50} value of 1.06% recorded. Clove reported to have the LC_{50} value of 1.86%. Coriander and Bael has a higher LC_{50} value of 9.14 and 10.78% respectively and again fenugreek resulted the highest LC_{50} value of 25.16% which was the highest over the others.

(Table 4).Chaubey (2011) reported that *P. nigrum* (black pepper) essential oils showed significant fumigant toxicity in *S. oryzae* adults with median concentrations (LC_{50}) of 0.58 µL cm^{-1} air respectively which supports our results.At 24 HAT the LC_{50} values of garlic was37.86%, but at 48 HAT it was reduced to 4.94% and at 72 HAT it was 2.85%. However Ragaa *et al.,*(2012) conducted an experiment to evaluate the toxicities of garlic oil against the rice weevil, *S. oryzae* adults and found that the LC_{50} value of garlic oil was 10.81 ml / kg. The oil at LC_{50}'s caused a significant decrease in the mean number of eggs laid by females as compared to the control and completely inhibited adult emergence. Karanj and castor oil had the same LC_{50} value of 1.06% recorded. Clove reported to have the LC_{50} value of 1.86%. Coriander and Bael has a higher LC_{50} value of 9.14 and 10.78% respectively and again fenugreek resulted the highest LC_{50} value of 25.16% which was the highest over the others. But there is no report on the LC_{50} value of these mentioned products.

Conclusion

It is concluded that the average rate of mortality over time and doses was significantly higher in black pepper.

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Conflict of interest

The authors declare that they have no conflict of interest.

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