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Effect of Custard Apple (Annona Squamosa L.) Extract on the Mortality of the Red-Flour-,Beetle, Tribolium Castaneum HBST

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University of Rajshahi

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EFFECT OF CUSTARD APPLE (ANNONA SQUAMOSA L.) EXTRACT ON THE MORTALITY OF THE RED-FLOUR BEETLE, TRIBOLIUM CASTANEUM HBST.

Thesis Submitted to the Institute of Biological Sciences, Rajshahi University in fulfilment of the requirements for the degree of Master of Philosophy.

BY

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SEPTEMBER, 1992

Dedication

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To my paronts

this work in most respectfully

dedicated

DECLARATION

This is to declare that the thesis submitted for the Degree of Master of Philosophy to the Institute of Biological Sciences, Rajshahi University is based on my original investigation, and was carried out under the Supervision of Professor M. Khalequzzaman, Department of Zoology, Rajshahi University.

The work as a whole or in part thereof has not been submitted in any form for any other degree at any place.

> Sillana. 12.9.92. (Mst. Shajia Sultana)

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The author.

ABSTRACT

The needs for evolution of pest management strategies based on non-insecticidal chemicals having behavioural or physiological activity with insectistatic potential with or without selective insecticide deployment, has been recognized as an ecological imperative for well over a decade now. However, such chemicals are often highly specific, biodegradable, of low persistance, and their control potential is sophisticated and long-term. Although ecologically desirable, these very characteristics of noninsecticidal chemicals weigh against their economic feasibility and reduce their appeal to the primary users – the farmers.

For this purpose an investigation has been carried out on the effect of chemicals extracted from the seed of custard apple, <u>Annona squamosa</u> Linn., an insecticide-methacrifos and their combined doses on <u>Tribolium castaneum</u> strains local, CR-I, FSS-II and CTC 12.

Custard apple seeds after drying extracted in four chemicals viz., Petroleum Spirit, ethyl acetate, acetone and methanol. Those four type of chemicals extracted from the seeds along with methacrifos tested on the adult beetles for all the strains. The extracted materials also treated on the larvae. Again the low doses of extracted chemicals and insecticide were applied combindly on the adult \underline{T} . <u>castaneum</u> to observe the synergistic effect.

It was found that all the chemicals extracted from the seeds by different solvents offered considerable mortality to the adult beetles. Highest toxicity was observed in the chemicals

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extracted by petroleum spirit for local and FSS-II strain, and results also indicate that the strain CR-I showed maximum susceptibility and the strain local showed highest resistance to the insecticide methacrifos.

It was observed that all chemicals extracted offered mortality to the larvae of <u>T</u>. <u>castaneum</u>. The extraction with petroleum spirit was found more toxicant for all the experimented strains. The larvae treated with the seed extraction showed variable larval durations. Prolonged larval period was observed for all the cases with respect to control except petroleum spirit extraction. Significant (P \leq 0.001) analysis of variance were found among doses and strains in all the extraction for larval and pupal period. Only the extraction petroleum spirit showed insignificant results for both larval and pupal period.

The fecundity and hatchability of the eggs laid by the adults emarged from the treated and control larvae were also investigated. It was observed that the control insect laid more eggs and the eggs showed more hatchability then the treated ones. Analysis of variance performed for all the extractions among different doses and within the strains showed significant results for fecundity and hatchability. But the extraction in petroleum spirit showed insignificant results within the strains.

By using low doses of both extracted chemicals and insecticides methacrifos combindly, it was found that the extractions have synergistic role on methacrifos in most of the cases. The results suggests that, custard apple plant contains some alkaloids, steroids, oils and acids which may offer a distinct antifeeding effect as well as some destructive effects on \underline{T} . <u>castaneum</u>.

INTRODUCTION

1. INTRODUCTION

Pesticides are often considerd to be the most potent control technology for pests. Continuous or heavy usage of some pesticides has created serious problems arising from factors such as direct toxicity to parasites, predators, pollinators, fish and man (Munakata, 1977; Pimentel, 1981), Pesticide resistance (Brown, 1968; Georghiou and Taylor, 1977; Schmutterer, 1981, Waiss <u>et al</u>, 1981), susceptibility of crop plants to insect pests (Pimentel, 1977), and increased environmental and social costs (Pimentel <u>et al</u>., 1980). It has therefore, become necessary to complement our reliance on synthetic pesticides with less hazardous, safe and biodegradable substitutes.

The need for evolution of pest management strategies based on non-insecticidal chemicals having behavioral or physiological activity with insectistatic potential, with or without selective insecticide deployment, has been recognized as an ecological imperative for well over a decade now. However, such chemicals are often highly specific, biodegradable, of low persistence, and their control potential is sophisticated and long-term. Although ecologically desirable, these very characteristics of non-insecticidal chemicals weigh against their economic feasibility and reduce their appeal to the primary users - the farmers.

The increasingly serious problems of pest resistance to pesticides and of contamination of the biosphere associated with large-scale use of broad-spectrum synthetic pesticids have dictated the need for effective, biodegradable pesticides with greater selectivity (Saxena, 1983). This awarness has created a world wide interest in the re-evaluation and use of age-old, traditional botanical pest control agents.

Insect antifeedants and feeding deterrents are chemicals which appear to be reasonable alternatives to the use of commercial insecticides. Many natural plant products possess insect antifeedant activities. These compounds probably play a role as resistance factors in the defence of plants against insect attack. This can be a novel approach in pest management programmes.

Recently, the search for naturally occurring antifeedants against pests of field crops and storage has been intensified. A number of investigators isolated, identified and screened chemical compounds from leaves and seeds of many botanical families for insect feeding deterrence and growth inhabition (Jacobson <u>et al., 1975; Bernays and Chapman, 1977; Doskotch <u>et al.,</u> 1977; Jacobson, 1977; Sudhakar <u>et al., 1978; Carpenter et al.,</u> 1979; Warthen, 1979; Jurd and Manners, 1980; Menn, 1980).</u>

Unlike synthetic pesticides that kill both hosts and parasites, preys and predators, naturally occurring antifeedants or feeding deterrents are relatively safe for natural enemies of pest species because of their biodegradable natural and relative safety to useful organisms in the environment. A large number of scientific papers and reports cover the subject of naturally occurring insect antifeedants and feeding deterrents in plants (Gill and Lewis, 1971; Girish and Jain, 1974; Jacobson <u>et al.</u>,

1975; Bernays and Chapman, 1977; Doskotch <u>et al</u>; 1977; Munakata, 1977; Sudhakar <u>et al</u>: 1978; Warthen, 1979; Dethier, 1980; Jacobson, 1981; Menn, 1980; Schmutterer and Rembold, 1980).

It is an age old practice still prevalent in our country to mix dried indigenous leaves of odourous and poisonous plants with stored grain for protection against insects with much The available information on pyrethrins, rotenone and success. nicotine shows that these insecticides of plant origin are comparatively safer to mammals and higher animals (Feinstien, 1952) and suggests possibility of occurrence of such insecticides in other plant resoures hither to unexplored. Further, testing of plant materials for insecticidal properties may help in the development of new efficient synthetic insecticides. These promising attributes led to evaluate the potential use of custard apple Annona squamosa Linn. seed against red flour beetle, Tribolium castaneum (Herbst), a major pest of stored products; specially pulses, millets, and cereals (Cotton, 1947; Purthi and Singh, 1950; Dyte et al., 1975) in the present investigation. The seed of A. squamosa extracted with four solvents and treated on four varieties of <u>T. castaneum</u> to obtain dose mortality rate. The lowest One insecticide methacrifos has also been applied. doses of insecticide and seed extracts combindly treated on the same insect to observe the synergistic effect if any.

1.1 Description of the plant:

The family Annonaceae consists in the main of aromatic trees and shrubs of tropical origin. It contains from 800 to 900 species in some 80 genera, widely distributed in the tropics, with an extra tropical ramification in Atlantic North America. Among the principal genera are <u>Asimia</u>, <u>Uvaria</u>, <u>Guatteria</u>, <u>Monodora</u>, <u>Rollinia</u>, <u>Xylopia</u>, <u>Annona</u> and <u>Artabotrys</u> (Tattersfield and Potter, 1940). The genus <u>Annona</u> Linn. has about 90 species of trees and shrubs which are distributed mainly in tropical America, but a few are natives of the tropics of Asia and Africa. Three species are met within India, of which two may be described as naturalised (Watt, 1889)

<u>A. squamosa</u> popularly known as custard apple of Europeans in India; sweet-sup or sugar apple of the West Indies and America is a small tree naturalised in Bangal and the North-west provinces (Watt, 1889). Flower solitary, terminal, sepals 3, small, valvate, petals 3-6, valvate, 2-seriat, outer triquetrous, base concave, stamens numerous; anther-cell narrow, dorsal, contiguous, top of connective ovoid. Ovaries many, subconnate, style oblong, ovule, 1 erect. Ripe carpels confluent into amany - celled ovoid or globose, many-sceded fruit.

1.2 Chemistry of Annona:

The chemistry of plants of the family Annonaceae has been little investigated. Cortina (1901) reported to have found among other constituents a resin present in <u>A</u>. <u>cherimola</u> to which is ascribed the emetic-cathartic action of the seeds. Callan and Tutin (1911) published an account of their chemical examination of the leaves of <u>A</u>. <u>muricata</u>. They isolated a steam-volatile essential oil, a small amount of uncrystallizable alkaloid, several fatty acids, myricyl alcohol, sitosterol and a compound "annonol", $C_{23}H_{38}O_4$, which was later regraded by Power and Salway (1913) as being a member of the group of phytosterol glucosides (Phytostero-lines).

Trimurti (1924) isolated a minute amount of an alkaloid from the leaves of <u>A</u>. <u>squamosa</u>, but glucosides were not shown to be present. Santos (1930) obtained an alkaloid, annonaine, $C_{17}H_{16}O_3N$, in a yield of 0.03-0.04% from the bark of <u>A</u>. <u>reticulata</u>. The same alkaloid was isolated from the bark of <u>A</u>. <u>squamosa</u> by Reyes and Santos (1931), in a yield of 0.14%, but a slightly different formula was later ascribed to it $C_{17}H_{17}O_3N$ (Santos, 1932). From the bark of the closely allied genus <u>Asimina triloba</u>, Manske (1938) isolated the alkaloid annolobine, $C_{17}H_{17}O_3N$. Santos and Reyes (1932) and Barger and Sargent (1939) made studies of the alkaloids of <u>Artabotrys suaveolens</u>, N.O. Annonaceae, and the three alkaloids isolated from the bark by the latter investigators were :

(1)	Artabotrine	0.19%	C ₂₀ H ₂₃ O ₄ N
(2)	Suaveoline	0.0013%	$C_{12}H_{21}O_{4}N$
(3)	Artabotrinine	0.012%	C ₁₈ H ₁₇ O ₃ N

Barger and Sargent (1939) considered artabotrine probably to be ro-hydroxy - 4:5:6-trimethoxy-aporphine : suaveoline, 4:10-dihydroxy-5:6-dimethoxyaporphine; and artabotrinine, 2-methaoxy- 5:6-methylenedioxynoraporphine.

1.3 Insecticidal properties of Annona spp.:

In 1938 a report of the insecticidal effect of A. reticulata upon the scale insect, Lacanium vride Green, was issued by the Mysore Department of Agriculture (1938). Hot alcoholic extracts. water suspensions of the concentrated hot alcoholic extracts of seed and apparently alcoholic extracts of stem, bark and leaf and root bark were tested. All were found to be toxic : "the chemically prepared alcoholic extract of the seed was very toxic at 0.125% strength, a mortality of 70-80% being obtained". It is. however, not guite clear whether the concentration is expressed in terms of the plant material or the extract. Extracts of stem bark, leaf and root bark at 10% concentration gave respectively 100, 70 and 60% mortalities. No information is available as to the method of testing employed, but it was claimed that to this insect the hot alcoholic extracts of the seed of A, reticulata were more toxic than Derris elliptica. As, however, no particulars were given of the analytical characteristics of the derris used. This comparison may possess little value. Tests with other plants including Mundulea Suberosa (Sericea)were carried out. Extracts of none of them approached those of the seed of A. reticulata in potency.

In view of these results a supply of several species of <u>Annona</u> was obtained from Ceylon through the good offices of the colonial office and the Department of Agriculture, Peradeniya, Ceylon. They were <u>A. reticulata</u> (custard-apple), leaves, stem, root and seed; <u>A. palustris</u> (Glabra) (alligator apple), leaves,

stem, root; <u>A</u>. <u>muricata</u> (sour sop), leaves, stem, root, seed; <u>A</u>. <u>squamosa</u> (sugar apple), leaves, stem, root where omitted the seed was not available at the time of collection.

MATERIALS AND METHODS

2. MATERIALS AND METHODS

2.1 Collection of the beetles T. castaneum :

Four strain of <u>Tribolium castaneum</u> i.e. Local, CR-I, FSS-II, (susceptible) and CTC 12 (resistant) were collected from the laboratory culture of the Crop Protection and Toxicology Laboratory, Department of Zoology, Rajshahi University, of which CR-I FSS-II and CTC 12 were previously collected from the Crop Protection Laboratory, Department of Agricultural and Environmental Science, University of Newcastle Upon Tyne, England; during August 1989.

2.2 Culture of the beetles;

Cultures were maintained for each of the strains in a beakers (500 ml) containing food medium and pieces of crumpled filter papers placed inside the food medium for the easy movement of the beetles. The beakers were covered with pieces of cloth at the top and kept in an incubator at $30^{\circ} \pm 0.5^{\circ}$ C without light and humidity control (Plate 1-4).

2.21 Preparation of food medium:

A standard mixture of whole wheat flour with powdered dryyeast (19:1) was used as a food medium throughout the experiments (Park and Frank, 1948; Zyromska-Rudzka, 1966). Both the flour and yeast were priviously passed through a 60-mesh sieve. The food medium was sterilized at 120[°]C for six hours in an oven.

Plate 1.

Culture of T. castaneum in a glass jar.

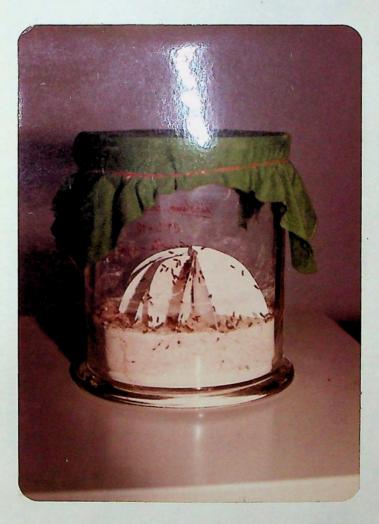
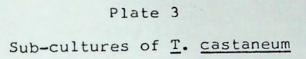


Plate 2.

Culture of \underline{T} . castaneum in an incubator





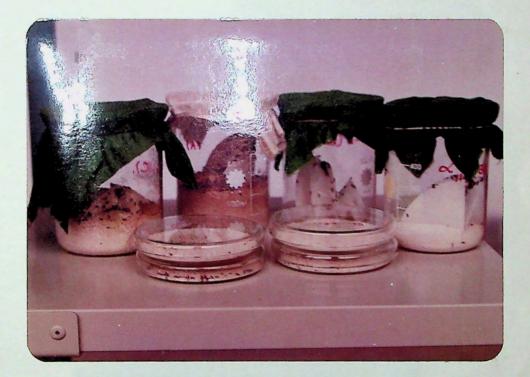


Plate 4.

Drying of collected seeds in an oven



Food was not used until at least 15 days after sterilization to allow its moisture content to equilibrate with the environment.

2.22 Collection of eggs:

About 200 beetles were pleaced in a 500 ml beaker containing food medium. The beaker was covered with a piece of cloth and kept in an incubator at $30^{\circ}C \pm 0.5^{\circ}C$. On the following days the eggs were collected by sieving the food medium through 30-mesh and 60-mesh sieves separating adults and eggs respectively. Eggs were transferred to petridish (30 cm in diametre) incubated in the same temperature.

2.23 Collection of newly hatched larvae:

Larvae hatched in about 5 days in that conditions. Newly hatched larvae were then collected with a fine pointed brush and transferred to the food medium.

2.24 Collection of newly formed adults:

Before starting the experiments a huge number of the flour beetles were reared to get a regular supply of the newly formed adults. For this purpose ten cultures were prepared in large glass jars (120X120 mm). Each jar contained 500 gm of wheat flour properly mixed with appropriate quantity of yeast and 50 pairs (male and female) of the adult insects were released in the medium. In regular intervals the cultures were checked and the eggs and larvae were separated by the previously mentioned method of sieving. When sufficient adults were produced in the sub-cultures they were collected for the experiments by separating them from the food medium. For this purpose some pieces of filter paper were kept inside the jar on the flour. The adult beetles crawled up on the paper. The paper was taken out with the help of a forceps and the beelts were collected in a small beaker (50 ml) with the help of a camel-hair brush.

2.3 Collection of plant seeds and process of extraction:

The seeds of custard apple (<u>A</u>. <u>squamosa</u> L.) were collected and dried in an oven at 60° C for 36 hours. The dried seeds were powdered in a morter and pestle. Extraction of the seeds was done in a soxhlet's apperatus. The solvents used were petroleum spirit, ethyl acetate, acetone, and methanol. The extraction was done in the following way :

At first known quantity of dried seed powder was kept in a thimble. The thimble was then put inside the extraction apparatus and requisite quantity of the solvent was poured inside the apparatus and extraction was done $60^{\circ}C \pm 1^{\circ}C$. Four solvents were used serially according to the order stated above. When extraction completed for one solvent the materials inside the thimble dried and weighed before starting extraction with another solvent (Plate 5 and 6).

Plate 5

E

Extraction of A. squamosa seeds in Soxhelet's apparatus.





Condensation of extract liqued in a rotary vacuum evaporator



2.4 Preparation of doses:

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The extracted liquid was dried in a rotary vacuum evaporator and the dried extracted material then weighed and dissolved in the solvent according to the proportion of dry-weight in seed. This was taken as the highest dose. Then other doses were made by serial dilution with the same solvent (Plate 7).

For each extracted material five doses including control (only solvent) were used to test the mortality rate of <u>T</u>. <u>castaneum</u> adults strainslocal, CR-I, FSS-II and CTC 12, the former three strains are susceptible and the latter was resistant to insecticide. For each dose 1 ml liquid was dropped on a petridish (90 mm) and dried. Four plastic rings (30 mm) were placed inside the petridish and 10 adult beetles were released in each ring. Thus within the petridish each ring served as a replication.

The doses were calculated by measuring the dry-weight of the extract (ugm) in 1 ml of the solvent divided by the surface area of the petridish, i.e. ugm/sq. cm.

2.5 Dose-mortality experiments with seed extracts on the adults:

The petridishes treated with extracted materials having adult beetles were kept in the incubator at $30^{\circ} \pm 0.5^{\circ}$ C. The mortality of the adults were recorded after 12 and 24 hours of treatment. Thus for each of the four extractions from seeds of custard-apple was tested on the adults of the four strains of the beetles <u>T</u>. <u>castaneum</u> having five doses including control (only solvent) with four replications in each. The recorded data were subjected Plate 7.

Preparation of doses and seting of an experiment



to be probit analysis according to Finney (1947) and Busvine (1971).

2.6 Dose mortality experiments with insecticide on the adult:

The insecticide tested on the adults of \underline{T} . <u>castaneum</u> was methacrifos [methyl (E)-3-3(dimethoxyphos-phinothioylony)-2methaylacrylate, commercially available of Damfin 950 Ec of Ciba-Geigy]. This insecticide was diluted in distilled water and the doses were made. The mortality of the adults were also recorded after 12 and 24 hours of the treatment and subjected to probit analysis.

2.7 Dose-mortality experiments with seed extracts on the larvae:

The newly hatched larvae were collected from the stock culture and 40 one day old larvae were placed in a treated glass vial with 1.56 gm. of food (2.7 cm. diametre) with four replications for each dose. The larvae were observed regularly until all pupated. The pupae were collected by sieving the food medium and sexed by microscopic examination of the exo-genital processes of the female pupae (Halstead, 1963). The sexed pupae were kept in the petridish and observed daily for eclosion. The resultant adults were paired (male and female) on the day of the eclosion and placed in a petridish for egg collection and the eggs were collected for 7 days at regularly (Plate 8-11).

The larval and pupal mortality, fecundity and hatchability of eggs from the adults emerged from treated and control larvae were carefully recorded.

Plate 8.

Experimental Larvae.



Plate 9. Treated larvae.



Plate 10.

Wingless pupae resulted from the treated pupae



Plate 11.

Deformed adults resulted from the treated larvae



2.8 Experiments with combined dose of seed extracts and insecticide on the adults:

After completion of the experiments with insecticide and extraction, the lowest dose of the seed extracts and insecticide was combined and tested on the adult <u>T</u>. <u>castaneum</u>. For this purpose the lowest dose of insecticide was made with the four solvents, i.e. Petroleum Spirit, ethylacetate, acetone, and methanol. Then the lowest dose of seed extract in a solvent was properly mixed with the lowest dose of the insecticide in the same solvent. Thus four combined dose were made for four solvents and treated in the petridishes in the same way described previously. So the ecombined doses were made and applied on different strains of <u>T</u>. <u>castaneum</u>. The mortality rate was tested using chi-square based on an expected mortality for the sum of two individual effects as given by Mather (1940).

$x^{2} = \frac{(N_{C} X_{S} X_{A} - X_{C} N_{S} N_{A})^{2} N_{S} N_{A}}{X_{S} X_{A} N_{C} \{ N_{S} N_{A} (N_{S} N_{A} - X_{S} X_{A}) + N_{C} N_{A} N_{A} Y_{S} + N_{C} N_{S} X_{S} Y_{A} \}}$

Where, N_S, N_A and N_C are the total number of insects used in the treatments of toxicant (insecticides), test material and their combined doses respectively.

 X_A , X_S and X_C represents the total numbers of insects surviving in treatments of toxicant (insecticide), test material and their combined doses respectively.

 Y_S and Y_A represent the number of insects killed in toxicant (insecticide) and test material individual treatment respectively, and Y_C represent the number of insects killed in their combined doses.

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Significant chi-square result indicates observed mortality and combined chemicals is greater than expected and synergism is occuring. The combined effects on adult mortality were classified on the criteria for synergism (Hewlett, 1960) as described by Benz (1971).



Data on the adult mortality of <u>T</u>. <u>castaneum</u> with the seed extracts of <u>A</u>. <u>squamosa</u> by different solvents and with the insecticide, methacrifos are presented in Tables 1-10. Results concerning the larval mortality with seed extracts by different solvents, larval period, pupal period, fecundity, and hatchability are presented in Tables 11-24. The mortality due to combined action of methacrifos and plant extractions have been presented in Tables 25-28.

3.1 Effect of seed extractions of <u>A. squamosa</u> on the mortality of adult <u>T. castaneum</u>;

Results on the mortality of <u>T</u>. <u>castaneum</u> local strain are given in Table 1 and Appendix Tables I-VII. Among the four solvents viz., Petroleum Spirit, ethylacetate, acetone, and methanol, the extraction with petroleum spirit showed the highest mortality (100.0%) in the highest dose (4367.99/ugm/sq.cm) both after 12 and 24 hours of treatments. The mortality was recorded as 85.0 and 95.0%; 65.0 and 85.0%; and 87.5 and 92.5% with ethyl acetate, acetone and methanol extractions for 12 and 24 hours after treatments respectively in the highest doses (5497.95 3746.64, and 2343.98/ugm/sq.cm) for the above three extractions (Table 1). The results also shows that the extraction with methanol was more toxic followed by Petroleum Spirit, ethyl acetate, and acetone for both 12 and 24 hours. The LD₅₀ values have been calculated as 405.51 and 206.06/ugm/sq.cm. in Petroleum Spirit extraction, 1749.85 and 548.28/ugm/sq.cm. in ethyl acetate

extraction, and 354.81 and 117.76,ugm/sq.cm in methanol extraction for 12 and 24 hours after treatment respectively. In the extraction with acetone LD₅₀ value (946.24,ugm/sq.cm) have been calculated only for 24 hours after treatments (Table 5).

Results concerning the mortality of CR-I strain are given in Table 2, and Appendix Tables VIII-XIII. The highest doses of 10060.31, 14147.52, 12268.60 and 3109.08 ugm/sq.cm showed the highest mortality of 100.0, and 100.0%; 90.0 and 92.5%; 17.5 and 42.5%; and 95.0 and 97.5, in the extractions Petroleum Spirit, ethyl acetate, acetone and methanol for 12 and 24 hours respectively (Table 2). In this case, methanol was the more toxic then other extractions. The LD₅₀ values have been calculated as 477.53 and 306.90 ugm/sq.cm in Petroleum Spirit and 403.65 and 257.63 ugm/sq.cm in methanol for 12 and 24 hours after treatment respectively. The extractions with ethyl acetate and acetone offered mortality (LD₅₀ values, 2857.59 and 21330.45 ugm/sq.cm) only for 24 hours after treatments (Table 6).

The results on the mortality of FSS-II strain are presented in Table 3 and Appendix Table XIV-XX. The highest mortality of 100.0 and 100.0%; 82.5 and 100.0%; 82.2 and 97.5%; and 100.0 and 100.0%, were observed in the highest doses of 4367.99, 5497.95, 3746.95 and 2343.98 ugm/sq.cm. With the extraction Petroleum Spirit, ethyl acetate, acetone, and methanol for 12 and 24 hours respectively (Table 3). In this strain maximum toxic response was observed with the extraction Petroleum Spirit followed by methanol and ethyl acetate for both 12 and 24 hours after treatments. The LD₅₀ values were 130.02 and 82.04 ugm/sq.cm.

Table 1. Mortality Percentage of Adult <u>T. castaneum</u> (Local) with different doses of seed extract of <u>A. squamosa</u>,

Solvent		Dose ∕ugm/sq.cm	Mortali	ty ^p ercentage After	
<u></u>			12 hours	24 hours	
Petroleum Spirit	Α.	4367.99	100.0	100.0	
Sprire	в.	436.80	50.0	70.0	
	с.	43.68	7.5	12.5	
	D.	4.37	-	2.5	
	0.	Control	-	-	
Ethyl acetate	Α.	5497.95	85.0	95.0	
	в.	549.80	15.0	37.5	
	c.	54.98	2.5	10.0	
	D.	5.50	2.5	5.0	
	٥.	Control	-	-	
Acetone	Α.	3746.64	65.0	85.0	
	в.	374.66	-	1 5.0	
	c.	37.47	-	10.0	
	D.	3.75	-	-	
	0.	Control	-	-	
Methanol	Α.	2343.98	87.5	92.5	
	в.	234.40	42.5	72.5	
	c.	23.44	2.5	10.0	
	D.	2.34		5.0	
	0.	Control			

Table 2. Mortality Percentage of Adult <u>T</u>. <u>castaneum</u> (CR-I) with different doses of seed extract of <u>A</u>. <u>squamosa</u>.

Solvent		Dose ⁄ugm/sq.cm	Mortality Aft	Percentage er
			12 hours	24 hours
Petroleum	Α.	10060.30	100.0	100.0
Spirit	B.	1006.03	75.0	87.5
	c.	100.60	7.5	7.5
	D.	10.06	-	2.5
	0.	Control	-	-
Ethyl acetate	Α.	14147.52	90.0	92.5
	в.	1414.75	12.5	22.5
	c.	141.48	-	2.5
	D.	14.15	-	-
	0.	Control	_	-
Acetone	А.	12268.60	17.5	42.5
	В.	1226.86	2.5	2.5
	с.	122.69		2.5
	D.	12.27	-	-
	0.	Control	-	-
Methanol	Α.	3109.08	95.0	97.5
	в.	310.91	27.5	37.5
	c.	31.09	17.5	22.5
	D.	3.11	7.5	17.5
	0.	Control	5.0	7.5

Table 3. Mortality Percentage of Adult <u>T</u>. <u>castaneum</u> (FSS-II) with different doses of seed extract of <u>A</u>. <u>squamosa</u>,

Solvent	1	Dose ∕ugm/sq.cm	Mortality Afte	
			12 hours	24 hours
Petroleum	Α.	4367.99	100.0	100.0
Spirit	в.	436.80	87.5	92.5
	C.	43.68	15.0	27.5
	D.	4.37	-	5.5
	0.	Control	-	2.5
Ethyl	Α.	5497.95	82.5	100.0
acetate	в.	549.80	7.5	35.0
	c.	54.98	2.5.	7.5
	D.	5,50	2.5	2.5
	0.	Control	_	-
Acetone	Α.	3746.64	82.2	97.5
	в.	374.66	-	32.5
	с.	37.47	-	15.0
	D.	3.75	-	-
	0.	Control	-	-
Methanol	Α.	2343.98	100.0	100.0
	в.	234.40	10.0	27.5
	c.	23.44	7.5	15.0
	D.	2.34	2.5	10.0
	0.	Control	2.5	7.5

Table 4. Mortality Percentage of Adult <u>T</u>. <u>castaneum</u> (CTC12) with different doses of seed extract of <u>A</u>. <u>squamosa</u>,

Solvent		Dose ugm/sq.cm	Mortal	ity Percentage After
			12 hours	24 hours
Petroleum	Α.	4367.99	100.0	100.0
Spirit	в.	436.80	75.0	90.0
	с.	43.68	17.5	25.0
I	D.	4.37		5.0
	0.	Control	-	-
Ethyl acetate	Α.	5497.95	87.5	100.0
	в.	549.80	25.0	67.0
	c.	54.98	7.5	17.5
	D.	5.50		5.0
	0.	Control	-	-
Acetone	Α.	3746.64	100.0	100.0
	в.	374.66	5.0	15.0
	c.	37.47	-	10.0
	D.	3.75	-	7.5
	0.	Control	-	-
Methanol	Α.	2343.98	90.0	95.5
	в.	234.40	87.5	95.0
	c.	23.44	77.5	90.0
	D.	2.34	7.5	15.0
	0.	Control		-

Table 5. LD_{50} , 95% confidence limit and regression equations of seed extracts on the mortality of adult <u>T</u>. <u>castaneum</u> (Local),

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Solvent	LD	50 ^{/ugm/sq.cm}	i -	on equation		
	12 hours (Lower - Upper)•	24 hours	12 hours	24 hours		
Petroleum Spirit	405.51 (234.96-699.84)	206.06 (123.31-344.35)	y≖0.88+1.58x	y≖1.68+1.43x		
Ethyl acetate	1749.85 (1101.54-2779.71)	548.28 (325.09-924.70)	y=0.007+1.52x	x y≖1.96+1.11x		
Acetone	_ `.	946.24 (729.46-1227.44)	-	y = 1.32+1.24x		
Methanol	354.81 (229.09 - 549.54)	117.76 (71.94-192.75)	y=1.14+1.51x	,y≖2•26+1•18x		
	•Figures in parenthesis showed the 95% conf. limit.					
	50	ence limit and regre mortality of adult <u>I</u>				
Solvent	L	^{,D} ₅₀ /ugm/sq.cm After	Regression Afte			
	12 hours (Lower - Upper)•	24 hours (Lower - Upper)	12 hours	24 hours		
Petroleum Spirit	477.53 (290.40-785.24)	306.90 (211.84-444.63)	y=2.15x-0.76	y=0.20+1.93x		
Ethyl acetate	-	285 7. 59 (1945.36-4197.59)	-	y=1.84x-1.36		
Acetone	-	21330.45 (8090.96-56234.13)	-	y=0.19+1.11x		
Methanol	403.65	257.63	y=1.97+1.16x	y=2.80+6.91x		

•Figures in parenthesis showed the 95% conf. limit.

Solvent		lgm∕sq.cm ter	Regression equation After		
	12 hours (Lower - Upper)•	24 hours (Lower - Upper)	12 hours	24 hours	
Petroleum Spirit	130.02 ((91.41-184.93)	82.04 (56.10-119.95)	y=0.36+2.20x	y ≖1. 56+1.80×	
Ethyl acetate	1986.09 (1161.45-3396.25)	769.13 (376.70-1570.36)	y=1.04+1.20x	y=1.53+1.20x	
Acetone	-	393.55 (239.33-647.14)	-	y=1.53+1.34x	
Methanol	629.51 (306.90-1291.22)	457.09 (205.59-1016.25)	y≖0.39+1.65x	y=1.41+1.16x	

Table 7. LD₅₀, 95% confidence limit and regression equations of seed extracts on the mortality of adult <u>T</u>. <u>castaneum</u> (FSS-II).

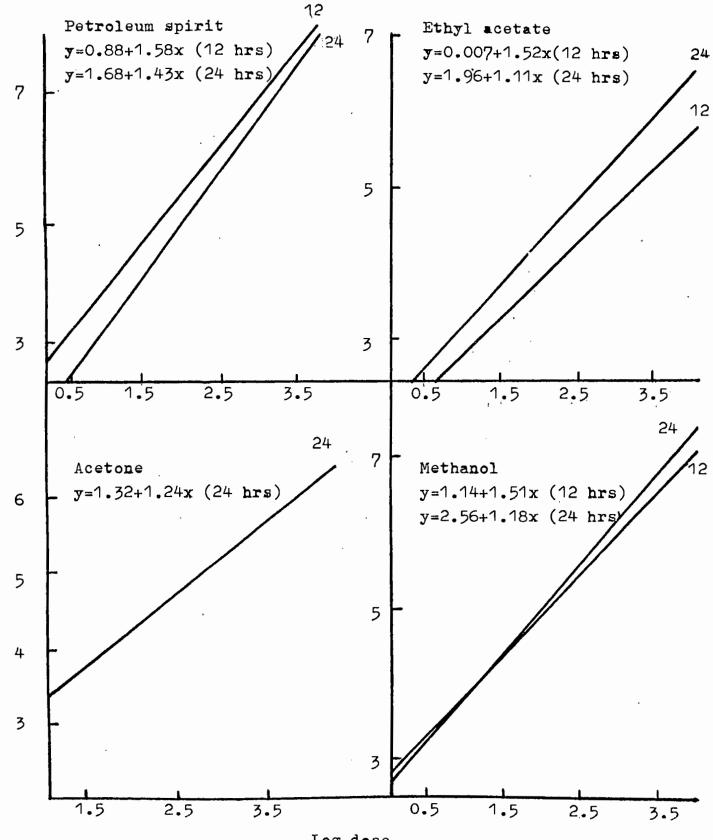
• Figures in parenthesis showed the 95% conf. limit.

Table 8. LD_{50} , 95% confidence limit and regression equations of seed extracts on the mortality of adult <u>T</u>. <u>castaneum</u> (CTC 12).

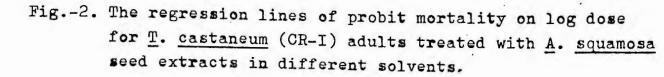
Solvent	,	ugm/sq.cm ter	Regression equation After		
	12 hours (Lower - Upper)•	24 hours (Lower - Upper)	12 hours	24 hcurs	
Petroleum Spirit	168.66 (104.47-272.27)	79.43 (50.82-124.17)	y≖1.38+1.62x	y=2.15+1.50x	
Ethyl acetate	1061.70 (671.43-1678.80)	244.84 (132.43-452.90)	y=0.91+1.35x	y=2.20+1.17x	
Acetone	-	1129.80 (706.32-1807.17)	. –	y=1.96x-0.97	
Methanol	16.90 (8.91-32.06)	7.78 (4.59-13.18)	y≈3.92+0.88x	y ≖3. 93+1.20x	

Figures in parenthesis showed the 95% conf. limit.

Fig.-1. The regression lines of probit mortality on log dose for <u>T</u>. <u>castaneum</u> (Local) adults treated with <u>A</u>. <u>squamosa</u> seed extracts in different solvents.



Probit mortality



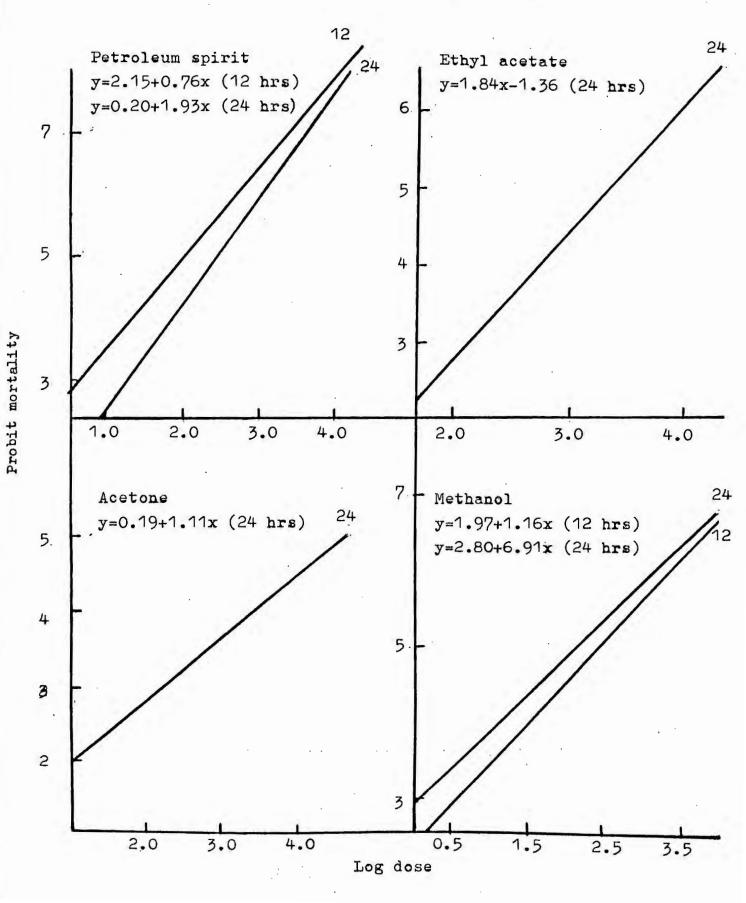


Fig.-3. The regression lines of probit mortality on log dose for <u>T</u>. <u>castaneum</u> (FSS-II) adults treated with <u>A</u>. <u>squamosa</u> seed extracts in different solvents.

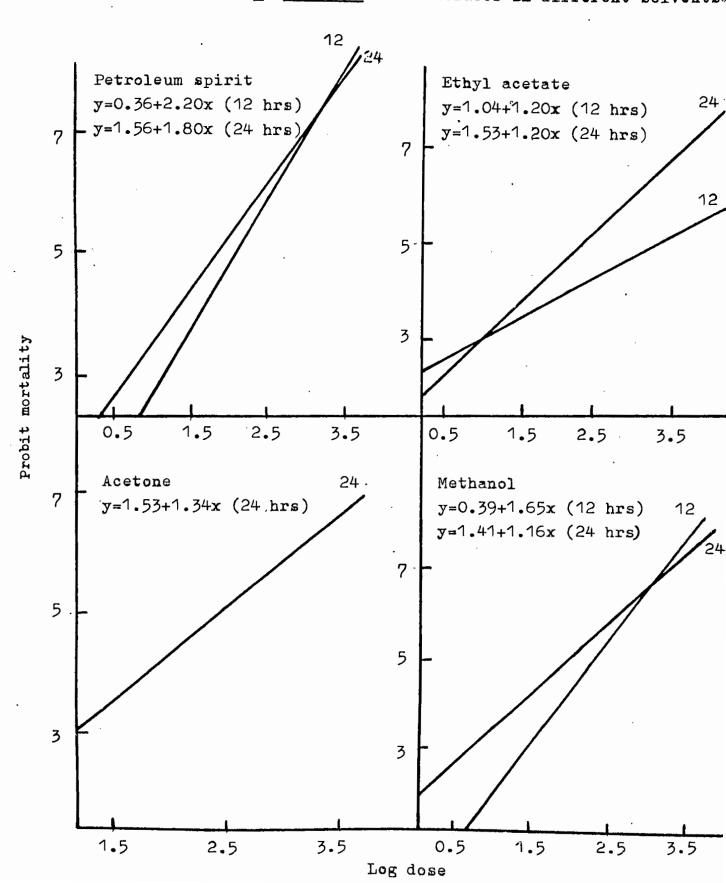
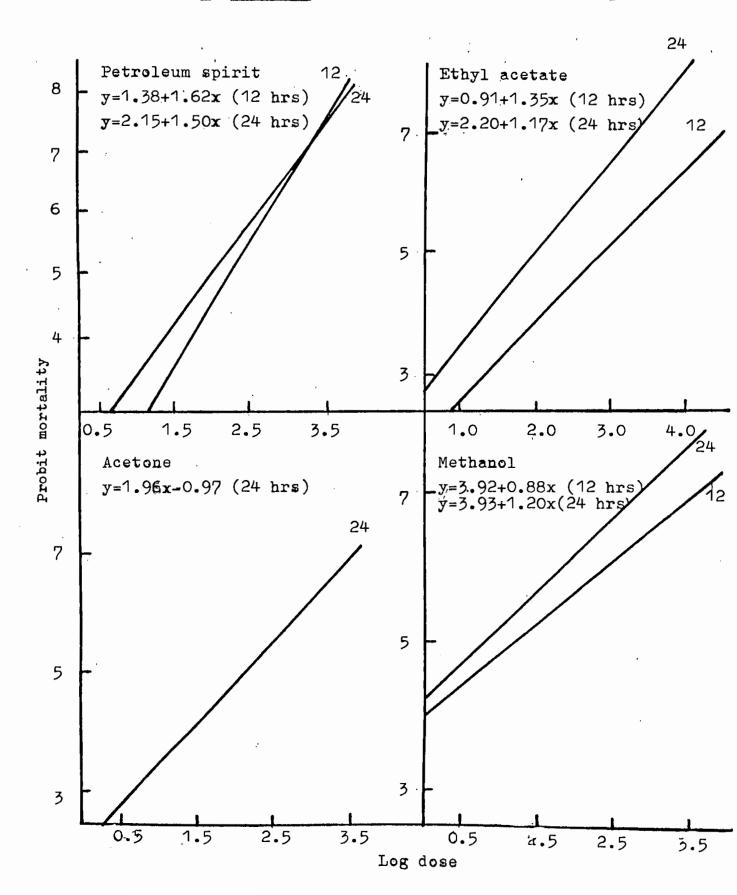


Fig.-4. The regression lines of probit mortality on log dose for <u>T</u>. <u>castaneum</u> (CTC 12) adults treated with <u>A</u>. <u>squamosa</u> seed extracts in different solvents.



in Petroleum Spirit; 1986.09 and 769.13 ugm/sq.cm. in ethyl acetate; 629.51 and 457.09 ugm/sq.cm. in methanol for 12 and 24 hours respectively. In the extraction acetone LD₅₀ value (393.55 ugm/sq.cm.) was recorded only for 24 hours (Table 7).

In case of resistant strain CTC 12(Table 4 and Appendix Tables XXI-XXVII) it was observed that the highest mortality of 100.0 and 100.0%; 87.5 and 100.0%; 100.0 and 100.0%; and 90.0 and 95.5%, were recorded in the highest doses of 4367.99, 5497.95, 3746.64 and 2343.98,ugm/sq.cm. in the extractions Petroleum Spirit, ethyl acetate, acetone and methanol for 12 and 24 hours after treatments respectively (Table 4). After 24 hours treatment the observed LD₅₀ values were 79.43, 244.84, 1129.80 and 7.78,ugm/sq.cm in Petroleum spirit, ethyl acetate, acetone and methanol extractions respectively. Here the extraction methanol showed the highest toxicity on the beetles (Table 8).

The regression equation and 95% confidence limits have also been included in Tables 5-8 for different strains in different extractions of 12 and 24 hours after treatment. The regression lines plotted for the same are presented in Figures 1-4.

3.2 Effect of methacrifos on the mortality of adults. <u>T. castaneum</u>:

Results on the mortality of adult \underline{T} . <u>castaneum</u> with the insecticide methacrifos have been presented in Table 9 and Appendix Tables XXVIII-XXXV. The highest dose 1.493 µgm/sq.cm.

Strain	Dose /ugm/sq.cm	Mortality Percentage	
		12 hours	24 hours
Local	A. 1.493	77.5	90.0
	B. 0.1493	45.0	55.0
	C. 0.01493	37.5	55.0
	D. 0.001493	17.5	52.5
	0. Control	-	-
CR-I	A. 1.493	80.0	100.0
	B. 0.1493	55.0	62.5
	C. 0.01493	37.5	57.5
	D. 0.001493	25.0	37.5
	0. Control	-	-
FSS-II	A. 1.493	87.5	95.0
	B. 0.1493	55.0	62.5
	C. 0.01493	25.0	50.0
	D. 0.001493	20.0	35.0
	0. Control	-	-
CTC-12	A. 1.493	50.0	62.5
	B. 0.1493	38.0	50.0
	C. 0.01493	20.0	47.5
	D. 0.001493	12.5	32.5
	0. Control	-	-

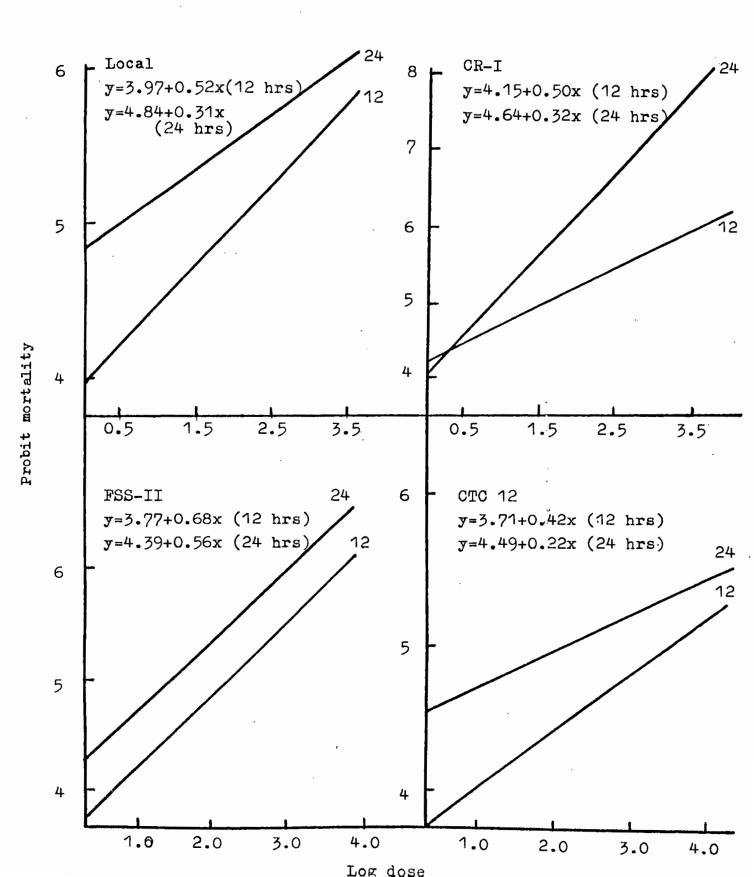
Table 9. Mortality percentage of Adult <u>T</u>. <u>castaneum</u> treated with methacrifos,

Table 10. LD_{50} , 95% confidence limit and regression equations of methacrifos on the mortality of adult <u>T</u>. <u>castaneum</u>,

Strain	LD ₅₀ /ugm	a/sg.cm	Regressi	on equation
	After	5	Af	ter
	12 hours (Lower - Upper)•	24 hours (Lower - Upper)	12 hours	24 hours
Local	0.0977 (0.0382-0.250)	0.0034 (0.00042-0.0273)	y=3.97+0.52x	y≖4.84+0.31x
CR-I	0.0510 (0.0201-0.1312)	0.0135 (0.0022-0.0828)	y=4.15+0.50x	y=4.64+0.32x
FSS-II	0.0631 (0.0303-0.1315)	0.0120 (0.0046-0.0314)	y=3.77+0.68x	y≖4.39+0.56x
CTC 12	1.176 (0.2087-6.6300)	0.0741 (0.0091-0.6012)	y=3.71+0.42x	y=4.49+0.22x

• Figures in parenthesis showed the 95% conf. limit.

Fig-5. The regression lines of probit mortality on log dose for different strains of \underline{T} . <u>castaneum</u> adults treated with methacrifos,



showed the maximum mortality in FSS-II (87.5%) followed by CR-I (80.0%) local (77.5%) and CTC 12 (50.5%) for 12 hours after treatments while after 24 hours after treatments the highest mortality was observed in CR-I (100.0%) followed by FSS-II (95.0%) local (90.0%) and CTC 12 (62.5%) (Table 9). The LD 50 values 0.0977 and 0.0034; 0.051 and 0.0135; 0.0631 and 0.012; and 1.176 and 0.0741 ugm/sq.cm. were calculated for 12 and 24 hours after treatments for local, CR-I, FSS-II, and CTC 12 strains respectively (Table 10). The result $_A$ also indicate that for 12 hours treatment CR-I strain showed maximum susceptibility to insecticide methacrifos followed by FSS-II, CTC 12 and local. For 24 hours treatment more toxicity were observed in local strain followed by FSS-II, CR-I, and CTC 12. The regression equations and 95% confidence limits are presented in Table 10 and the regression lines are presented in figure 5.

3.3 Effect of seed extractions of <u>A. squamosa</u> on the mortality of larvae of <u>T. castaneum</u>.

The mortality of larvae of different strains of <u>T</u>. <u>castaneum</u> with variable doses of extraction in different solvents have been presented in Tables 11-14 and Appendix Tables XXXVI-LI. The tables also included LD_{50} with 95% confidence limit and regression equations. The regression lines are presented in Figure 6-9.

For local strain it was observed that the extraction extracted with petroleum spirit offered the highest mortality followed by ethyl acetate and methanol. The LD₅₀ in/ugm/sq.cm. has been calculated as 0.0293, 0.395, 0.6893, and 4.130 at

Table 11. Mortality percentage, LD_{50} , 95% confidence limit and regression equation of seed extracts on <u>T</u>. <u>castaneum</u> (Local) larvae.

Solvent	Dose /ugm/sq.cm	Mortality percentage	LD ₅₀ /ugm/sq.cm (Lower-Upper)*	Regression equation
Petroleum	A. 48.53	97.5	0.0293	y=4.74 + 0.55x
Spirit	B. 4.853	(0.0059-0.1455) 87.5		
	C: 0.4853	80.0		
	D. 0.04853	60.0		
	0. Control	12.5		
Ethyl	A. 61.08	92.5	0.3950	y=3.85 + 0.72x
	B. 6.108	82.5	(0.1832-0.8531)	
	C. 0.6108	77.5		
	D. 0.06108	30.0		
C	0. Control	15.0		
Acetone	A. 41.63	92.5	0.6893 (0.3524-1.3450)	y=3.60 + 0.76x
	B. 4.163	80.0	(0,3524-1,3450)	
	C. 0.4163	52.5		
	D. 0.04163	35.0		
	0. Control	20.0		
Methanol	A. 26.04	75.0	4.130 (2.051-8.318)	y=3.30 + 0.65x
	B. 2.604	60.0	(2.031-0.510)	
	C. 0.2604	40.0		
	D. 0.02604	27.5		
	0. Control	22.5		

•Figures in parenthesis showed the 95% conf. limit.

Solvent	Dose /ugm/sq.cm	Mortality percentage	LD ₅₀ ∕ugm/sq.cm (Lower-Upper)•	Regression equation
Petroleum Spirit	A. 48.53	97.5	0.0101 (0.0011-0.0923)	y≖4.85 + 0.51x
	B. 4.853	90.0		
	C. 0.4853	85.0		
	D. 0.04853	65.0		
	0. Control	22.5		
Ethyl acetate	A. 61.08	95.0	0.0436 (0.0277-0.0685)	y=4.64 + 0.55x
	B. 6.108	90.0		
	C. 0.6108	82.5		
	D. 0.06108	57.5		
	0. Control	15.0		
Acetone	A. 41.63	95.0	0.2673 (0.1274-0.5610)	y≖3.93 + 0.75×
	B. 4.163	87.5		
	C. 0.4163	67.5		
	D. 0.04163	42.5		
	0, Control	22.5		
Methanol	A. 26.04	100.0	0.0597 (0.0213-0.1671)	y=4.48 + 0.67x
	B. 2.604	87.5		
	C. 0.2604	70.0		
	D. 0.02604	45.0	•••	
	0. Control	7.50		

Table 12. Mortality percentage, LD_{50} , 95% confidence limit and regression equation of seed extracts on <u>T</u>. <u>castaneum</u> (CR-I) larvae.

•Figures in parenthesis showed the 95% conf. limit.

Table 13.	Mortality percentage, LD ₅₀ , 95% confidence limit
	and regression equation of seed extracts on \underline{T}_{\bullet}
	<u>castaneum</u> (FSS-II) larvae,

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Solvent	Dose /ugm/sq.cm	Mortaluty percentage	LD ₅₀ /ugm/sq.cm (Lower-Upper)	Regression equation
Petroleum	A. 48.53	100.0	0.0448 (0.0133-0.1503)	y=4.82 + 0.70x
Spirit	B. 4.853	92.5	(0.0133=0.1303)	
	C. 0.4853	80.0		
	D. 0.04853	60.0		
	0. Control	15.0		
Ethyl	A. 61.08	90.0	0.2163 (0.1107-0.4227)	y=4.23 + 0.58x
acetate	B. 6.108	87.5		
	C. 0.6108	70.0		
	D. 0. p 6108	40.0		
	0. Control	12.5		
Acetone	A. 41.63	97.5	0.0286 (0.0046-0.1791)	y=4.79 + 0.46x
	B. 4.163	82.5	(0.0040-0.1791)	
·	C. 0.4163	70.0		
	D. 0.04163	65.0		
	0. Control	15.0		
Methanol	A. 26.04	62.5	15.539	y=3.66 + 0.42x
	B. 2.604	52.5	(14.588-16.443)	
	C. 0.2604	42.5		
	D. 0.02604	30.0		
	0. Control	22.5		

•Figures in parenthesis showed the 95% conf. limit.

Solvent	Dose ∕ugm/sq.cm	Mortality percentage	LD _{50/} ugm/sq.cm (Lower-Upper)•	Regression equation	
Petroleum Spirit	A. 48.53	100.0	0.0539	y=4.34 + 0.90x	
	B. 4.853	97.5	(0.0356-0.0817)		
	C. 0.4853	82.5			
	D. 0.04853	60.0			
	0. Control	20.0			
Ethyl acetate	A. 61.08	77.5	0.4046 (0.1061-1.5430)	y=4.55 + 0.28x	
	B. 6.108	72.5	(0.1061-1.5450)		
	C. 0.6108	65.0			
	D. 0.06108	52.5			
	0. Control	22.5			
Acetone	A. 41.63	95.0	0.0785 (0.0329-0.1875)	y=4.32 + 0.76x	
	B. 4.163	90.0	(0.032)=0.10737		
	C. 0.4163	72.5			
	D. 0.04163	52.5			
	0. Control	20.0			
Methanol	A. 26.04	95.0	0.0153	y=4.92 + 0.43x.	
	B. 2.604	85.0	(0.0021-0.1148)		
	C. 0.2604	75.0			
	D. 0.02604	62.5			
	0. Comtrol	17.5			

Table 14. Mortality percentage, LD_{50} , 95% confidence limit and regression equation of seed extracts on <u>T</u>. <u>castaneum</u> (CTC 12) larvae.

•Figures in parenthesis showed the 95% conf. limit.

Fig-6. The regression lines of probit mortality on log dose for \underline{T} . <u>castaneum</u> (Local) larvae treated with <u>A</u>. <u>squamosa</u> seed extracts in different solvents.

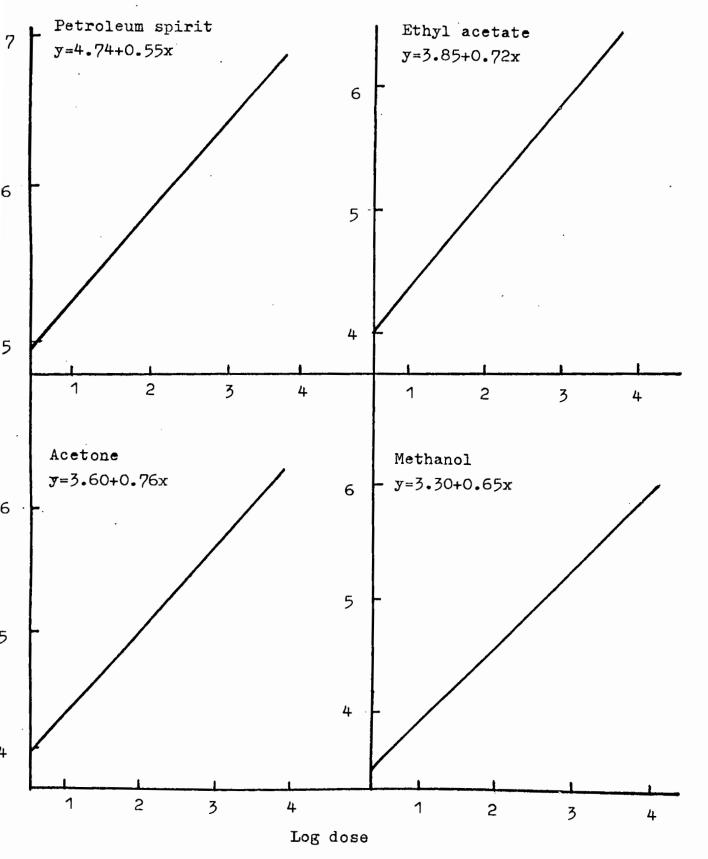


Fig-7. The regression lines of probit mortality on log dose for <u>T. castaneum</u> (CR-I) larvae treated with <u>A. squamosa</u> seed extracts in different solvents.

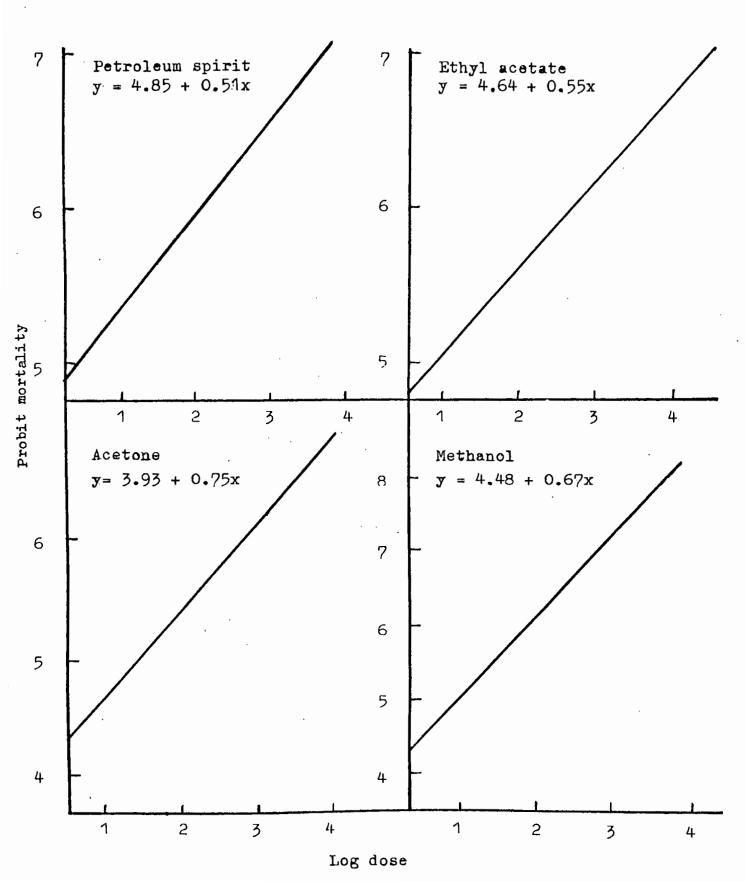


Fig-8. The regression lines of probit mortality on log dose for <u>T</u>. <u>castaneum</u> (FSS-II) larvae treated with <u>A</u>. <u>squamosa</u> seed extracts in different solvents,

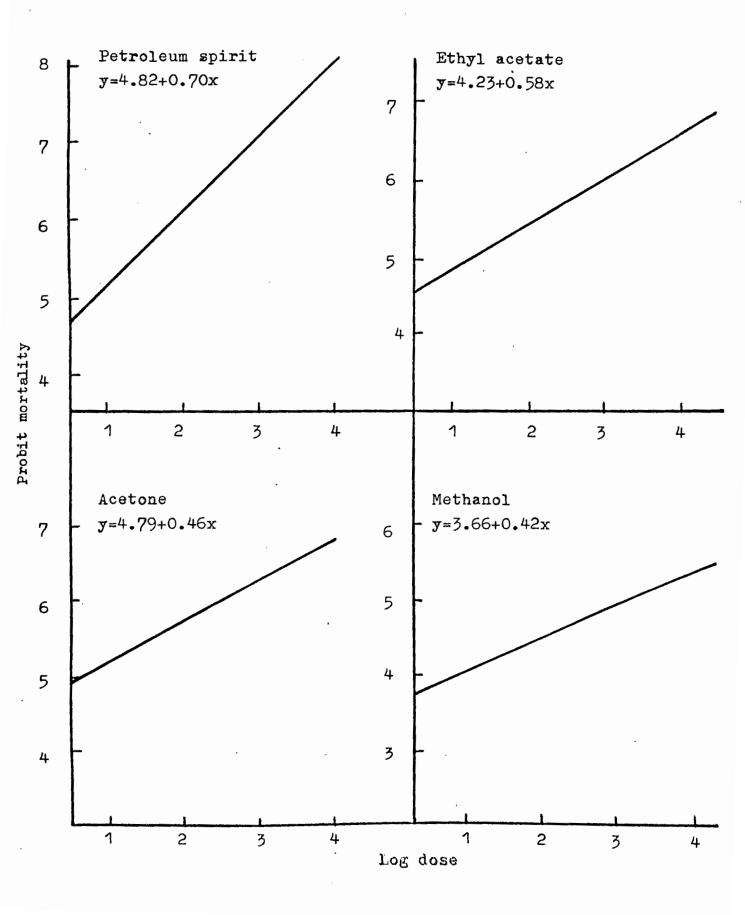
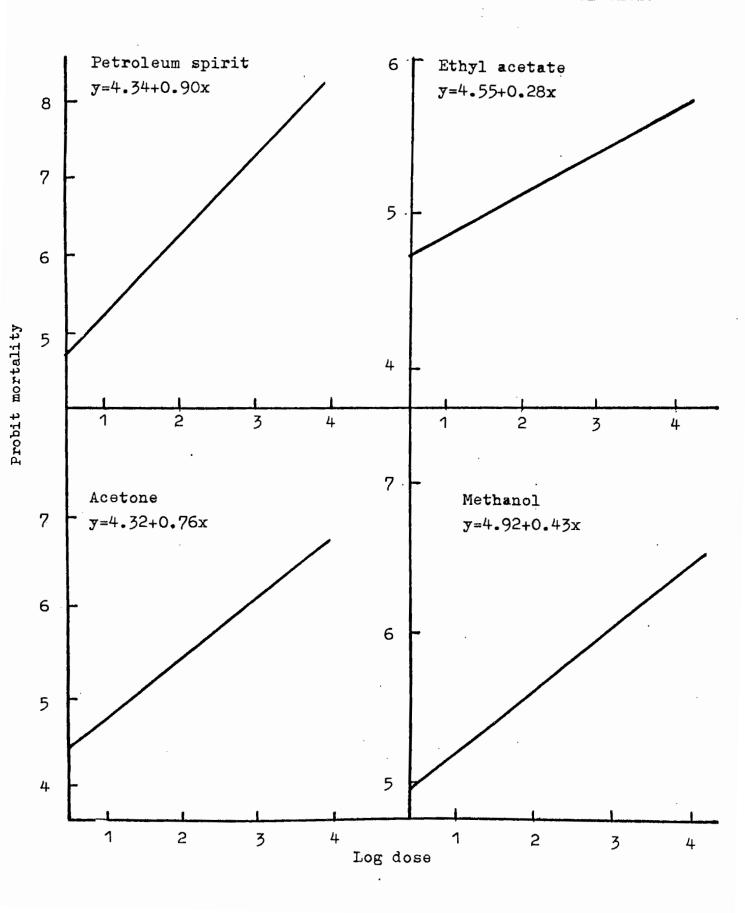


Fig-9. The regression lines of probit mortality on log dose for \underline{T} . <u>castaneum</u> (CTC 12) larvae treated with <u>A. squamosa</u> seed extracts in different solvents.



petroleum spirit, ethyl acetate, acetone, and methanol extractions respectively. For CR-I strain the LD₅₀ values were 0.0101, 0.0436, 0.2673, and 0.0597/ugm/sq.cm. in the above extractions respectively. In case of FSS-II strain the values were 0.0448, 0.2163, 0.0286 and 50.539/ugm/sq.cm, and for CTC 12 strain the values were 0.0539, 0.4046, 0.0785 and 0.0513/ugm/sq.cm. in the above mentioned extraction respectively. From the results it has been observed that seed extractions with petroleum spirit offered the highest mortality of larvae.

3.4 Effect of seed extraction of <u>A</u>. <u>squamosa</u> on the duration of the immature stages of <u>T</u>. <u>castaneum</u> :

The larvae treated with different doses of seed extract in different solvents showed variable larval periods which are presented in Table 15 and Figure 10. It was observed that in all cases the larval period prolonged with respect to control.

The analysis of variance on the larval period between the strains and between the doses has been shown in Appendix Table LII-LV. The larval period of the treated larvae was insignificant within doses and control and within strains, when they treated with petroleum spirit extraction. But in case of ethyl acetate, acetone, and methanol extractions larval period of the treated larvae significantly varied with control (P \leq 0.001).

The pupal period was also effected with the larval treatment of extractions and it varied with control in all extractions (Table 16 and Figure 11). The analysis of variance of the pupal period among different doses and control showed similar trand as

Table 15.	Larval period (mean \pm SD) of different strains of
	T. castaneum treated with different extractions.

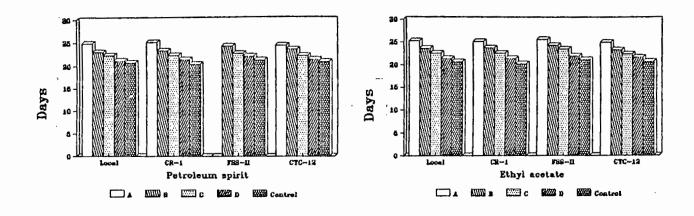
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Solvent	Dośes /ugm/sq.cm	Strain				
		Local	CR-I	FSS-II	CTC 12	
Petroleum Spirit	A. 48.53	24.89 <u>+</u> 0.140	25.10 <u>+</u> 0.143	-	24.28 <u>+</u> 0.130	
	B. 4.853	23.05 <u>+</u> 0.150	23.21 <u>+</u> 0.157	24.31 <u>+</u> 0.223	2 3. 51 <u>+</u> 0.120	
	C. 0.4853	22 . 27 <u>+</u> 0.141	22 . 20 <u>+</u> 0.086	22.56 <u>+</u> 0.217	22.13 <u>+</u> 0.135	
	D. 9.04853	21.18 <u>+</u> 0.104	21.21 <u>+</u> 0.144	21 . 94 <u>+</u> 0.217	21.28 <u>+</u> 0.093	
	0. Control	20.62 <u>+</u> 0.082	20.20 <u>+</u> 0.066	21.09 <u>+</u> 0.140	20.76 <u>+</u> 0.105	
Ethyl acetate	A. 61.08	25.19 <u>+</u> 0.081	25.07 <u>+</u> 0.142	25.61 <u>+</u> 0.158	25.04 <u>+</u> 0.163	
	B. 6.108	23.59 <u>+</u> 0.120	23.71 <u>+</u> 0.105	24.35 <u>+</u> 0.152	23.40 <u>+</u> 0.126	
	C. 0.6108	22 . 50 <u>+</u> 0.100	22.53 <u>+</u> 0.181	23.48 <u>+</u> 0.121	22.46 <u>+</u> 0.110	
	D. 0.06108	21.38 <u>+</u> 0.121	21.35 <u>+</u> 0.188	21.99 <u>+</u> 0.156	21.71 <u>+</u> 0.109	
	0. Control	20.62 <u>+</u> 0.082	20.20 <u>+</u> 0.066	21.09 <u>+</u> 0.140	20.76 <u>+</u> 0.105	
Acetone	A. 41.63	25.48 <u>+</u> 0.142	25.13 <u>+</u> 0.155	25.60 <u>+</u> 0.243	25.41 <u>+</u> 0.152	
	B. 4.163	24.24 <u>+</u> 0.141	23.22 <u>+</u> 0.210	24 . 35 <u>+</u> 0.152	24.74 <u>+</u> 0.093	
	C. 0.4163	23.21 <u>+</u> 0.116	22.50 <u>+</u> 0.132	23.48 <u>+</u> 0.121	23.25 <u>+</u> 0.186	
	D. 0.04163	22.05 <u>+</u> 0.107	21.30 <u>+</u> 0.112	21.99 <u>+</u> 0.156	22 . 17 <u>+</u> 0.154	
	0. Control	20.62 <u>+</u> 0.082	20.20 <u>+</u> 0.066	21.09 <u>+</u> 0.140	20.76 <u>+</u> 0.105	
Methanol	A. 26.04	24.70 <u>+</u> 0.084	25.15 <u>+</u> 0.125	25.02 <u>+</u> 0.181	24.83 <u>+</u> 0.194	
	B. 2.604	23.72 <u>+</u> 0.101	23.61 <u>+</u> 0.111	23.65 <u>+</u> 0.168	23.26 <u>+</u> 0.173	
	C. 0.2604	22.34 <u>+</u> 0.109	22.46 <u>+</u> 0.136	22.42 <u>+</u> 0.186	22.44 <u>+</u> 0.199	
	D. 0.02604	21.10 <u>+</u> 0.128	21.19 <u>+</u> 0.089	21.36 <u>+</u> 0.185	21.82 <u>+</u> 0.114	
	0. Control	20.62 <u>+</u> 0.082	20.20 <u>+</u> 0.066	21.09 <u>+</u> 0.140	20.76 <u>+</u> 0.105	

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Solvent		Doses	Strain			
		/ugm/sq.cm	Local	CR-I	FSS-II	СТС 12
Petroleum Spirit	Α.	48.53	6.88 <u>+</u> 0.059	6.85 <u>+</u> 0.077	_	7.12 <u>+</u> 0.058
	в.	4.853	6.68 <u>+</u> 0.052	6.69 <u>+</u> 0.068	6•73 <u>+</u> 0•075	6.82 <u>+</u> 0.084
	c.	0.4853	6.37 <u>+</u> 0.069	6.21 <u>+</u> 0.054	6.32 <u>+</u> 0.058	6.42 <u>+</u> 0.048
	D.	0.04853	6.07 <u>+</u> 0.058	5.92 <u>+</u> 0.054	5.92 <u>+</u> 0.073	6.19 <u>+</u> 0.049
	0.	Control	5.81 <u>+</u> 0.039	5.61 <u>+</u> 0.058	5.43 <u>+</u> 0.054	5.91 <u>+</u> 0.054
Ethyl acetate	Α.	61.08	6.80 <u>+</u> 0.073	6.79 <u>+</u> 0.059	6.66 <u>+</u> 0.068	7.06 <u>+</u> 0.048
	в.	6.108	6.52 <u>+</u> 0.062	6.53 <u>+</u> 0.047	6.41 <u>+</u> 0.062	6.77 <u>+</u> 0.062
	c.	0.6108	6.26 <u>+</u> 0.060	6 . 17 <u>+</u> 0.049	6.05 <u>+</u> 0.072	6 . 47 <u>+</u> 0.054
	D.	0.06108	5.95 <u>+</u> 0.045	5.76 <u>+</u> 0.057	5.73 <u>+</u> 0.091	6.12 <u>+</u> 0.050
	0.	Control	5.81 <u>+</u> 0.039	5.61 <u>+</u> 0.058	5.43 <u>+</u> 0.054	5.91 <u>+</u> 0.054
Acetone	۸.	41,63	6.83 <u>+</u> 0.038	6.86 <u>+</u> 0.054	6.81 <u>+</u> 0.071	6.95 <u>+</u> 0.075
	Β.	4.163	6.65 <u>+</u> 0.054	6.45 <u>+</u> 0.051	6.57 <u>+</u> 0.048	6.60 <u>+</u> 0.057
	c.	0.4163	6.45 <u>+</u> 0.046	6.18 <u>+</u> 0.061	6.26 <u>+</u> 0.059	6.40 <u>+</u> 0.070
	D.	0.04163	6.14 <u>+</u> 0.047	5. 91 <u>+</u> 0.058	5.73 <u>+</u> 0.068	6.16 <u>+</u> 0.047
	0.	Control	5.81 <u>+</u> 0.039	5.61 <u>+</u> 0.058	5.43 <u>+</u> 0.054	5.91 <u>+</u> 0.054
Methanol	Α.	26.04	6.76 <u>+</u> 0.065	.6.91 <u>+</u> 0.067	6.74 <u>+</u> 0.076	7.16 <u>+</u> 0.055
	в.	2.604	6.50 <u>+</u> 0.064	6•54 <u>+</u> 0•056	6.47 <u>+</u> 0.083	6.77 <u>+</u> 0.049
	c.	0.2604	6.23 <u>+</u> 0.048	6.29 <u>+</u> 0.057	6 .19<u>+</u>0.0 62	6.52 <u>+</u> 0.066
	D,	0.02604	6.08 <u>+</u> 0.039	5.85 <u>+</u> 0.064	5.81 <u>+</u> 0.061	6.23 <u>+</u> 0.050
	0.	Control	5.81 <u>+</u> 0.039	5.61 <u>+</u> 0.058	5.43 <u>+</u> 0.054	5.91 <u>+</u> 0.054



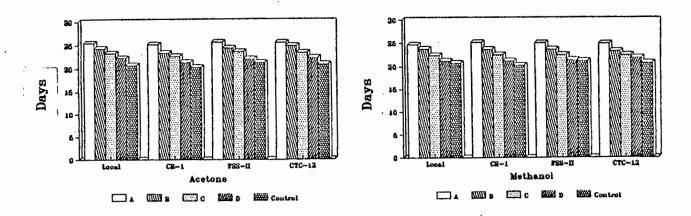
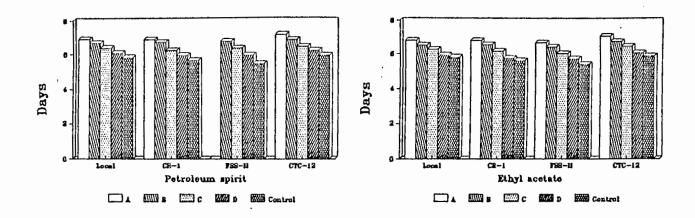


Fig10. Larval period by different strains of *T.castaneum* in different doses seed extraction of *A. squamosa* by different solvents.

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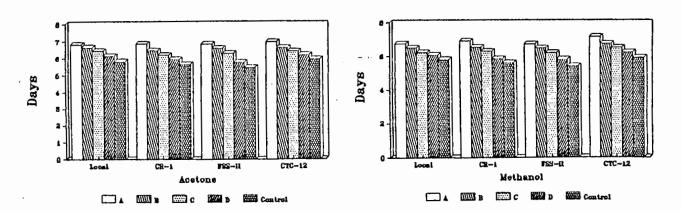


Fig1]. Pupal period by different strains of *T.castaneum* in different doses seed extraction of *A.squamosa* by different solvents.

as observed for larval period, i.e., only the pupae and larvae of ethyl acetate, acetone and methanol extractions showed significance difference with control and for petroleum spirit extraction treated larvae the pupal period was insignificant (Appendix Tables LVI-LIX).

3.5 Fecundity and hatchability of eggs of the adults resulted from the treated larvae with plant extracts : >

The adults emerged from the treated larvae were kept for oviposition and the number of eggs laid in first saven days has been presented in Tables 17-20 and Figure 12. It was observed that the larvae treated with the extraction in petroleum spirit gave the adults which oviposited 4.14, 7.14, 10.71, 14.00, and 22.42 eggs per day in A, B, C, D doses and control respectively for Local strain. The fecundity was 3.71, 6.71, 9.42, 14.57, and 21.85 for CR-I strain; in the above doses respectively. In FSS-II and CTC 12 strain 100% mortality of larvae occure in the highest dose A. In doses B,C,D and control the fecundity was recorded as 8.00, 11.85, 16.57, and 24.00, for FSS-II strains and 4.71, 7.71, 12.14, and 21.14 in CTC 12 strains respectively.

For the extraction with ethyl acetate the fecundity was recorded for Local strain as 4.71, 9.42, 13.00, 16.14 and 24.14; in CR-I strain it was 4.42, 7.57, 11.85, 16.14 and 23.71; in FSS-II strain it was 6.57, 10.85, 14.14, 19.24 and 24.28; and in CTC 12 strain the fecundity was 7.28, 11.57, 15.75, 19.57 and 25.14 eggs per day per female in the doses A, B, C, D and control respectively. For the extraction with acetone the

fecundity was recorded for local strain as 4.14, 7.57, 11.71, 17.71, and 23.42; in CR-I strain if 7.28, 10.57, 13.85, 18.71 and 24.42; in FSS-II strain it was 6.85, 10.28, 13.85, 19.14, and 24.57; and CTC 12 strain the fecundity was 7.71, 11.57, 16.00, 19.42 and 26.00 eggs per day per female in the doses A, B, C, D and control respectively. For the extraction with methanol the fecundity was recorded for Local strain as 6.42, 8.57, 13.28, 19.28, and 25.71; in CR-I strain it was 6.71, 10.28, 13.38, 18.42, and 25.14; in FSS-II strain it was 4.57, 8.42, 13.71, 18.42, and 23.57; and CTC 12 strain the fecundity was 7.42, 10.85, 15.57, 19.71 and 24.14 eggs per day per female in the doses A, B, C, D and control respectively.

In all cases the fecundity among different dose of all extractions differ significantly (P<0.001). But in case of the fecundity among different strains with petroleum spirit extraction it differ significantly (P<0.05) and the mean number of eggs laid per day per female of CTC 12 strain significantly differ with all other strains. There occured no significant difference between the mean number of eggs laid of local and CR-I strain (Appendix Table LX). In ethyl acetate extraction the mean number of eggs laid among the four strain differ significantly, and the LSD value 0.1% level of significance shows that there is no differences among the number of eggs laid of local, CR-I, and among FSS-II and CTC 12 strains (Appendix Tables LXI). In acetone extraction the fecundity (Appendix Table LXII) among different strains differ significantly (P<0. ϕ 01). But in case of methanol extraction the LSD value at 5% level of significance

shows that the mean number of eggs laid of FSS-II strain significantly differ with CR-I and CTC 12 only (Appendix Table LXIII). So it was observed that the control insects always laid more eggs than the adults emarged from the treated larvae with extractions.

The hatchability of the eggs laid by the adults emarged from the treated and control larvae has been presented in Tables 21-24. It was observed that the hatchability of the eggs laid by the female emarged from the petroleum spirit treated larvae were 43.06, 46.94, 55.95, 61.94, and 100.0% in A, B, C, D doses and control respectively for local strain. It was 46.67, 51.50, 59.23, 63.50 and 96.61% for CR-I strain; in the above doses respectively. In FSS-II and CTC 12 strain 100% mortality of larvae was occur in the highest doses A. In doses B, C, D and control the hatchability was recorded as 45.34, 51.23, 56.37 and 98.44%, for FSS-II strain and 46.77, 53.08, 59.34 and 100.0% in CTC 12 strain respectively.

For the extraction with ethyl acetate the hatchability was recorded for local strain as 44.55, 50.94, 58.19, 62.86 and 100.0%; in CR-I strain it was 44.36, 49.64, 52.86, 60.27, and 98.70%; in FSS-II strain it was 50.41, 55.05, 60.01, 64.72, and 99.10%; and CTC 12 strain in hatchability was 51.77, 54.36, 58.83, 65.49 and 100.0% in the doses A, B, C, D and control respectively. For the extraction with acetone the hatchability was recorded for local strain as 40.69, 44.68, 53.66, 63.43 and 100.0%; in CR-I strain it was 50.48, 53.59, 58.06, 64.05 and

Table 17. The number of egg-laid by <u>T</u>. <u>castaneum</u> per female per day in different doses of petroleum spirit seed extraction of <u>A</u>. <u>squamosa</u>.

Strain	Doses /ugm/sq.cm			Replic	ation	(days)			Mean
	/	1	2	3	4	5	6	7	
Local	A. 48.53	1	2	3	3	6	6	8	4.14
	B. 4.853	2	3	4	7	9	11	14	7.14
	C. 0.4853	3	5	6	9	13	17	22	10.71
	D. 0.04853	5	6	7	12	17	22	29	14.00
	0. Control	. 8	8	. 10	19	30	36	46	22.42
CR-I	A. 48.53	1	1	3	3	4	6	8	3.71
	B. 4.853	2	3	4	6	7	· 10	15	6.71
	C. 0.4853	2	3	5	9	13	15	19	9.42
	D. 0.04853	4	6	7	13	19	22	31	14.57
	0, Control	7	9	9	21	29	35	43	21.85
FSS-II	A. 48.53			-	_	_	_	-	-
	B. 4.853	2	3	6	7	11	12	15	8.00
•	C. 0.4853	4	6	8	11	13	19	22	11.85
	D. 0.04853	5	8	10	19	20	24	30	16.57
	0. Control	7	10	13	29	31	36	42	24.00
CTC 12	A. 48.53	-	-			-		-	-
	B. 4.853	1	2	3	5	6	7	9	4.71
	C. 0.4853	2	.4	5	. 7	9	12	15	7.71
	D. 0.04853	4	6	· 7	12	15	19	22	12.14
	0. Control	7	10	12	20	`29	27	43	21.14

Table 18.	The number of egg-laid by \underline{T} . castaneum per female
	per day in different doses of Ethyl acetate seed
	extraction of A. squamosa,

<u>Chundun</u>		•							
Strain	Doses /ugm/sq.cm					(days)			Mean
	// 	1	2	3	4	5	6	7	
Local	A. 61.08	1	2	4	5	、 [*] 5	7	9	4.71
	B. 6.108	3	4	6	9	11	15	18	9.42
	C. 0.6108	4	6	7.	12	16	20	26	13.00
• •	D. 0.06108	. 5	. 7	, 9	15	. 19	24	34	16.14
	0. Control	9	11	12	23	34	38	42	24.14
CR-I	A. 61.08	1	2	3	4	4	7	10	4.42
	B. 6.108	1	3	4	5	9	14	17	7.57
	C. 0.6108	3	5	6	9	<i>.</i> 16	19	25	11.85
	D. 0.06108	5	· 7	9	14	20	26	, 3 2	16.14
	0. Control	9	10	11	26	33	37	40	23.71
FSS-II	A. 61.08	2	3	4	7	8	10	12	6.57
	B. 6.108	3	5	· 7	10	12	17	22	10.85
	C. 0.6108	4	·. 6	. 8	15	18	22	26	14.14
	D. 0.06108 ·	⁻ 6	9.	11	22	23	30	35	19.42
·	0. Control	8	11 .	12	26	.34	38	41	24.28
CTC 12	A. 61.08	2	2	4	7	10	11	15	7.28
-	B. 6.108	3	5	6	13	12	17	25	11.57
÷ .	C. 0.6108	4	6	7	16	20	25	31	15.75
	D. 0.06108	6	8	9	21	25	31	37	19.57
	0. Control	· 9	11	14	25	31	36	50	25.14

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Table 19. The number of egg-laid by <u>T</u>. <u>castaneum</u> per female per day in different doses of Acetone seed extraction of <u>A</u>. <u>squamosa</u>.

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Strain	Doses	i 1		Replic	+100	(daya)			1
	/ugm/sq.cm	1	2	Replica	,				Mean
		L			4	5	6	7	· · · · · · · · · · · · · · · · · · ·
Local	A. 41.63	1	2	3	4	. 5	6	8	4.14
	B. 4.163	2	3	6	. 7	9	11	15	7.57
	C. 0.4163	3	6	8	11	14	18	22	11.71
	D. 0.04163	6	7	9	19	21	29	33	17.71
	0. Control	7	9	11.	24	31	34	48	23.42
CR-I	A. 41.63	. 2	2	3	7	11	12	14	7.28
	B. 4.163	3	4	5	11	13	17	21	10.57
	C. 0.4163	4	6	6	14	. 17	23	27	13.85
	D. 0.04163	6	8	- 9	19	23	30	[.] 36	18.71
	0. Control	8	9	10	25	35	39	45	24.42
FSS-II	A. 41.63	2	3	4	6	9	11	13	6.85
	B. 4.163	3	5	6	11	13	15	19	10.28
	C. 0.4163	4	7	9	14	19	20	24	13.85
	D. 0.04163	6	9	12	20	26	29	32	19.14
	0. Control	8	13	15	27	31	35	43	24.57
CTC 12	A. 41.63	2	3	5	6	11	13	14	7.71
	B. 4.163	3	6	7	10	14	19	22	11.57
	C. 0.4163	4	7	· 8	17	21	26	29	16.00
	D. 0.04163	. 5	8	10	20	26	30	37	19.42
	0. Control	10	13	. 15	29	33	37 ·	45	26.00

Table 20. The number of egg-laid by <u>T</u>. <u>castaneum</u> per female per day in different doses of Methanol seed extraction of <u>A</u>. <u>squamosa</u>.

Strain	Doses /ugm/sq.cm			Replic	atior	(days)			Mean
		1	2	3	4	5	6	7	; ; ;
Local	A. 26.04	2	3	5	5	8	10	12	6.42
	B. 2.604	2	4	6	8	10	14	16	8.57
	C. 0.2604	4	6	9	11	16	, 22	25	13.28
	D. 0.02604	6	. 8	10	21	21	31	38	19.28
	0. Control	8	10	12	27	-35	39	49	25.71
CR-I	A. 26.04	2	3	3	6	9	. 11	13	6.71
	B. 2.604	Ş	4	5	10	14	16	20	10.28
	C. 0.2604	4	7 .	8	14	. 17	22	25	13.853
	D. 0.02604	6	9	. 9	18	24	29	34	18.42
	0. Control	. 8	11	12	28	30	40	47	25.14
FSS-II	A. 26.04	1	2	4	5	6	6	, 8	4.57
	B. 2.604	2	4	5	9	12	14	. 13	8.42
	C. 0.2604	4	· 5	8	13	20	22	24	13.71
	D. 0.02604	5	8	9	19	24	30	34	18.42
	0. Control	9	9	11	26	35	. 35	40	23.57
СТС 12	A. 26,04	2	. 3	4	9	11	11	12	7.42
	B. 2.604	3	5	6	11	13	18	. 20	10.85
	C. 0.2604	5	7	9	16	19	25	28	15.57
	D. 0.02604	6	9	11	22	24	32	34	19.71
	0. Control	. 8	12	• 14	27	30	36	. 42	24.14

Table 21. Hatching percentage of eggs laid by <u>T</u>. <u>castaneum</u> in different doses of petroleum spirit seed extractions of <u>A</u>. <u>squamosa</u>,

Strain	Doses		Re	plicati	on (day	в)			Mean
	/ugm/sq.cm	1	2	3	4	5	6	7	
Loca1	A. 48.53	0	50.00	33.33	66.67	50.00	33.33	25.00	43.06
	B. 4.853	50.00	33.33	50.00	42.86	55.56	45.45	50.00	46.74 94
	C. 0.4853	66.67	40.00	66.67	55.56	46.15	52.94	63.64	55.95
	D.0.04853	60.00	75.00	42.86	66.67	58.82	68.18	62.07	61.94
	0. Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CR-I	A. 48.53	0	0	33.33	66.67	50.00	33.33	50.00	46.67
	B. 4.853	50.00	33.33	50.00	66.67	57.14	50.00	53.33	51.50
	C.0.4853	50.00	.66.67	60.00	55.56	61.54	60.00	63.16	59.23
	D.0.04853	75.00	6 6.67	42.86	53.85	68.42	72.73	74.19	63.50
	0.Control	100.00	88.89	100.00	100.00	93.10	94,29	100.00	96.61
FSS-II	A. 48.53	0	0	0	0	0	0	0	0
	B. 4.853	50.00	33.33	66.67	42.85	36.36	41.67	46.67	45.34
	C.0.4853	50.00	66.67	75.00	36.36	38.46	42.11	50.00	51.23
	D.0.04853	60.00	62.50	60.00	42.11	55.00	58.33	56.67	56.37
	0.Control	100.00	100.00	92.31	100.00	96.77	100.00	100.00	98.44
CTC 12	A. 48.53	0	0	0	0	0	0	0.	0
	B. 4.853	0	50.00	33.33	60.00	50.00	42.86	44.44	46.77
	C.0.4853	50.00	75.00	40.00	57.14	44.44	58.33	46.67	53.08
	D.0.04853	75.00	66.67	42.86	50.00	53.33	68.42	59.09	59.34
	0.Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00 .

Table 22. Hatching percentage of eggs laid by <u>T</u>. <u>castaneum</u> in different doses of ethyl acetate seed extractior of <u>A</u>. <u>squamosa</u>,

Strain	Doses		Re	plicati	on (day	s)			Mean
	/ugm/sq.cm	1	2	3	4	5	6	7	
Local	A. 61.08	0	50.00	50.00	40.00	40.00	42.85	44.44	44.55
	B. 6.108	33.33	50.00	66.67	55.56	54.55	46.67	50.00	50 .9 714
	C. 0.6108	75.00	66.67	42.86	50.00	56.25	55.00	61.54	58.29 1º
	D. 0.06108	60.00	57.14	66.67	60.00	73.68	66.67	55.88	62.86
,	0. Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CR-I	A. 61.08	0	50.00	33.33	50.00	50.00	42.86	40.00	44.36
	B. 6.108	0	33.33	50.00	60.00	44.44	57.14	52.94	49.64
	C. 0.6108	33.33	60.00	50.00	55.55	62.50	52.63	56.00	52.86
	D. 0.06108	60.00	57.14	66.67	57.14	60.00	61.54	59.38	60.27
	0. Control	100.00	100.00	90.91	100.00	100.00	100.00	100.00	98.70
FSS-II	A. 61.08	50.00	33.33	75.00	42.86	50.00	60.00	41.67	50.41
	B. 6.108	66.67	60.00	42.85	50.00	58.33	52.94	54.54	55.05
	C. 0.6108	75 <u>.</u> 00	66.67	50.00	46.67	61.11	59.09	61.54	60.01
	D. 0.06108	66.67	77.76	54.55	63.64	60.86	66.67	62.86	64.72
	0. Control	100.00	100.00	100.00	96.15	100.00	100.00	97.56	99.10
CTC 12	A. 61.08	50.00	50.00	75.00	42.86	50.00	54.54	40.00	51.77
	B. 6.108	66.67	60.00	66.67	46.15	50.00	47.06	44.00	54.36
	C. 0.6108	75.00	66.67	42.86	50.00	60.00	56.00	61.29	58.83
	D. 0.06108	66.67	75.00	55.56	61.90	64.00	67 .7 4	67.56	65.49
	0. Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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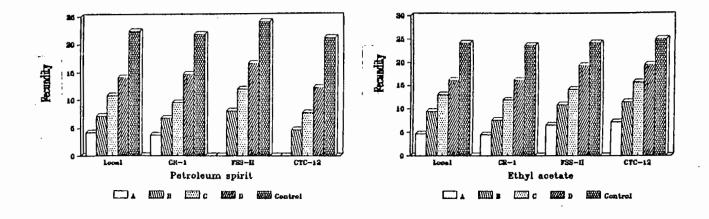
Table 23. Hatching percentage of eggs laid by <u>T</u>. <u>castaneum</u> in different doses of acetone seed extractions of <u>A</u>. <u>squamosa</u>,

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Strain	Doses		Re	eplicat	ion (da	ys)			Mean
	/ugm/sq.cm	1	2	3	4	5	6	7	
Local	A. 41.63	0	50.00	33.33	50.00	40.00	33.33	37.50	40.69
	B. 4.163	50.00	33.33	50.00	42.86	44.44	45.45	46.67	44.68
	C. 0.4163	66.67	50.00	62.50	36.36	50.00	55.56	54.55	53.66
	D. 0.04163	66.67	71.42	44.44	57.89	61.90	68.96	72.73	63.43
	0. Control :	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CR-I	A. 4163	50.00	50.00	33.33	57.14	54.55	58.33	50.00	50.48
	B. 4.163	66.67	50.00	40.00	54.55	53.84	52.94	57.14	53.59
	C. 0.4163	50.00	66.67	66.67	50.00	52.94	60.86	59.26	58.06
	D. 0.04163	66.67	75.00	55.56	68.42	56.52	66.67	. 63.89	64.05
	0. Control	100.00	100.00	100.00	100.00	97.14	100.00	100.00	99.59
FSS-II	A. 41.63	50.00	33.33	50.00	66.67	55.56	54.55	53.85	51.99
·	B. 4.163	33.33	60.00	50.00	45.45	53.85	60.00	68.42	53.01
	C. 0.4163	50.00	57.14	55.55	42.86	57.89	60.00	66.67	55.73
	D. 0.04163	66.67	66.67	58.33	60.00	53.85	62.07	62.50	61.44
	0. Control	100.00	92.30	100.00	100.00	100.00	100.00	100.00	98.90
CTC 12	A. 41.63	50.00	66.67	40.00	50.00	54.55	53.85	57.14	53.17
	B. 4.163	66.67	50.00	57.14	60.00	50.00	52.63	54,55	55.85
	C. 0.4163	75.00	42.85	62.50	47.05	61.90	61.54	65.52	59.48
	D. 0.04163	60.00	75.00	60.00	65.00	61.54	66.67	67.56	65.11
	0. Control :	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 24. Hatching percentage of eggs laid by <u>T</u>. <u>castaneum</u> in different doses of methanol seed extractions of <u>A</u>. <u>squamosa</u>,

Strain	Doses		Re	plicati	on (day	(s)			Mean
	/ugm/sq.cm	1	2	3	4	5	6	7	
Local	A. 26.04	50.00	33.33	40.00	60.00	37.50	40.00	33.33	42.02
	B. 2.604	50.00	50.00	33.33	62.50	40.00	42.85	43.75	46.06
	C. 0.2604	25.00	66.67	55.56	54.55	50.00	50.00	52.00	50.54
	D. 0.02604	66.67	62.50	60.00	57.14	52.38	54.83	57.89	58.77
	D. Control	100.00	100.00	100.00	100.00	100.00	100.00	97.96	99.71
CR-I	A. 26.04	50.00	33.33	33.33	66.67	55.56	45.45	53.85	48.31
	B. 2.604	66.67	50.00	40.00	50.00	57.14	50.00	50.00	51.97
	C. 0.2604	50.00	57.14	62.50	57.14	52.94	59.09	56.00	56.40
	D. 0.02604	66.67	55.56	55.56	61.11	62.50	62.07	58.82	60.33
	0. Control	100.00	9 0.91	100.00	100.00	100.00	100.00	100.00	98.70
FSS-II	A. 26.04	0	50.00	50.00	40.00	50.00	66.67	37.50	49.03
	B. 2.604	50.00	50.00	60.00	55.56	58.33	57.14	46.15	53.88
	C. 0.2604	50.00	60.00	62.50	61.54	60.00	63.64	62.50	60.03
	D. 0.02604	60.00	62.50	66.67	63.16	62.50	66.67	61.76	63.32
	0. Control	100.00	100.00	100.00	100.00	100.00	100.00	97.50	99.64
CTC 12	A. 26.04	50.00	66.67	50.00	55.56	45.45	45.45	41.67	50.69
	B. 2.604	66.67	40.00	50.00	54.55	46.15	55.56	55.55	52.64
	C. 0.2604	60.00	. 57.14	55.56	56.25	52.63	56.00	57.14	56.39
	D. 0.02604	66.67	66.67	45.45	59.09	62.50	62.50	64.71	61.08
	0. Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



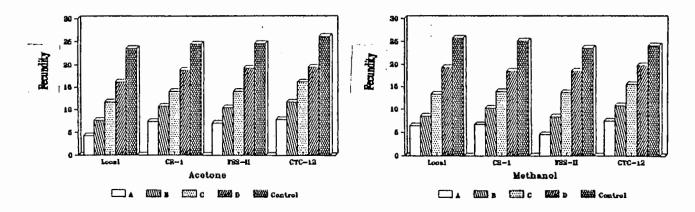
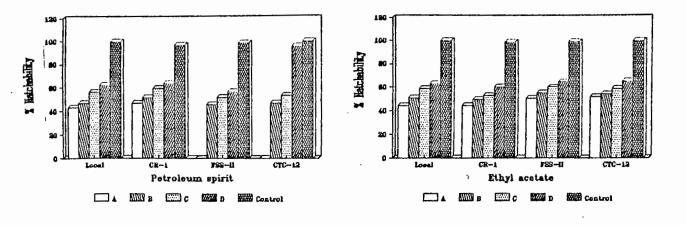


Fig 12. Number of eggs-laid by *T.castaneum* per female per day in defferent doses seed extraction of *A.*squamosa by different solvents.



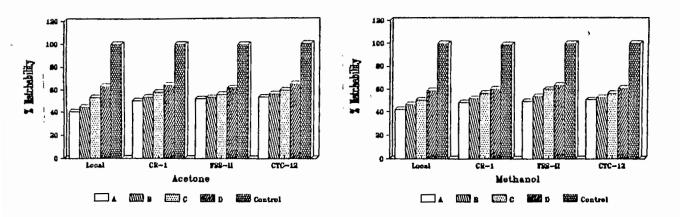


Fig 13. Hatchability of *T.castaneum* in different doses seed extraction of *A.squamosa* by different solvents.

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99.59%; in FSS-II strain it was 51.99, 53.01, 55.73, 61.44 and 98.90%; and CTC 12 strain the hatchability was recorded for methaw local strain as 42.02, 46.06, 50.54, 58.77 and 99.71%; in CR-I strain they were 48.31, 51.97, 56.40, 60.33, and 98.70%; in FSS-II strain it was 49.03, 53.88, 60.02, 63.32 and 99.64%; and CTC 12 strain the hatchability was 50.69, 52.64, 56.39, 61.08 and 100.0% in the doses A, B, C, D and control respectively.

The analysis of variance of hatchability among different strains and among different doses are performed. Within strains the results is significant in all extractions except in petroleum spirit. But among the doses and control it shows always highly significant (P < 0.01) results.

In petroleum spirit extraction the hatchability of eggs laid by female emarged from the treated larvae shows that the mean control hatchability percentage differ significantly with the treated ones. The LSD value shows that in all extractions the control mean always differ significantly at 0.1% level of significance with the treated ones (Appendix Table LXIV-LXVII).

3.6 Effect of combined doses of seed extractions of <u>A. squamosa</u> and methacrifos.on the adult of <u>T. castaneum</u>:

The results for the combined action of seed extracts and methacrifos are presented in Tables 25-28. Seed extracts of <u>A. squamosa</u> played a synergistic role on methacrifos killing significantly higher numbers of the flour beetle, <u>T. castaneum</u> with the mortality due to the individual action of the seed

extracts and methacrifos for all the strains. But the extraction with ethyl acetate showed no synergistic effect on <u>T</u>. <u>castaneum</u> except CTC 12, where significant result is found. Also the insignificant results were obtained in case of extraction methanol for CR-I after 12 and 24 hours of treatment and CTC 12 strain only for 24 hours.

The mortality of the adults due to low dose of insecticide, seed extracts, and their combined doses for four studied strain after 12 and 24 hours after treatment have been presented in figures 14-21.

Table 25.Mortality of adult <u>T</u>. <u>castaneum</u> (Local) treated in insecticide <u>A. squamosa</u> seed extractions and their combined doseg

Treat- ment	Dose of extraction /ugm/sq.cm	N _S	Υ _s	× _s	NA	Y _A	× _A	N _C	Чс	×c.	Chi- sq.
SPS12	4.37	40	7	3,3	40	0	40	40	18	22	10.476
SEA12	5,50	40	7	33	40	1	39	40	13	27	2.151
SAC12	3.75	40	7	33	40	0	40	40	16	24	7.013
SME12	2.34	40	7	33	40	0	40	40	20	20	14.632
SPS24	4.37	40	21	19	40	1	39	40	32	8	5.638 [*]
SEA24	5.50	40	21	19	40	2	38	40	28	12	1.893
SAC24	3.75	40	21	19	40	0	40	40	30	10	4.060
SME24	2.34	40	21	19	40	2	38	40	31	9	4.236

Dose of insecticide = 0.001493/ugm/sq.cm Notes : $N_{s} = number of insects used in insecticide$ Y_s = number of insects killed in insecticide X_c = number of insects surviving in insecticide N_A = number of insects used in extract $Y_A =$ number of insects killed in extract X_A = number of insects surviving in extract N_{C} = number of insects used in combined dose Y_{C} = number of insects killed in combined dose X_{C} = number of insects surviving in combined dose SPT= Seed extract in petroleum spirit SET= Seed extract in ethyl acetate SAT= Seed extract in acetone SMT= Seed extract in methanol 12 and 24 indicate the duration of treatment (in hours) *P<0.05, **P<0.01 and ***P<0.001

Table 26. Mortality of adult <u>T</u>. <u>castaneum</u> (CR-I) treated in insecticide <u>A</u>. <u>squamosa</u> seed extractions and their combined dose.

Treat- ment	Dose of extraction /ugm/sq.cm	N _s	¥s	× _s	NA	Υ _A	X _A	^N с	Чс	× _c	Chi- sq.
SPS12	10.060	40	10	30	40	0	40	40	19	21	5.400
SEA12	14.148	40	10	30	40	0	40	40	16	24	2.400
SAC12	12.269	40	10	30	40	0	40	40	21	19	8.067
SME12	3.109	40	10	, 30 `	40	3	37	40	18	22	2.007
SPS24	10.060	40	15	25	40	1	39	40	25	15	4.671
SEA24	14.148	40	15	25	40	0	40	40	21	19	1.920
SAC24	12.269	40	15	25	4 0	0	40	40	24	16	4.320
SME24	3.109	40	15	25	40	7	33	. 40	25	15	1.699

Dose of insecticide = 0.001493/ugm/sq.cm. Notes : N_{s} = number of insects used in insecticide $Y_s =$ number of insects killed in insecticide X_s = number of insects surviving in insecticide N_A = number of insects used in extract $Y_{A} =$ number of insects killed in extract X_A = number of insects surviving in extract N_{c} = number of insects used in combined dose Y_{C} = number of insects killed in combined dose X_{C} = number of insects surviving in combined dose SPT= Seed extract in petroleum spirit SET= Seed extract in ethyl acetate SAT= Seed extract in acetone SMT= Seed extract in methanol 12 and 24 indicate the duration of treatment (in hours) *P<0.05 and ***P<0.01

Table 27. Mortality of adult <u>T. castaneum</u> (FSS-II) treatment in insecticide <u>A. squamosa</u> seed extractions and their combined dose.

Treat- ment	Dose of extraction ugm/sq.cm	N _S	Υ _S	× _s	NA	Υ _A	× _A	N _C	Чс	× _C	Chi- sq.
SPS12	4.37	40	8	32	40	0	40	40	16	24	5.000
SEA12	5.50	40	8	32	4 0	1	39	40	14	26	1.992
SAC12	3.75	40	8	32	40	0	40	40	19	21	9.453
SME12	2.34	40	8	32	40	1	39	40	17	23	4.954
SPS24	4.37	40	14	26	40	2	38	40	24	16	4.099
SEA24	5.50	40	14	26	40	1	39 ´	40	21	19	2.198
SAC24	3.75	40	14	26	40	0	40	40	28	12	10.769
SME24	2.34	40	14	26	40	3	37	40	25	15	4.416

Dose of insecticide = 0.001493/ugm/sq.cm

Notes :

 $N_S =$ number of insects used in insecticide $Y_S =$ number of insects killed in insecticide $X_S =$ number of insects surviving in insecticide $N_A =$ number of insects used in extract $Y_A =$ number of insects killed in extract $X_A =$ number of insects surviving in extract $N_C =$ number of insects used in combined dose $Y_C =$ number of insects killed in combined dose $X_C =$ number of insects surviving in combined dose SPT= Seed extract in petroleum spirit SET= Seed extract in ethyl acetate SAT= Seed extract in methanol 12 and 24 indicate the duration of treatment (in hours) *P<0.05 and ***P<0.01

Table 28. Mortality of adult T. castaneum (CTC 12) treated in insecticide A. squamosa seed extractions and their combined dose.

Treat- ment	Dose of extraction ugm/sq.cm	N _S	Υ _S	x _s	N _A	Y _A	× _A	N _С	Чс	× _c	Chi- sq.
SPS12	. 4.37	40	5	35	40	0	40	40	13	27	7.314
SEA12	5.50	40	5	35	40	0	40	40	17	23	16.457
SAC12	3.75	40	5	35	40	0	40	40	18	22	19.314
SME12	2.34	40	. 5	35	40	3	37	40	15	25	4.518
SPS24	4.37	40	13	27	40	2	38	40	24	16	5.848
SEA24	5.50	40	13	27	40	2	38	40	26	14	7.546
SAC24	3.75	40	13	27	40	3.	37	.40	17	13	7.899
SME24	2.34	40	13	27	40	6	•34	40	24	16	2.619

Dose of insecticide = 0.001493 /ugm/sq.cm

Notes :

 N_{S} = number of insects used in insecticide Y_{s} = number of insects killed in insecticide X_s = number of insects surviving in insecticide N_A = number of insects used in extract Y_A = number of insects killed in extract X_{A} = number of insects surviving in extract N_{C} = number of insects used in combined dose Y_{C} = number of insects killed in combined dose. X_{C} = number of insects surviving in combined dose SPT= Seed extract in petroleum spirit SET= Seed extract in ethyl acetate SAT= Seed extract in acetone "SMT= Seed extract in methanol 12 and 24 indicate the duration of treatment (in hours) * P<0.05, ** P<0.01 and *** P<0.001

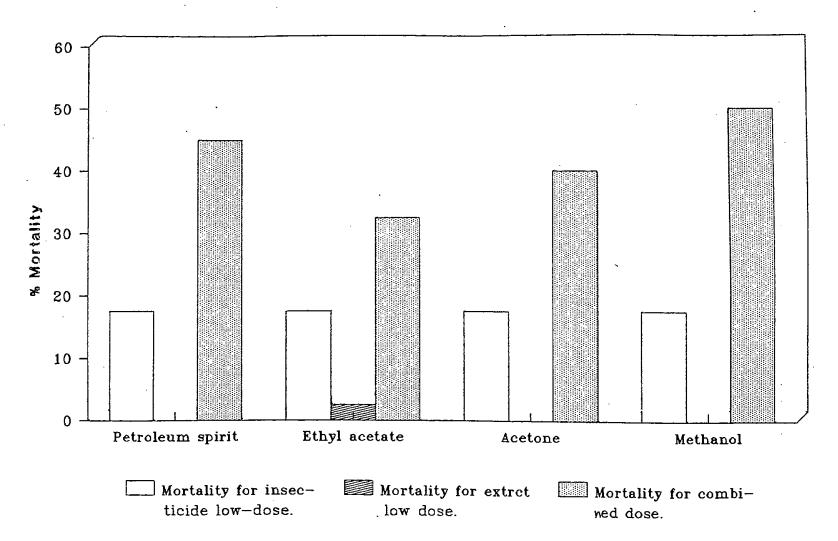


Fig 14. Mortality percentage of adult *T.castaneum* (Local) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 12 hours treatment.

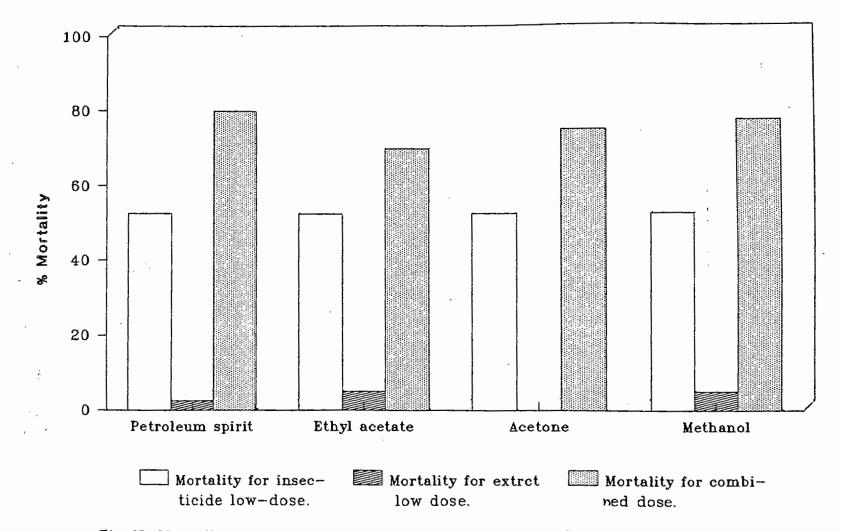


Fig 15. Mortality percentage of adult *T.castaneum* (Local) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 24 hours treatment.

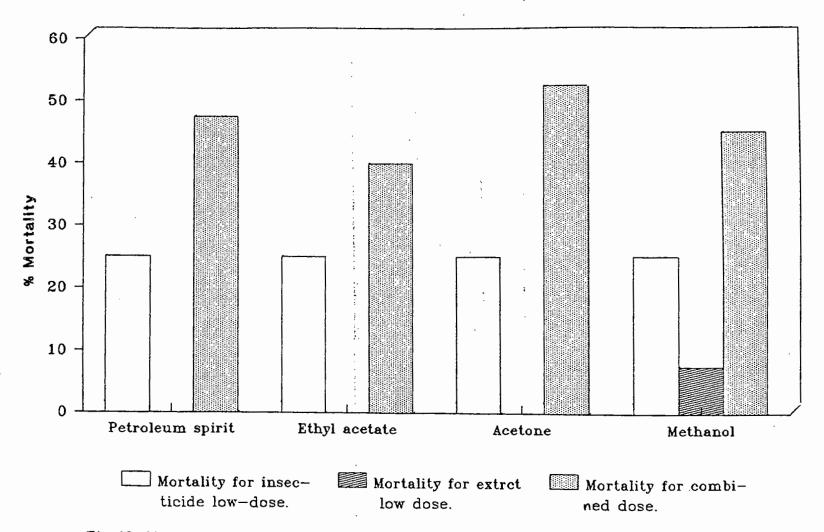


Fig 16. Mortality percentage of adult *T.castaneum* (CR-I) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 12 hours treatment.

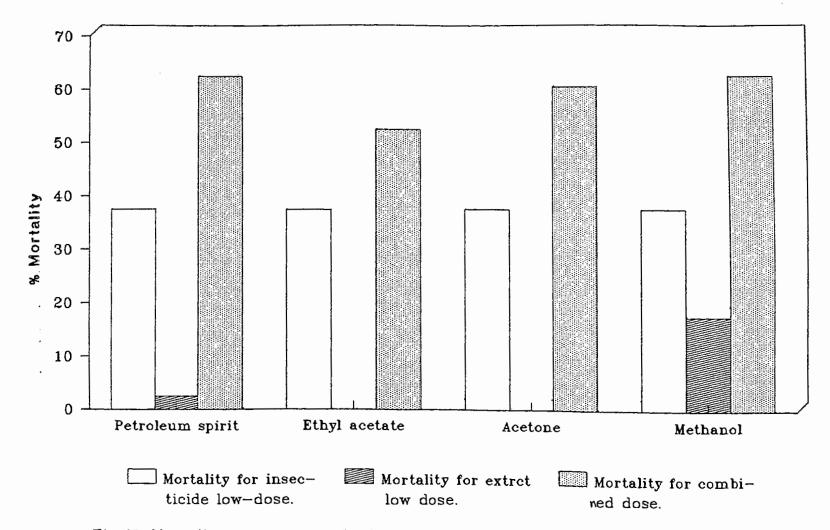


Fig 17. Mortality percentage of adult *T.castaneum* (CR-1) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 24 hours treatment.

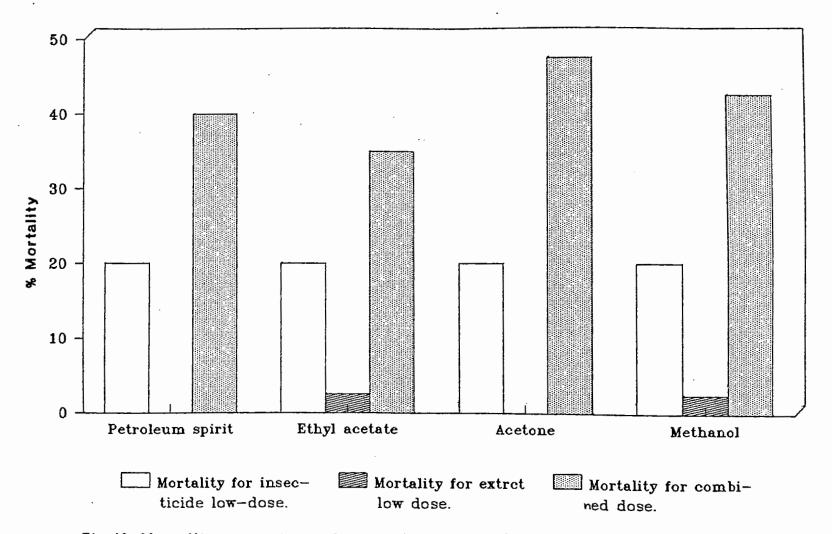


Fig 18. Mortality percentage of adult *T.castaneum* (FSS-II) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 12 hours treatment.

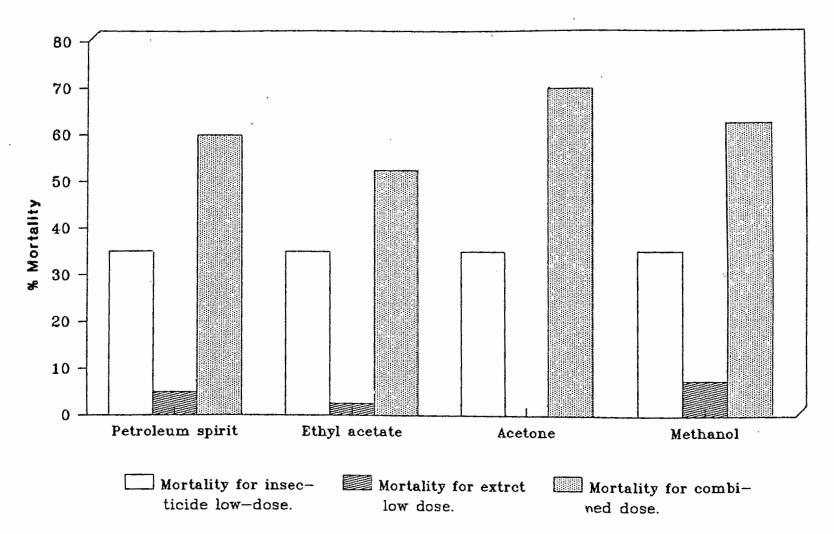


Fig 19. Mortality percentage of adult *T.castaneum* (FSS-II) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 24 hours treatment.

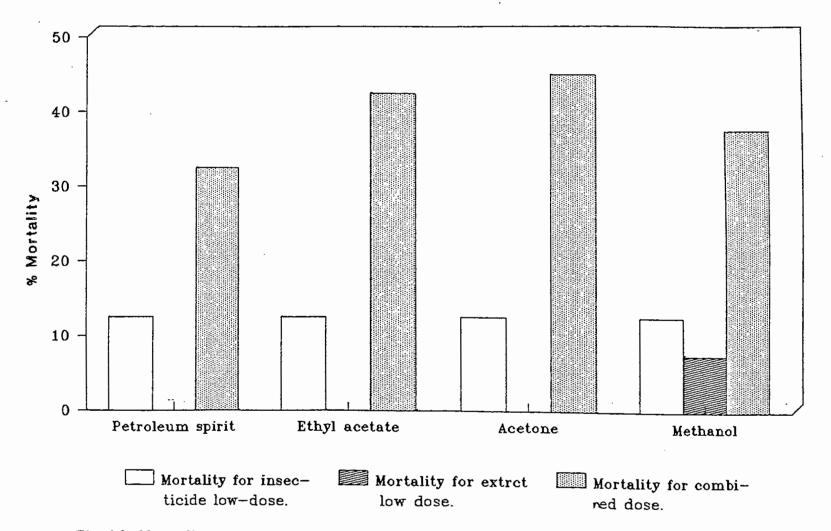


Fig 20. Mortality percentage of adult *T.castaneum* (CTC 12)treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 12 hours treatment.

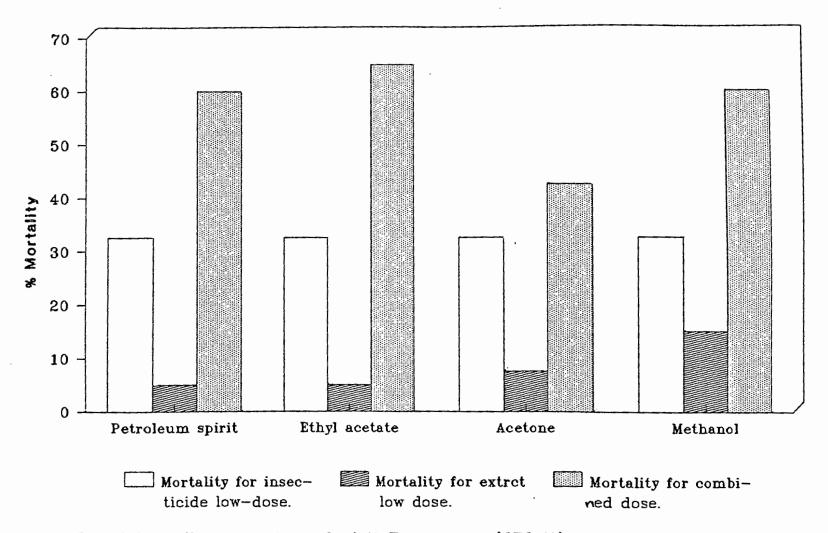
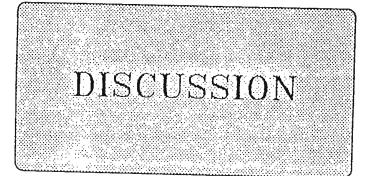


Fig 21. Mortality percentage of adult *T.castaneum* (CTC 12) treated with seed extraction *A.squamosa*, methacrifos and their combined doses after 24 hours treatment.



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4. DISCUSSION

Secondary plant substances so far identified as "a insect feeding deterrerts" vary widely in structural types and molecular complexivity. This diversity, coupled with a paucity of experimental work on modes of action of antifeedants, makes any attempt to identify a common structural basis for activity, even within the same class of compounds, an extremely difficult task (Hassanali <u>et al.</u>, 1983).

The suitability of a plant as food for insects depends on its chemical composition. In many cases, feeding inhibitors are of primary importance in determining which plants are eaten and the extent to which they can be consumed (Thorsteinson, 1960 ; Hsiao, 1969). Antifeedants are of significant importance in insect pest management because they are pest specific, non-poisonous, and hence harmless to pest's natural enemies. Antifeedants, which retard feeding activities of pest insects and reduce their damage by rendering treated plants unattractive, offer considerable scope in crop proction (Munakata, 1970). These materials could be applied to crop plants in much the same way as insecticide.

The chemistry of plants of the family Annonaceae has been little investigated. Cortina (1901) reported to have found among other constituents a resin present in <u>A. cherimola</u> to which is ascribed the emetic-cathartic action of the seeds. Callan and Tutin (1911) published an account of their chemical examination of the leaves of <u>A. muricata</u>. They isolated a

steam-volatile essential oil, a small amount of uncrystallizable alkaloid,several fatty acids, myricyl alcohol, sitosterol and a compound "annonol" C₂₃H₃₈O₄. Which was later regarded by Power and Salway (1913) as being a member of the group of phytosterol glucosides (phytosterolines).

Trimurti (1924) isolated a minute amount of an alkaloid from the leaves of <u>A</u>. <u>squamosa</u>, but glucosides were not shown Santos (1930) obtained an alkaloid, anonaine, to be present. C₁₇H₁₆O₃N in a yield of 0.03-0.04% from the bark of <u>A</u>. <u>reticulata</u>. The same alkaloid was isolated from the bark of A. squamosa by Reyes and Santos (1931), in a yield of 0.14% but a slightly different formula was later ascribed to it C17H1703N (Santos, 1932). From the bark of the closely allied genus Asimina Sp. triloba Manske (1938) isolated the alkaloid annolobine, C17H1703N. Santos and Reyes (1932), and Barger and Sargent (1939) made studies of the alkaloids of Artabotrys suaveolens and the three alkaloids isolated from the bark by the latter investigators were Arbabotrine (0.19%, C₂₀H₂₃O₄N), Suaveoline (0.0013%, $C_{12}H_{21}O_4N$ and Artabotrinine (0.012%, $C_{18}H_{17}O_3N$).

Barger and Sargent (1939) considered attabotrine probably to be 10 hydroxy - 4:5:6 - trimethoxy - aporphine, Suaveoline, 4:10 - dihydroxy - 5:6 - dimethoxy - aporphine; and artabotrinine, 2-methoxy - 5:6 - methylenedioxynoraporphine.

Bhatta and Narayanan (1938) reported the insecticidal effect of <u>A</u>. <u>reticulata</u> upon the scale insect <u>Lecanium</u> <u>viride</u>

Green in Mysore, India. Hot alcoholic extracts water suspensions of the concentrated hot alcoholic extracts of seed and apparently alcoholic extracts of stem, bark and leaf and root bark were tested. All were found to be toxic : "the chemically prepared alcoholic extract of the seed was very toxic at 0.125% strength, a mortality of 70-80% being obtained". It is however, not quite clear whether the concentration is expressed in terms of the plant material or the extract. Extracts of stem bark, leaf and root bark at 10% concentration gave respectively 100, 70 and 60% mortalities. No information is available as to the method of testing employed, but it was claimed that to this insect the hot alcoholic extracts of the seed of A. reticulata were more toxic than <u>Derris elliptica</u>. As however no particulars were given of the analytical characteristics of the derris used this comparison may possess little value.

Harper <u>et al</u>. (1947) examined the effect of the petroleum ether insoluable extract of the seed of <u>A</u>. <u>squamosa</u> on <u>Macrosi-</u> <u>phoniella sanborni</u> and recorded the LD₅₀ as 7.8 mg/1 with regression equation Y=3.07 + 2.18x. The present experiment shows that the petroleum spirit extraction of <u>A</u>. <u>squamosa</u> offered the highest mortality of the adult followed by ethyl acetate, methanol, and acetone extractions. Khanam <u>et al</u>. (1991) used the methanol extract of <u>A</u>. <u>squamosa</u> on <u>Sitophilus oryzae</u> and recorded the LD₅₀ values as 21244.86, 4980.54, 3623.71, 1923.17 and 2420.50 ppm after 2, 4, 6, 8, and 10 days of treatment respectively. Deshmukh and Borle (1975) tested the seed extracts of <u>A</u>. <u>squamosa</u> and

observed highest mortality of aphid, <u>Dactynotus</u> <u>carthami</u> as 20% in petroleum spirit and 85.33% in absolute alchohol extract with regression equation as Y = 2.63 + 1.65x for the later.

In the present investigation the extraction was done serially with four solvents for separating different compounds. Petroleum spirit generally extracts oils, fat and fatty acids; ethyl acetate extracts, tarpin, alkaloids, flavour compounds and steroids; acetone separates chlorophyl, dye and other alkaloid which are not soluble in ethyl acetate; and methanol extracts all kinds of remaining alkaloids and acidic compounds (Islam, 1991).

Flour beetles may be utilized for biological assessment of nutritive values of certain foodstaffs for humans and livestocks (Birk and Applebaum, 1960; Chirigos <u>et al</u>., 1960). Since general nutritional requirements of <u>Tribolium</u> are in many respects similar to those of warmblooded animals. Further more they have a ubiquitous distribution and are easily reared on synthetic diet (Hinton, 1956; Birk <u>et al</u>., 1962). As the red flour beetle <u>T</u>. <u>castaneum</u> is probably one of the most frequently kept laboratory insect, four strain of them used in present study to compare to mortality by plant extracts as well as insecticide. From the results of the plant extracts it is found that LD_{50} value is higher incase of CTC 12 strain with petroleum spirit extraction, FSS-II strain with ethyl acetate extraction, CR-I strain with acetone extraction and FSS-II with

methanol extraction. But incase of insecticide the LD_{50} value is always higher in CTC 12 strain. FSS-II strain is a recognized susceptible variety of <u>T</u>. <u>castaneum</u>, so the mortality rate was always higher in comparison to other strain. It was also observed that due to larval treatment with plant extracts in low doses some deform larvae were occured. The larvae which became adult also laid fewer number of eggs effecting the reproductive system of the beetle.

From tables 25 to 28 it is evident that most of the combined doses offered synergism having significant Chi-square. In 1940, Eagleson succeeded in synergising pyrethrum with sesame oil, seven years later, Dove (1947) demonstrated that the efficacy of pyrethrum could be increased by maxing it with piperonyl butoxide, subsequently, many substances were discovered which could be used as pyrethrum synergists. In addition, other insecticides, especially natural insecticides, like ryania dust (Reed & Filmer, 1950), Sabadilla (Blum & Kearns, 1957) and Rotenone (Brannon, 1947), could be symergistic.

There could be two hypotheses for the mode of action of the synergist. The first one, according to Hewlett (1960) and to Metcalf (1967), is that the synergists inhibit the enzymes responsible for toxicant degradation. Othaki <u>et al</u>. (1968) and Othaki & Williams (1970) showed that the insect body contains enzymes for the degradation of hormones like the molting hormone (MH), which may be a mode of action of seed extracts. Another possible explanation was advanced by Leuschner (1974)

and by Walker & Thompson (1973) who found that simultaneous application of MH and junenile hormone (JH) caused an increase in MH-activity.

A hypothesis for the mode of action of MH and JH when applied together was advanced by Socha & Sehnal in 1972. They suggested that the MH activated the synthesis of ribonucleic acid (RNA) and JH simultaneously induced a duplication of the deribonucleic acid (DNA). This process causes such a severe disturbance in the insect that it leads to its death because the DNA and RNA syntheses are mutually separated and perhaps, exclude each other (Du Praw, 1967).

Classical insecticide "synergists" were investigated as potential modifiers of formamidine toxicity to acarines and insects, and both antagonistic and synergistic interactions were observed. The toxicity of chlordimeform to southern cattle tick larvae was antagonized in order of potency by sesamex, piperonyl butoxide and tropital (Knowles and Roulston, 1972, 1973). Dittrich (1966) found that a mixture of vapors of chlordimeform and dichlorvos was synergistic to the carmine spider mite and a number of observations along similar lines subsequently have been made. Thus mixtures of chlordimeform with organophos_ phates, pyrethroids, carbamates toxaphene or diflubenzuron were synergistic to tobacco budworm larvae (Plapp, 1976). In another study, Plapp (1979) tested four formamidines (chlordimeform, amitraz, U-42662, and U-4650) as synergists for the synthetic pyrethroids permethrin, fenvalerate and decamethrin against

larvae of the bollowrm and the tobacco budworm; chlordimeform and U-42662 were most active, increasing toxicity of permethrin and fenvalerate by 2-15 times. Dittrich <u>et al.</u>, (1981) working with <u>Spodoptera littoralis</u> found that chlordime-form was synergistic with monocrotophos and resmethrin in some cases. Mixtures of amitraz with endosulfan (Weighton and Kerry, 1979), methomyl (Kerry and Weighton, 1979a), or pyrethroids (Badmin and Knigh⁴; ⁷ 1979) were synergistic amitraz-permethrin mixture was synergistic to larvae of <u>Spodoptera littoralis</u> (Kerry and Weighton, 1979b); and armitraz-organophosphate mixture was synergistic to the tobacco budworm (Zeck, 1978).

The synergistic action of the plant extracts, used in the present experiment, is to some extent similar to the results of Dyte and Rowlands (1970) who reported higher mortality of <u>T</u>. <u>castaneum</u> adults in combined doses of insecticide, e.g., Fenitrothion and Bromoxon.and Malaoxon and Synergist (e.g., Sesa Sexamax, SKF 525 A and PAOB-1) in comparison with the mortality due to individual action of the chemicals. This result is also similar to that of Ishaaya <u>et al</u>., (1983) who reported higher mortality of <u>T</u>. <u>castaneum</u> in combined doses of insecticide (e.g., trans and sis-cypermethrin) and synergist pyperonyl butoxide in comparison with the mortality due to individual action of the chemicals.

1-120 Store

- 21 S. L. L. L.

5. CONCLUSION

The unqualified success of chemical pesticides, ironically, created a dilemma. Many of our requisites in life coevolved with pesticide technology to such an extent that we have become, in large part, dependent on this technology. Yet, there are warnings that make us question how secure this technology is for the future.

Increased pest resistance is limiting the effectiveness of many pesticides. Worldwide, there presently are at least 305 species of insects, mites, and ticks that possess strains resistant to one or more chemical pesticides (II). Resistance in certain rodents and plant pathogens is currently limiting the effectiveness of pesticides against these pests (12). Despite efforts taken by the Environmental Protection Agency in the past five years to prohibit or restrict the use of pesticides that pose intolerable risks, the effects of pesticides on human health and the environment remain a continual concern for us all. Α study recently completed by the council on Environmental quality suggests a general trend toward reduced aquatic contamination by chlorinated hydrocarbon insecticides in several major rivers in the southern United States, even though low levels of these materials still persist. Difficult to assess are the longterm effects of the less persistent replacements such as organophosphorus insecticides.

Effective control of crop pests and vectors by the smallscale farmer in developing countries of Asia and Africa has been limited because of the prohibitive costs of insecticides. These farmers are constrained to spend either very little on pesticides or to resort to underdosing. As cost of synthetically derived, commercial products rise progressively, their usage will decline further, resulting in lower yields. On the other hand, plants like custard-apple can be grown by marginal farmers in Asia and Africa with minimal maintenance, and their oils can be extracted using simple devices. Although these oil may not match synthetic insecticides in efficacy, even the partial pest control obtained by using them is better than no control at all. Effectiveness against pests, safety for the environment, low cost, and availability of these oils emphasize that they should be considered seriously for pest and vector control.

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APPENDICES

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APPENDIX TABLE - I

Do		Log dose	No. of insect used		% Killed	Emp. prob.	Exp. prob.	Work prob.	
/ugi	m/sq.cm	x	n	r	р		Y	У	
٨.	4367.99	3.640	40	40	100.0	8.09	7.81	8.12	
в.	436.80	2.640	40	20	50.0	5.00	5.56	4.92	
с.	43.68	1.640	40	3	7.5	3.59	3.31	3.63	
D.	4.37	0.640	40	-	-	-	-		
٥.	Control	-	40	-	-	-	-	-	

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Petroleum spirit after 12 hours,

Weighting co-eff.	Weight					
w *	₩=w'n	WX	wy	wx ²	wy ²	wxy
0.025	1.00	3.64	8.12	13.25	65.93	29.56
0.558	22.32	58.92	109.81	155.55	540.29	289.90
0,238	9.52	15.61	34.56	25.60	125.44	56.68
-	-	-	-	-	-	• –
-	-	-	-	_	-	-
	32.84	78.18	125.49	194.40	731.66	376.13
$\bar{x} = 2.38$	-				Results	:
$\bar{y} = 4.64$					v ≖ 0.	0147

y = 0.88 + 1.58x

v = 0.0147 m = 405.51 $m_1 = 234.96$ $m_2 = 699.84$ Chi-sq. = 26.99

APPENDIX TABLE - II

No. of : No. of Log % Emp. insect Exp. Work insect Dose . dose killed prob. used killed prob. prob. /ugm/sq.cm х n r р Y Y A. 4367.99 3.640 40 40 100.0 8,09 7.63 7.94 Β. 436.80 2.640 40 28 70.0 5.52 5.98 5.41 C. 43.68 1.640 40 5 12.5 3.87 4.32 3.93 D. 4.37 0.640 40 1 2.5 3.12 2.67 3.35 0. Control 40 _

Dose-mortality data of adult <u>T. castaneum</u> (Local) treated with seed extract in Petroleum spirit after 24 hours,

Weighting co-eff.	Weight					
w '	₩=w'n	WX	wy	wx ²	wy ²	wxy
.0.040	1.60	5.82	12.70	21.20	100.87	46.23
0.439	17.56	46.36	94.99	122.39	513.95	250.77
0.532	21.28	34.90	83.63	57.23	328.67	137.15
0.062	2.48	1.59	8.31	1.02	27.83	5.32
-	-	-	-	-	-	-
	42.92	88.67	199.64	201.84	971.32	439.47

 $\vec{x} = 2.07$ $\vec{y} = 4.65$ y = 1.68 + 1.93x Results :

V = 0.0129m = 206.06 m₁ = 123.31 m₂ = 344.35 Chi-sq. = 5.506

APPENDIX TABLE - III

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Ethylacetate after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.
	x	n	r	р		Y	Y
A. 5497.95	3.740	40	34	85.0	6.04	5.50	6.03
B. 549.80	2.740	40	6	15.0	3.96	4.54	4.05
C. 54.98	1.740	40	l	2.5	3.12	3.58	2.23
D. 5.50	0.740	40	1	2.5	3.12	2.62	3.35
0. Control	-	40	-	-	-	_	-

Weighting co-eff.	Weight					
w'	W=w'n	. WX	wy	wx ²	wy ²	wxy
0.439	17.56	65.67	105.89	245.62	638.50	396.03
0.581	23.24	63.68	94.12	174.48	381.19	257.89
0.302	12.08	21.02	26.94	36.57	60.07	46.88
0.062	2.48	1.84	8.31	1.36	27.83	6.15
-	-	-	-	-		
	55.36	152.21	235.26	458.03	1107.59	706.94

x 2.75 = 4.25 ÿ = 0.07 + 1.52x Y

=

Results :

v = 0.0105m = 1749.85 $m_1 = 1101.54$ $m_2 = 2779.71$ $Chi-sq. = 16.573^{***}$

APPINDIX TABLE - IV

:

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Ethylacetate after 24 hours,

Dos		Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.	
	n/sq.cm	x	n	r	р		Y	У	
Α.	5497.95	3.740	40	38	95.0	6.64	6.22	6.53	
В₊	549.80	2.740	40	15	37.5	4.69	5.14	4.69	
c.	54.98	1.740	40	4	10.0	3.72	4.06	3.79	
D.	5.50	0.740	40	2	5.5	3.36	2.98	3.51	
0.	Control	-	40	-	-	-	-	-	

Weighting co-eff.	Weight	C 0 5 6 8	1 0 0 0	6 0 0 0 0	2 0 2 0	
w۱	₩=w'n	WX	wy	wx ²	wy ²	wxy
0.370	14.80	55.35	96.64	207.01	631.06	361.43
0.634	25.36	69.49	118.94	190.40	557.83	325.90
0.471	18.84	32.78	71.40	57.04	270.61	124.24
0.131	5.24	3.88	18.39	3.88	64.55	13.61
-		-	-	-		-
	64.24	161.50	305.37	458.33	1524.05	825.17

- $\vec{x} = 2.51$
- $\bar{y} = 4.75$

y = 1.96 + 1.11x

Results :

V = 0.0135 m = 548.28 $m_1 = 325.09$ $m_2 = 924.70$ Chi-sq. = 8.395

APPENDIX TABLE - V

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Acetone after 24 hours,

	ose m∕sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.
<u>_</u>	,, oq•c	x	n	r	р		Y	У
Α.	3746.64	3.574	40	34	85.0	6.04	5.73	5.99
Β.	374.66	2.574	40	6	15.0	3.96	4.57	4.07
c.	37.47	1.574	40	4	10.0	3.72	3.41	3.81
D.	3.75	0.574	40	-	-	-	-	_
0.	Control	-	40	-	-	-	-	-

Weighting co-eff.	Weight					
w'	₩=w'n	WX	wy	wx ²	wy ²	wxy
0.532	21.28	76.05	127.46	271.82	763,53	455.54
0.601	24.04	61.88	97.84	159.28	398.22	251.84
0.238	9.52	14.98	36.27	23.59	138.19	57.09
-		-	-	-	-	-
-		-	-	-	_	-
	54.84	152,92	261.57	454.69	1299.94	764.47

 $\bar{x} = 2.79$

 $\bar{y} = 4.77$

y = 1.32 + 1.24x

Results : V = 0.0127 m = 946.24 $m_1 = 729.46$ $m_2 = 1227.44$ Chi-sq. = 9.236

APPENDIX TABLE - VI

Dose-mortality data of adult <u>T. castaneum</u> (Local) treated with seed extract in Methanol after 12 hours.

Do	se n∕sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.	
/ugi	n7 5q.€Cm	x	n	r	р		Y	У	
A.	2343.98	3.370	40	35	87.5	6.18	6.24	6.15	
Β.	234.40	2.370	40	17	42.5	4.82	4.71	4.81	
C.	23.44	1.370	40	1	2.5	3.12	3.18	3.06	
D.	2.34	0.370	40	-	-	-	-	-	
0.	Control	-	40	-	-	-	-	-	

	igh -ef	ting f.	Weight					
	w	1	₩≕w'n	₩x	wy	wx ²	wy ²	₩ху
0.	370		14.80	49.88	91.02	168.08	559.78	306.74
0.	616		24.64	58.40	118.52	138.40	570.07	280.89
0.	180		7.20	9.86	22.03	13.51	67.42	30.18
-			-	-	-	-	-	
-			-	-	-	-		-
			46.64	118.14	231.57	319.99	1197.27	617.81
x	122	2.53	, <u></u>				Results :	
Ŷ	=	4.97	,				V = 0.00	
y ≕ 1.14 + 1.51>					m = 354. $m_1 = 229.$ $m_2 = 549.$ Chi-sq. =	07 54		

APPENDIX TABLE - VII

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Methanol after 24 hours.

Dos		Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.
/ugi	m/sq.cm	x	n	r	р		Y	У
Α.	2343.98	3.370	40	37	92.5	6.48	6.48	6.43
В.	234.40	2.370	4 0	29	72.5	5.61	5.36	5,59
c.	23.44	1.370	40	4	10.0	3.72	4.23	3.82
D.	2.34	0.370	40	2	5.0	3.36	3.11	3.42
0.	Control		40	-	-	-	-	-

Weighting co-eff.	Weight					
۳,	₩=w'n	WX	wy .	wx ²	wy ²	wxy
0.269	10.76	36.26	69.18	122.20	444.83	233.14
0.601	24.04	56.97	134.38	135.03	751.20	318.48
0.503	20.12	27.56	76.86	37.76	293.60	105.30
0.154	6.16	2.28	21.07	0.84	72.05	7.80
-	-	-	-	-	-	
	61.08	123.08	301.49	295.83	1561.68	664.71
$\overline{\mathbf{x}} = 2.02$					Results :	

x = 2.02

 $\bar{y} = 4.94$

y = 2.56 + 1.18x

V = 0.0118m = 117.76 m₁ = 71.94 m₂ = 192.75 Chi-sq. = 6.593

APPENDIX TABLE - VIII

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR-I) treated with seed extract in Petroleum spirit after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work prob.
	x	n	r	р		Y	У
A.10060.301	4.003	40	40	100.00	8.09	8.03	8.30
B.1006.030	3.003	40	30	75.00	5.67	5.78	5.67
C.100.603	2.003	40	3	7.50	3.59	3.53	3.56
D.10.060	1.003	40	0	-	-	-	-
0.Control	-	40	0	-	-	-	-

Weighting co-eff.	^g Weight					
w '	W= w'n	ŴX	wy	wx ²	wy ²	wxy
0.015	0.60	2.40	4.98	9.61	41.33	19.93
0.503	20.12	60.42	114.08	181.44	646.84	342.58
0.269	10.76	21.55	38.31	43.17	136.37	76.73
-	-	-	-	-	-	-
-	-	-	-	-		-
	31.48	84.37	157.37	234.22	824.55	439.25
$\overline{\overline{x}} = 2.6$	58				Results	:
$\overline{y} = 5.0$	0				$\mathbf{V} = 0 \cdot 0$	121
-					m = 4.77	.53
y = 2.3	5x - 0.76				$m_1 = 290$	
					$m_2 = 785$.24
					Chi-sq.	= 0.078

APPENDIX TABLE - IX

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR-I) treated with seed extract in Petroleum spirit after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	У
A.10060.301	4.003	40	40	100.0	8.09	7.87	8.21
B.1006.030	3.003	40	35	87.5	6.18	6.12	6.15
C.100.603	2.003	40	3	7.5	3.59	4.37	3.81
D.10.060	1.003	40	1	2.5	3.12	2.62	3.34
0.Control	-	40	0		-	-	-

Weighting co-eff.	Weight					
w'	₩= w'n	wx	wy	wx ²	wy ²	wxy
0.019	0.76	3.04	6.24	12.169	51.23	24.98
0.405	16.20	48.65	99.63	146.100	612.72	299.19
0.558	22.32	44.71	85.04	89.550	324.00	170.34
0.062	2.48	2.49	8.28	2.500	27.66	8.30
-	-	- .	-	-		
	41.76	98.89	199.19	250.320	1015.61	502.81

 $\bar{x} = 2.37$

 $\bar{y} = 4.77$

y = 0.20 + 1.93x

Results : V = 0.0067 m = 306.90 $m_1 = 211.84$ $m_2 = 444.63$

Chi - sq. = 5.972

APPENDIX TABLE - X

Dose	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
/ugm/sq.cm	x	n	r	р		Y	У
A.14147.518	4.151	40	37	92.5	6.48	6.30	6.43
B.1414.752	3.151	40	9	22.5	4.26	4.62	4.27
C.141.475	2.151	40	1	2.5	3.12	2.94	3.06
D.14.148	1.151	40	-	-	-	-	-
0.Control	-	40	-	-	-	-	-

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR - I) treated with seed extract in Ethylacetate after 24 hours.

Weight			5 6 4 1		
₩= w'n	WX	wy	wx ²	wy ²	wxy
13.44	55.79	86.42	231.58	555.68	358.73
24.04	75.75	102.65	238.69	438.32	323.45
4.40	9.46	13.46	20.35	41.19	28.95
-	-	-	-	-	-
_	_ ·	-	-	-	
41.88	141.00	202.53	490.62	1035.18	711.13
	W= w'n 13.44 24.04 4.40 -	W= w'n Wx 13.44 55.79 24.04 75.75 4.40 9.46 	Weight W= w'n wx wy 13.44 55.79 86.42 24.04 75.75 102.65 4.40 9.46 13.46 	Weight W= w'n wx wy wx ² 13.44 55.79 86.42 231.58 24.04 75.75 102.65 238.69 4.40 9.46 13.46 20.35 	WeightWxWy wx^2 wy^2 13.4455.7986.42231.58555.6824.0475.75102.65238.69438.324.409.4613.4620.3541.19

 $\bar{x} = 3.37$

 $\bar{y} = 4.84$

Y = 1.84x - 1.36

Results : V = 0.0072 m = 2857.59 $m_1 = 1945.36$ $m_2 = 4197.59$ Chi-sq. = 2.304

APPENDIX TABLE - XI

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR - I) treated with seed extract in Acetone after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	у.
A.12268.603	4.089	40	17	42.5	4.82	4.54	4.83
B.1226.860	3.089	40	1	2.5	3.12	3.69	3.29
C.122.686	2.089	40	1	2.5	3.12	2.84	3.11
D.12.269	1.089	40	0	-	-	-	-
0.Control	-	40	0	-		-	-

Weighting co-eff.	Weight		1 1 1 1 1			
w'	₩= w'n	WX	wy	wx ²	wy ²	wxy
0.581	23.24	95.03	112.25	388.58	542.17	458.99
0.336	13.44	41.52	44.22	128.26	145.48	136.60
0.092	3.68	7.69	11.44	16.06	35.58	23.89
-	-	-	-	-	-	-
-	-	-	-	-		_
	40.36	144.23	167.91	532.89	723.23	619.48

 $\bar{x} = 3.57$

 $\bar{y} = 4.16$

y = 0.19 + 1.11x

Results :

V = 0.0463m = 21330.45 m₁ = 8090.96 m₂ = 56234.13 Chi-sq. = 2.479

APPENDIX TABLE - XII

Dose	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % killed	Emp. prob.	Exp. prob.	Work. prob.
/ugm/sq.cm	x	n	r	р	ATTIEU		Y	y y
A.3109.075	3.493	40	38	95.0	94.74	6.64	6.13	6.48
B.310.908	2.493	40	11	27.5	23.68	4.29	5.03	4.29
C.31.091	1.493	40	7	17.5	13.16	3.87	3.93	3.88
D.3.109	0.493	40	3	7.5	2.63	3.12	2.83	3.15
0.Control	-	40	2	5.0	-	-		-

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR - I) treated with seed extract in Methanol after 12 hours,

Weighting co-eff.	Weight		1 1 1 1			
W 1	W = w'n	wx	wy	wx ²	wy ²	₩ху
0.405	16.20	56.59	104.98	197.670	680.27	366.27
0.532	21.28	53.05	91.29	132.250	391.63	227.59
0.405	16.20	24.19	62.86	36.120	243.90	93.85
0.092	3.68	1.81	11.59	0.893	36.51	5.71
-	_	-	-	-	-	-
	57.36	135.64	270.72	366.93	1352.31	693.84
$\overline{x} = 2.37$					Results	:
ÿ. = 4.72					V = 0.02	
Y ≈ 1.97 +	1.16x				m = 403 $m_1 = 238$ $m_2 = 683$ Chi-sq. =	.23 .91

APPENDIX TABLE - XIII

Dose-mortality data of adult <u>T. castaneum</u> (CR - I) treated with seed extract in Methanol after 24 hours,

Dose	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % killed	Emp. prob.	Exp. prob.	Work. prob.
/ugm/sq.cm	x	n	r	р			Y	У
A.3109.075	3.493	40	39	97.5	97.29	6.88	6.28	6.71
B.310.908	2.493	40	15	37.5	32.43	4.53	5.29	4.53
C.31.091	1.493	40	9	22.5	16.22	4.01	4.31	4.05
D.3.109	0.493	40	7	17.5	10.81	3.77	3.32	3.98
0.Control		40	3	7.5	-	-	-	-

Weighting co-eff.	Weight	1 1 5 1 1				
w'	₩ = w'n	WX	wy	wx ²	wy ²	wxy
0.336	13.44	46.95	96.18	163.99	645.37	315.03
0.616	24.64	61.43	111.62	153.14	505.64	278.28
0.532	21.28	31.77	86.18	47.43	349.03	128.67
0.208	8.32	4.10	33.11	2.02	131.78	16.32
-	_	-	-	-	-	
	67.68	144.25	321.10	366.60	1631.81	738.30
$\bar{x} = 2.13$					Results	:
$\bar{Y} = 4.74$					$\mathbf{V} = 0$	
Y = 2.80 +	0.91v				m = 25	
1 - 2.00 +	, O°2TX				1	5.28 8.32

chi-sq. = 60.331

•

APPENDIX TABLE - XIV

pose-mortality data of adult \underline{T} . <u>castaneum</u> (FSS - II) treated with seed extract in Petroleum spirit after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	Y
A.4367.99	3.640	40	40	100.00	8.09	8.14	8.40
B. 436.80	2.640	40	35	87.50	6.18	6.08	6.15
C. 43.68	1.640	40	6	15.00	3,96	4.01	3.96
D. 4.37	0.640	40	-		-	_	-
0. Control	-	40	-	-	-	-	-

Weighting | Weight co-eff. wx² wy² w' W= w'n wх wy WXY 13.47 5.82 31.08 0.001 . 1.60 3.70 0.44 112.91 612.72 263.02 0.405 16.20 42.77 99.63 275.38 114.05 47.23 69.54 0.439 17.56 28.80 919.18 390.54 165.97 172.86 73.17 34.20

x = 2.14

 $\bar{y} = 5.05$

y = 0.36 + 2.20x

Results : V = 0.0061 m = 130.02 $m_1 = 91.41$ $m_2 = 184.93$ Chi-sq. = 0.874

APPENDIX TABLE - XV

pose-mortality data of adult <u>T. castaneum</u> (FSS - II) treated with seed extract in Petroleum spirit after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р			Y	У
A.4367.99	3.640	40	40	100.00	100.00	8.09	8.04	8.30
B. 436.80	2.640	40	37	92.50	92.31	6.41	6.34	6.42
C. 43.68	1.640	40	11	27.50	25.64	4.36	4.65	4.37
D. 4.37	0.640	40	2	5.50	2.56	3.12	2.95	3.05
0.Control	-	40	1	2.50	-	-	-	-

Weighting co-eff.	Weight					
w '	W = w'n	wx	wy	wx ²	wy ²	wxy
0.015	0.60	2.184	4.98	7.95	41.33	18.13
0.336	13.44	35.480	86.28	93.67	553,92	227.78
0.616	24,64	40.410	107.68	66.27	470.56	176.60
0.131	_	3.350	15.98	2.14	48.74	10.23
_	-	_	-	-	-	-
	43.92	81.420	214.92	170.03	1114.55	432.74
					Results :	

 $\bar{x} = 1.85$

 $\bar{Y} = 4.89$

Y = 1.56 + 1.80x

,

Results : V = 0.0071 m = 82.04 $m_1 = 56.10$ $m_2 = 119.95$ Chi-sq. = 0.343

APPENDIX TABLE - XVI

pose-mortality data of adult \underline{T} . <u>castaneum</u> (FSS - II) treated with seed extract in Ethylacetate after 12 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	У
A.5497.95	3.740	40	33	82.5	5.95	5,29	5.84
B. 549.80	2.740	40	3	7.5	3.59	4.39	3.81
C. 54.98	1.740	40	1	2.5	3.12	3.50	3.17
D. 5.50	0.740	40	1	2.5	3.12	2.60	3.35
0.Control	-	40	-	-	-	-	·

wy

143.90

85.04

34.11

8.31

271.35

wy²

840.38

324.00

180.13

27.84

1300.35

Results :

v

m

= 0.0142

m₁ = 1161.45

 $m_2 = 3396.25$

= 1986.09

Chi-sq. = 13.563

wxy

538.19

233.01

59.35

6.15

836.70

wx²

344.64

167.58

32.57

1.36

546.15

Weighting

w١

co-eff.

0.616

0.558

0.269

0.062

 $\bar{x} = 2.89$

 $\bar{y} = 4.51$

y = 1.04 + 1.20x

Weight

W= w'n

24.64

22.32

10.76

2.48

60.20

WX

92.15

61.16

18.72

1.84

173.87

APPENDIX TABLE - XVII

Dose-mortality data of adult <u>T</u>. <u>Castaneum</u> (FSS - II) treated with seed extract in Ethylacetate after 24 hours,

.

Log dose	No. of insect used	No. of insect killed	~	Emp. prob.	Exp. prob.	Work. prob.
x	n	r	р		Y	ÿ
3.740	40	40	100.00	8.09	7.24	7.59
2.740	40	14	35.00	4.61	5.65	4.39
1.740	40	3	7.50	3.59	4.06	3.69
0.740	40	l	2.50	3.12	2.46	3.58
-	40	-	-	-	-	-
	dose x 3.740 2.740 1.740	dose insect used x n 3.740 40 2.740 40 1.740 40 0.740 40	dose insect used insect killed x n r 3.740 40 40 2.740 40 14 1.740 40 3 0.740 40 1	dose insect used insect killed insect killed % x n r p 3.740 40 40 100.00 2.740 40 14 35.00 1.740 40 3 7.50 0.740 40 1 2.50	dose insect used insect killed insect killed Emp. prob. x n r p 3.740 40 40 100.00 8.09 2.740 40 14 35.00 4.61 1.740 40 3 7.50 3.59 0.740 40 1 2.50 3.12	doseinsectinsectinsect%Emp.Exp.xnrpY3.7404040100.008.097.242.740401435.004.615.651.7404037.503.594.060.7404012.503.122.46

Weighting co-eff.	Weight					
w'	₩≕ w'n	WX	wy	wx ²	wy ²	wxy
0.092	3.68	13.76	27.93	51.47	211.99	104.46
0.532	21.28	58.31	93.42	159.76	410.11	255.97
0.471	18.84	32.78	69.52	57.04	256.53	120.96
0.050	2.00	1.48	7.16	1.10	25.63	5.30
-		-	-	-	_	-
	45.80	106.33	198.03	269.37	904.26	486.69
$\bar{x} = 2.32$ $\bar{y} = 4.32$ y = 1.53 +	1.20x				Results V = 0.0 m = 769 $m_1 = 370$ $m_2 = 157$ Chi-sq.	025 9.13 5.70

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APPENDIX TABLE - XVIII

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (FSS - II) treated with seed extract in Acetone after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	y
A.3746.64	3.574	40 -	39	97.5	7.05	6.74	6.90
B. 374.66	2.574	40	13	32.5	4.56	5.19	4.55
C. 37.47	1.574	40	6	15.0	3.96	3.65	4.02
D. 3.75	0.574	40		-	-	-	-
0.Control	-	40	-	-	-	-	

Weighting co-eff.	Weight		0 1 1 1 1	1 1 5 5		
w '	₩= w'n	ŴX	wy	wx ²	wy ²	₩ху
0.208	8.32	29.74	57.41	106.28	396.12	205.18
0.627	25.08	64.56	114.11	166.17	519.22	293.72
0.336	13.44	21.15	54.03	33.30	217.20	85.04
		-	-	-	-	-
-		-	-	-	-	-
. 	46.84	115.45	225.55	305.75	1132.54	583.95
					Recults	•

 $\bar{x} = 2.46$

 $\bar{y} = 4.82$

Y = 1.53 + 1.34x

Results :

V = 0.0123 m = 393.55 $m_1 = 239.33$ $m_2 = 647.14$ Chi-sq. = 6.399

APPENDIX TABLE - XIX

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (FSS - II) treated with seed extract in Methanol after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed		Corr. % killed	Emp. prob.	Exp. prob.	Work. prob.
ا بر ارج و در 	x	n	r	р			Y	У
A.2343.08	3.370	40	40	100.0	100.00	8.09	7.36	7.76
B. 234.40	2.370	40	4	10.0	7.69	3.59	5.04	3.94
C. 23.44	1.370	40	3	7.5	5.13	3.45	2.72	4.13
D. 2.34	0.370	40	1	2.5	-	~	-	-
0.Control	-	40	1	2.5	-	-	-	-

Weighting co-eff.	Weight					
w '	W = w'n	WX	wy	wx ²	wy ²	₩ХУ
0.062	2.48	8.36	19.24	28.17	149.34	64.84
0.637	25.48	60.39	100.39	143.12	395.54	237.92
0.076	3.04	4.16	12.56	5.71	51.85	17.21
-	-	· _	-	-	-	
-	-	-	-	-	-	-
	31.00	72.91	132.19	177.00	596.73	319.97

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 $\bar{x} = 2.35$

 $\bar{Y} = 4.26$

Y = 0.39 + 1.65x

Results :

V = 0.0253 m = 629.51 $m_1 = 306.90$ $m_2 = 1291.22$ Chi-sq. = 18.217

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APPENDIX TABLE - XX

pose-mortality data of adult \underline{T} . <u>castaneum</u> (FSS - II) treated with seed extract in Methanol after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	%	Corr. % killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р	xiiieu		Y	У
A.2343.98	3.370	40	40	100.0	100.00	8.09	7.09	7.51
B. 234.40	2.370	40	11	27.5	21.62	4.23	5.54	4.15
C. 23.44	1.370	40	6	15.0	8.11	3.59	3.98	3.67
D. 2.34	0.370	40	4	10.0	2.70	3.12	2.43	4.05
0.Control	-	40	3	7.5	-	-	-	-

Weighting co-eff.	Weight					
w۱	₩ = w'n	wx	wy	wx ²	wy ²	₩ХУ
0.110	4.40	14.83	33.04	49.97	248.16	111.34
0.581	23.24	55.08	96.45	130.54	400.25	228.59
0.439	17.56	24.06	64.45	32.96	236.51	88.30
0.040	1.60	0.59	6.48	0.22	26.24	2.40
-	-	-	-	-	-	-
	46.80	95.56	200.42	213.69	911.16	430.63

- $\bar{x} = 2.04$
- $\bar{Y} = 4.28$
- Y = 1.91 + 1.16x

Results : V = 0.0312 m = 457.09 $m_1 = 205.59$ $m_2 = 1016.25$ Chi-sq. = 28.105*

APPENDIX TABLE - XXI

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC -12) treated with seed extract in Petroleum spirit after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	У
A.4367.99	3.640	40	40	100.0	8.09	7.95	8.30
в. 436.80	2.640	40	30	75.0	5.67	5.95	5.62
C. 43.68	1.640	40	7	17.5	4.08	3.94	4.08
D. 4.37	0.640	40	-	-	-	-	
0.Control	-	40	-	-	 '		-

Weighting co-eff.	Weight					
w '	W= w'n	WX	wy	wx ²	wy ²	wxy
0.015	0.60	21.84	4.98	7.95	41.33	18.13
0.439	17.56	46.36	98.69	122.39	554.62	260.54
0.405	16.20	26.57	66.10	43.57	269.67	108.40
-	-	-	-	-	-	-
-	-	-	-	-	-	-
	34.36	75.11	169.76	173.91	865.62	387.07
$\bar{x} = 2.19$ $\bar{y} = 4.94$ y = 1.38	+ 1.62x				Results V = 0.0 m = 168 $m_1 = 104$ $m_2 = 272$ Chi-sq.	112 .66 .47 .27

APPENDIX TABLE - XXII

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Petroleum spirit after 24 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	У
A.4367.99	3.640	40	40	100.0	8.09	7.94	8.21
B. 436.80	2.640	40	36	90.0	6.28	6.32	6.29
C. 43.68	1.640	40	10	25.0	4.33	4.71	4.36
D. 4.37	0.640	40	2	5.0	3.36	3.09	3.42
0.Control	-	40	-	-	-	-	-
0.Control		40			-	-	

Weighting co-eff.	Weight					
w'	₩ =w'n	WX	wy	wx ²	wy ²	wxy
0.019	0.76	2.77	6.24	10.07	51.23	22.71
0.336	13.44	35.48	84.54	93.67	531.74	223.19
0.616	24.64	40.41	107.43	66.27	468.40	176.19
0.154	6.61	4.23	22.61	2.71	77.31	14.47
	-	_	-	-	-	-
	45.00	82.89	220.81	172.72	1128.68	436.55

 $\vec{x} = 1.84$

 $\bar{y} = 4.91$

y = 2.15 + 1.50x

Results :

V = 0.0099m = 79.43 m₁ = 50.82 m₂ = 124.17 Chi-sq. = 0.887

APPENDIX TABLE - XXIII

Dose-mortality data of adult <u>T</u>. castaneum (CTC - 12) treated with seed extract in Ethylacetate after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	'n	r	р		Y	y Y
A.5497.95	3.740	40	35	87.5	6.18	6.00	6.13
B. 549.80	2.740	40	10	25.0	4.33	4.70	4.36
C. 54.98	1.740	40	3	7.5	3.59	3.41	3.59
D. 5.50	0.740	40	-	-	-	-	-
0.Control	_	40	-	-	-	-	-

Weighting co-eff.	Weight	C 6 8				
w'	W= w'n	WX	wy	wx ²	wy ²	wxy
0.439	19.60	73.30	120.15	274.16	736.51	449.36
0.616	24.64	67.51	107.43	184.99	468.40	294.36
0.238	9.52	16.56	34.18	28.82	122.69	59.47
-	-	, -	-		_	-
-	-	-	-	-	-	, -
	53.76	157.38	261.76	487.97	1327.60	803.19
$\overline{x} = 2.93$					Results :	

 $\bar{Y} = 4.87$ Y = 0.91 + 1.35x V = 0.0104 m = 1061.70 $m_1 = 671.43$ $m_2 = 1678.80$ Chi-sq. = 3.914

APPENDIX TABLE - XXIV

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Ethylacetate after 24 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
·	x	n	r	р		Y	У
A.5497.95	3.740	40	40	100.0	8.09	7.59	7.94
B. 549.80	2.740	40	27	67.5	5.47	6.03	5.31
C. 54.98	1.740	40	7	17.5	4.08	4.47	4.12
D. 5.50	0.740	40	2	5.0	3.36	2.91	3.63
0.Control	-	40	-	-	-	-	

Weighting co-eff.	Weight			1		8 5 8 8 9 9
w '	₩ = w'n	wx	wy	wx ²	wy ²	wxy
0.040	1.60	5.98	12.70	22.38	100.87	47.50
0.439	17.56	48.11	93.24	131.83	495.12	255.48
0.581	23.24	40.44	95.75	70.36	394.49	166.61
0.110	4.40	3.26	15.97	2.41	57.98	11.82
- ·	-	-	-	-	-	-
	46.80	97.79	217.67	226.98	1048.41	481.40

- $\bar{x} = 2.09$
- $\bar{y} = 4.65$
- y = 2.20 + 1.17x

Results :

V = 0.0185m = 244.84 m₁ = 132.43 m₂ = 452.90 Chi-sq. = 5.275

APPENDIX TABLE - XXV

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Acetone after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	q		Y	У
A.3746.64	3.574	40	40	100.0	8.09	6.90	7.34
B. 374.66	2.574	40	6	15.0	3.96	5.53	3.97
C. 37.47	1.574	40	4	10.0	3.72	4.14	3.79
D. 3.75	0.574	40	3	7.5	3.59	2.78	4.52
0.Control	-	40	-	-	-	-	-

Weighting co-eff.	Weight					
w '	₩ = w'n	WX	wy	wx ²	wy ²	wxy
0.154	6.61	23.62	48.52	84.43	356.12	173.41
0.581	23.24	59.82	92.26	153.98	366.28	237.48
0.471	18.84	29.65	17.40	46.68	270.62	27.39
0.092	3.68	2.11	16.63	1.21	75.18	9.55
-	_	-	-	-	-	-
Name and a second s	51.92	115.21	174.81	286.30	1068.20	447.82

 $\bar{x} = 2.22$

 $\bar{y} = 3.37$

Y = 1.96x - 0.97

Results :

V = 0.0109m = 1129.80 m₁ = 706.32 m₂ = 1807.17 Chi-sq. = 361.996

APPENDIX TABLE - XXVI

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Methanol after 12 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	y
A.2343.98	3.370	40	36	90.0	6.28	6.73	6.11
в. 234.40	2.370	40	35	87.5	6.18	5.88	6.12
C. 23.44	1.370	40	31	77.5	5.77	5.03	5.70
D. 2.34	0.370	40	3	7.5	3.59	4.18	3.73
0.Control	-	40	-	-	-	-	-

Weighting co-eff.	Weight		1 4 3 1 1		1	/ / / / /	
w'	W = w'n	wx	wy	wx ²	wy ²	wxy	
0.208	8.32	28.04	50.84	94.49	310.60	171.33	
0.471	18.84	44.65	115.30	105.82	705.64	273.26	
0.637	25.48	345.91	145.24	47.82	827.85	198.98	
0.503	20.12	7.44	74.97	2.75	279.65	27.74	
-	-	-	-	-	-	-	
	72.76	115.04	386.35	250.88	2123.74	671.31	
$\bar{x} = 1.58$					Results	:	
$\bar{y} = 5.31$	V = 0.0202						
_					m = 16.90		
y = 3.92 +	0.88x				$m_1 = 8.9$	1	
					$m_2 = 32$.	06	

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chi-sq. = 18.649

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APPENDIX TABLE - XXVII

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Methanol after 24 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x	n	r	р		Y	У
A.2343.98	3.370	40	39	97.5	7.05	7.43	6.64
B. 234.40	2.370	40	38	95.0	6.64	6.46	6.62
C. 23.44	1.370	40	36	90.0	6.28	5.50	6.10
D. 2.34	0.370	40	6	15.0	3.96	4.54	4.05
0.Control	-	40	-	-	-	-	

Weighting co-eff.	Weight					* • • •
w'	W = w'n	wx	wy	wx ²	wy ²	wxy
0.062	2.48	8.36	16.47	28.17	109.34	55.50
0.269	10.76	25.50	71.23	60.44	471.55	168.82
0.581	23.24	31.84	141.76	43.62	864.76	144.21
0.581	23.24	8.60	94.12	3.18	381.19	34.82
-	_	-	-	-	-	-
	59.72	74.30	323.58	135.41	1826.84	453.35

 $\bar{x} = 1.24$

- $\bar{y} = 5.42$
- y = 3.98 + 1.20x

Results : V = 0.0136 m = 7.78 $m_1 = 4.59$ $m_2 = 13.18$

 $Chi_{-}sq_{-} = 10.503$

APPENDIX TABLE - XXVIII

Dose-mortality data of adult \underline{T} . <u>castaneum</u> (Local) treated with methacrifos after 12 hours,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+3)	n	r	Р		Y	У
A. 1.493	3.174	40	31	77.5	5.77	5.64	5.75
B. 0.1493	2.174	40	18	45.0	4.87	5.12	4.87
C. 0.01493	1.174	40	15	37.5	4.69	4.59	4.68
D. 0.001493	0.174	40	7	17.5	4.08	4.07	4.07

Weighting co-eff.	Weight					r 5 5 6
w'	W = W'n	WX	wy	wx ²	wy ²	wxy
0.558	22.32	70.884	128.34	244.86	737.96	407.35
0.634	25.36	55.133	123.50	119.86	601.93	268.50
0.601	24.04	28.233	112.51	33.13	526.55	132.08
0.471	18.84	3.278	76.80	0.57	312.58	13.34
	90.56	157.48	441.03	378.42	2179.02	821.27

 $\bar{x} = 1.74$

 $\bar{Y} = 4.87$

Y = 3.97 + 0.52x

Results : V = 0.0431 m = 0.0977 $m_1 = 0.0382$ $m_2 = 0.250$ Chi-sq. = 3.187

APPENDIX TABLE - XXIX

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (Local) treated with methacrifos after 24 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+3)	n	r	Р		Y	У
A. 1.493	3.174	40	36	90.0	6.28	5.95	6.24
B. 0.1493	2.174	40	22	55.0	5.13	5.59	5.07
C. 0.01493	1.174	40	22	55.0	5.13	5.23	5.13
D. 0.001493	0.174	40	21	52.5	5.08	4.87	5.06

Weighting co-eff.	Weight	5 6 7 8 8			, , , ,	
w '	W = W'n	WX	wy	wx ²	wy ²	wxy
0.439	17.56	55.74	109.57	176.92	683.72	347.78
0.558	22.32	48.52	113.16	105.48	573.72	246.01
0.627	25.08	29.44	128.66	34.56	660.03	151.05
0.634	25.36	4.41	128.32	0.77	649.30	22.33
	90.32	138.11	479.71	317.73	2566.77	767.17
					nogults	

 $\overline{x} = 1.53$ $\overline{y} = 5.31$

y = 4.84 + 0.31x

Results : V = 0.2131 m = 0.0034 $m_1 = 0.00042$ $m_2 = 0.0273$ Chi-sq. = 9.214

APPENDIX TABLE - XXX

pose-mortality data of adult \underline{T} . castaneum (CR - I) treated with methacrifos after 12 hours.

Dose ∕ugm/sg.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+3)	n	r	Р		Y	y
A. 1.493	3.174	40	32	80.0	5.84	5.74	5.84
B. 0.1493	2.174	40	22	55.0	5.13	5.25	5.12
C. 0.01493	1.174	40	15	37.5	4.69	4.75	4.68
D. 0.001493	0.174	40	10	25.0	4.33	4.25	4.33

Weighting co-eff.	Weight		8 8 9 9	2 5 8		
w'	W = w'n	WX	wy	wx ²	wy ²	wxy
0.532	21.28	67.54	124.28	214.37	725.80	394.46
0.616	24.64	53.57	126.16	116.46	645.94	274.27
0.627	25.08	29.44	117.37	34.56	549.29	137.79
0.532	21.28	3.70	92.14	0.64	398.97	16.03
	92.28	154.25	459.95	366.03	2319.00	822.56
$\bar{x} = 1.67$					Results	:

 $\bar{y} = 4.98$

y = 4.15 + 0.50x

Results :

V = 0.0434 m = 0.0513 $m_1 = 0.0201$ $m_2 = 0.1312$ Chi-sq. = 1.227

APPENDIX TABLE - XXXI

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CR - I) treated with methacrifos after 24 hours.

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Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+3)	n	r	Р		Y	У
A. 1.493	3.174	40	40	100.0	8.09	7.38	7.76
B. 0.1493	2.174	40	25	62.5	5.33	6.34	4.68
C. 0.01493	1.174	40	23	57.5	5.20	5.31	5.15
D. 0.001493	0.174	40	15	37.5	4.69	4.28	4.73

Weighting co-eff.	Weight		1 1 1 1	; ; ; ;		9 1 1 1 1
w'	W = w'n	ŴX	wy	wx ²	wy ²	wxy
0.062	2.48	7.87	19.24	24.98	149.30	61.07
0.336	13.44	29.21	62.90	63.50	294.37	136.74
0.616	24.64	28.92	126.90	33,95	653.54	148,98
0.532	21.28	3.70	100.64	0.64	476.03	17.51
						264 20
<u> </u>	61.84	69.70	309.68	123.07	1573.24	364.30

- $\vec{x} = 1.12$ $\vec{y} = 5.00$
- y = 4.64 + 0.32x

Results : V = 0.1617 m = 0.0135 $m_1 = 0.0022$ $m_2 = 0.0828$ Chi-sq. = 19.253

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APPENDIX TABLE - XXXII

pose-mortality data of adult <u>T</u>. <u>castaneum</u> (FSS - II) treated with methacrifos after 12 hours.

Dose /ugm/sq.cm	Log dose		No. of insect killed		Emp. prob.	Exp. prob.	Work. prob.
	x (+3)	n	r	Р		Y	Ŷ
A. 1.493	3.174	40	35	87.5	6.18	5.98	6.13
B. 0.1493	2.174	40	22	55.0	5.13	5.29	5.12
C. 0.01493	1.174	40	10	25.0	4.33	4.61	4.34
D. 0.001493	0.174	40	8	20.0	4.16	3.92	4.20

Weighting co-eff.	Weight					8 1 1 1 1 1
W '	W = w'n	wx	wy	wx ²	wy ²	Wxy
0.439	17.56	55.73	107.64	176.89	659.83	341.65
0.616	24.64	53.56	126.16	116.44	645.94	274.27
0.601	24.04	28.22	104.33	33.13	452.79	122.48
0.405	16.20	2.81	68.04	0.49	285.77	11.84
			406.17	326.95	2044.33	750.24
	82.44	140.32	400.17	520155	Results	•
$\bar{x} = 1.70$						
$\bar{y} = 4.93$					$\mathbf{V} = 0.0$	
Y — 4.95					m = 0.0	
Y = 3.77 +	0.68x				$m_1 = 0.0$	303
					$m_2 = 0.1$	315
					Chi-sq.	= 1.281

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APPENDIX TABLE - XXXIII

pose-mortality data of adult \underline{T} . castaneum (FSS - II) treated with methacrifos after 24 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x (+3)	n	r	P		Y	y
A. 1.493	3.174	40	38	95.0	6.64	6.36	6.61
B. 0.1493	2.174	40	25	62.5	5.33	5.72	5.27
C. 0.01493	1.174	40	20	50.0	5.00	5.07	5.00
D. 0.001493	0.174	40	14	35.0	4.61	4.43	4.63

Weighting co-eff.	Weight		, , , ,		1 	
w'	₩ = w'n	WX	wy	wx ²	wy ²	wxy
0.302	12.08	38.34	79.85	121.69	527.81	253.44
0.532	21.28	46.26	112.15	100.57	591.03	243.81
0.634	25.36	29.77	126.80	34.95	634.00	148.86
0.558	22.32	3,88	103.34	0.68	478.46	17.98
	81.04	118.26	422.14	257.89	2231.30	664.09

 $\bar{x} = 1.46$ $\bar{y} = 5.21$

y = 4.39 + 0.56x

Results : V = 0.0453 m = 0.012 $m_1 = 0.0046$ $m_2 = 0.0314$ Chi-sq. = 5.202

APPENDIX TABLE - XXXIV

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with methacrifos after 12 hours,

Dose Jugm/sq.cm	Log dose	No. of insect used	No. of insect killed		Emp. prob.	Exp. prob.	Work. prob.
Jugin, Sq. Chi	x (+3)	n	r	р		Y	У
A. 1.493	3.174	40	20	50.0	5.00	5.02	5.01
B. 0.1493	2.174	40	12	38.0	4.69	4.63	4.69
C. 0.01493	1.174	40	8	20.0	4.16	4.23	4.16
D. 0.001493	0.174	40	5	12.5	3.87	3.84	3.85

Weighting co-eff.	Weight			1 1 1 1 1 1		1 1 6 0 1
w '	₩ = w'n	wx	wy	wx ²	wy ²	wxy
0.633	25.32	80.36	126.85	255.06	635.52	402.62
0.601	24.04	52.26	112.75	113.61	528.80	245.12
0.503	20.12	23.62	82.70	27.73	344.03	97.09
0.370	14.80	2.57	56.98	0.45	219.37	9.91
					1 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	754.74
	84.28	158.81	379.28	396.85	1727.72	/54./4

 $\bar{x} = 1.88$

 $\bar{y} = 4.50$

y = 3.71 + 0.42x

Results : V = 0.1466 m = 1.176 $m_1 = 0.2087$ $m_2 = 6.63$ Chi-sq. = 3.448

APPENDIX TABLE - XXXV

Dose-mortality data of adult <u>T</u>. <u>castaneum</u> (CTC - 12) treated with methacrifos after 24 hours.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Emp. prob.	Exp. prob.	Work. prob.
	x (+3)	n	r	Р		Y	Y
A. 1.493	3.174	40	25	62.5	5.33	5.31	5.32
B. 0.1493	2.174	40	20	50.0	5.00	5.08	5.01
C. 0.01493	1.174	40	19	47.5	4.95	4.84	4.94
D. 0.001493	0.174	40	13	32.5	4.56	4.61	4.54

Weighting co-eff.	Weight		4 6 7 8 4 7	1 1 1 1 1		
w '	W = w'n	wx	wy	wx ²	wy ²	wxy
0.616	24.64	78.20	131.08	248.21	697.35	416.05
0.637	25.48	55.39	127.65	120.42	639.53	277.51
0.627	25.08	29.44	123.90	34.56	612.07	145.46
0.601	24.04	4.18	109.14	0.73	495.50	18.99
				402.02	2444.45	858.01
	99.24	167.21	491.77	403.92	2444.40	

 $\bar{x} = 1.69$

<u>ن</u>

- .y = 4.96
- y = 4.49 + 0.22x

Results :

V = 0.2155m = 0.0741 m₁ = 0.0091 m₂ = 0.6012 Chi-sq. = 0.651

APPENDIX TABLE - XXXVI

pose-mortality data of larvae <u>T</u>. <u>castaneum</u> (Local) treated with seed extract in Petroleum spirit,

pose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	×	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	' x(+2)	n	r	Р			Y	Y
A. 48.53	3.686	40	39	97.5	97.14	6.88	6.80	6.90
B. 4.853	2.686	40	35	87.5	85.71	6.08	6.23	6.05
C. 0.4853	1.686	40	32	80.0	77.14	5.74	5.67	5.74
D. 0.04853	0.686	40	24	60.0	54.29	5.10	5.10	5.11
0. Control	_	40	5	12.5	_ `	-	-	-

Weighting co-eff.	Weight		1 1 1 1	6 8 8 1		
w '	W = w'n	WX	wy	wx ²	wy ²	₩ху
0.180	7.20	26.54	49.68	97.83	312.79	183.12
0.370	14.80	39.75	89.54	106.79	541.72	240.50
0.532	21.28	35.88	122.15	60.49	701.14	205.94
0.634	25.36	17.40	129.59	11.94	662.20	88.90
-	-	-	-	-	-	-
	68.64	119.57	390.96	277.05	2247.85	718.46

- $\bar{x} = 1.74$
- $\bar{Y} = 5.70$
- Y = 4.74 + 0.55x

Results : V = 0.126 m = 0.0293 $m_1 = 0.0059$ $m_2 = 0.1455$ Chi-sq. = 1.626

APPENDIX TABLE - XXXVII

Dose-mortality data of larvae \underline{T} . <u>castaneum</u> (Local) treated with seed extract in Ethyl acetate.

Dose /ugm/sq.Cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
/ugiii/ 5q.c.iii	x(+2)	n	r	р			Y	У
A. 61.08	3.786	40	37	92.5	91.18	6.34	6.51	6.33
B. 6.108	2.786	40	33	82.5	79.41	5.81	5.82	5.82
C. 0.6108	1.786	40	31	77.5	73.53	5.64	5.12	5.59
D. 0.06108	8 0.786	40	12	30.0	17.65	4.08	4.43	4.11
0. Control	· · ·	40	6	15.0	-	-	-	-

Weighting co-eff.	Weight		8 8 9 9 9 9			
w'	₩= w'n	WX	wy	wx ²	wy ²	wxy
0.269	10.76	40.74	68.11	154.23	431.14	257.86
0.503	20.12	56.05	117.10	156.17	681.51	326.24
0.634	23.36	41.72	130.58	74.51	729.96	233.22
0.558	22.32	17.54	91.74	13.79	377.03	72.11
-	-	-	-	-		
	76.56	156.06	407.53	398.70	2219.64	889.43

 $\bar{x} = 2.04$

 $\bar{Y} = 5.32$

Y = 3.85 + 0.72x

Results : V = 0.029 m = 0.395 $m_1 = 0.1832$ $m_2 = 0.8531$ Chi-sq. = 9.771

APPENDIX TABLE - XXXVIII

	ose m/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
		x(+2)	n	r	Р			Y	<u>у</u>
Α.	41.63	3.619	40	37	92.5	90.63	6.34	6.36	6.31
B.	4.163	2.619	40	32	80.0	75.00	5.67	5.60	5.67
С.	0.4163	1.619	40	21	52.5	40.63	4.77	4.85	4.76
D.	0.04163	0.619	40	15	35.0	18.75	4.12	4.09	4.12
0.	Control	-	40	8	20.0	-	-	-	-

pose mortality data of larvae \underline{T} . <u>castaneum</u> (Local) treated with seed extract in Acetone.

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Weighting co-eff.	Weight	1 1 1 1				
w'	W = w'n	WX	wy	wx ²	wy ²	wxy
0.302	12.08	43.72	76.22	158.21	480.98	275.84
0.558	22.32	58,46	126.55	153.10	717.56	331.43
0.634	25.36	41.06	120.71	66.47	574.60	195.43
0.471	18.84	11.66	77.62	7.22	319.80	48.05
-		-	-	-	en	
	78.60	154.89	401.11	385.00	2092.94	850.75
					Results :	
$\bar{x} = 1.97$					$\mathbf{V} = 0.02$	22
5					m = 0.68	
$\bar{y} = 5.10$					$m_1 = 0.35$	
Y = 3.60 +	0.76x				$m_2 = 1.34$	15
					Chi-sq. =	1.251

APPENDIX TABLE - XXXIX

Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
x(+2)	n	r	Р			Y	У
3.416	40	30	75.0	67.74	5.47	5.55	5.45
2.416	40	24	60.0	48.39	4.95	4.87	4.96
1.416	40	16	40.0	22.58	4.26	4.20	4.25
0.416	4 0	11	27.5	6.45	3.45	3.52	3.48
-	40	9	22.5	-	_		-
	dose x(+2) 3.416 2.416 1.416	log insect dose used x(+2) n 3.416 40 2.416 40 1.416 40 1.416 40	log insect insect dose used killed x(+2) n r 3.416 40 30 2.416 40 24 1.416 40 16 0.416 40 11	log dose insect used insect killed % x(+2) n r p 3.416 40 30 75.0 2.416 40 24 60.0 1.416 40 16 40.0 1.416 40 11 27.5	$\log dose$ insectinsect%Corr. $dose$ usedkilledkilled% of $x(+2)$ nrp3.416403075.067.742.416402460.048.391.416401640.022.581.416401127.56.45	109 doseinsect usedinsect killed% killedCorr. killedEmp. prob. $x(+2)$ nrp 3.416 403075.067.745.47 2.416 402460.048.394.95 1.416 401640.022.584.26 1.416 401127.56.453.45	10g doseinsect usedinsect killed% killedCorr. % of killedEmp. prob.Exp. prob. $x(+2)$ nrpY 3.416 403075.067.745.475.55 2.416 402460.048.394.954.87 1.416 401640.022.584.264.20 1.416 401127.56.453.453.52

pose-mortality data of larvae \underline{T} . <u>castaneum</u> (Local) treated with seed extract in Methanol.

Weighting co-eff.	Weight				 	
	W = w'n	WX	wy	wx ²	wy ²	₩ху
0.558	22.32	76.25	121.64	260.45	662.96	415.52
0.634	25.36	61.27	125.79	148.03	623 .9 0	303.91
0.503	20.12	28.49	85.51	40.34	363.31	15.58
0.269	10.76	4.48	37.44	1.86	130.31	15.58
-	-	_	-	-	-	-
	78.56	170.48	370.38	450.68	1780.59	856.09
$\bar{x} = 2.17$	<u> </u>				Results :	
$\bar{Y} = 4.71$					V = 0.02	4
	0.65.				m = 4.13	
Y = 3.30 +	• 0.65X				$m_1 = 2.05$	
					$m_2 = 8.31$ Chi-sq. =	

APPENDIX TABLE - XL

pose-mortality data of larvae \underline{T} . <u>castaneum</u> (CR - I) treated with seed extract in Petroleum spirit,

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	work. prob.
	x(+2)	n	r	Р			Y	У
A. 48.53	3.686	40	39	97.5	96.77	7.05	6.95	6.82
B. 4.853	2.686	40	36	90.0	87.10	6.13	6.35	6.08
C. 0.4853	1.686	40	34	85.0	80.65	5.88	5.75	5.86
D. 0.04853	0.686	40	26	65.0	54.84	5.13	5.15	5.12
0. Control	, -	40	9.	22.5		-	-	-

Weight		1 1 5 1	 	l 1 1	\$ { } {
W = w'n	WX	wy	wx ²	wy ²	wxy
5.24	19.31	35.74	71.18	243.75	131.74
12.08	32.45	73,45	87.16	446.58	197.29
20.12	33.02	117.90	57.19	690.90	198.78
	17.20	128.41	11.80	647.46	88.09
_	-	-	-	-	-
	102.09	355,50	227.33	2028.69	615.90
	W = W'n 5.24	$W = W'n \qquad Wx$ 5.24 19.31 12.08 32.45 20.12 33.02 25.08 17.20	$W = W'n \qquad Wx \qquad Wy$ 5.24 19.31 35.74 12.08 32.45 73.45 20.12 33.02 117.90 25.08 17.20 128.41 $ $	W = w'nwxwywx ² 5.2419.3135.7471.1812.0832.4573.4587.1620.1233.02117.9057.1925.0817.20128.4111.80	W = w'n wx wy wx ² wy ² 5.24 19.31 35.74 71.18 243.75 12.08 32.45 73.45 87.16 446.58 20.12 33.02 117.90 57.19 690.90 25.08 17.20 128.41 11.80 647.46 - - - - -

 $\bar{x} = 1.65$

 $\bar{Y} = 5.69$

Y = 4.85 + 0.51x

Results : V = 0.241 m = 0.0101 $m_1 = 0.0011$ $m_2 = 0.0923$ Chi-sq. = 9.061

APPENDIX TABLE - XLI

pose-mortality data of larvae \underline{T} . castaneum (CR - I) treated with seed extract in Ethyl acetate,

	se m∕sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
/ug		x(+2)	n	r	P	Alled		Y	<u>у</u>
A.	61.08	3.786	40	3 8	95.0	94.12	6.55	6.58	6.57
Β.	6.108	2.786	40	36	90.0	88.24	6.18	6.01	6.16
C.	0.6108	1.786	40	33	82.5	79.41	5.81	5.45	5.80
D.	0.06108	0.786	40	23	57.5	50.00	5.00	4.88	5.00
0.	Control	-	40	6	15.0	-	-	-	-

Weighting Weight co-eff. wx² wy² wxy w' W = W'nwy wx 236.81 410.93 136.46 0.238 36.04 62.55 9.52 301.36 666.32 108.17 136.30 0.439 48.92 17.56 240.73 781.79 74.13 134.79 0.581 23.24 41.51 99.66 634.00 15.67 126.80 19.93 0.634 25.36 878.58 2493.04 362.56 432.31 146.40 75.68 Results : $\bar{x} = 1.93$ = 0.0101 v

 $\overline{Y} = 5.71$

Y = 4.64 + 0.55x

Results : V = 0.0101 m = 0.0436 $m_1 = 0.0277$ $m_2 = 0.0685$ Chi-sq. = 0.228

APPENDIX TABLE - XLII

Dose-mortality data of larvae \underline{T} . <u>castaneum</u> (CR - I) treated with seed extract in Acetone.

	se	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
Jug	m/sq.cm	x(+2)	n	r	₽			Y	У
Α.	41.63	3.619	40	38	95.0	93.55	6.55	6.63	6.52
в.	4.163	2.619	40	35	87.5	83.87	5.99	5.89	5.98
c.	0.4163	1.619	40	27	67.5	58.06	5.20	5.16	5.21
D.	0.04163	0.619	40	17	42.5	25.81	4.36	4.42	4.35
0.	Control	-	40	9	22.5	-	-	-	-

Weighting co-eff.	Weight					
w'	₩ = w'n	wx	wy	wx ²	wy ²	wxy
0.238	9.52	34.45	62.04	124.68	404.70	224.52
0.471	18.84	49.34	110.97	129.23	653,60	290.63
0.627	25.08	40.60	130.67	65.74	680.77	211.55
0.558	22.32	13.82	97.09	8,55	422.35	60.10
-	-	-	-	-	-	-
	75.76	138.22	400.80	328.20	2161.42	786.81

 $\bar{x} = 1.82$

 $\bar{y} = 5.29$

Y = 3.93 + 0.75x

Results :

V = 0.027 m = 0.2673 $m_1 = 0.1274$ $m_2 = 0.561$ Chi-sq. = 1.828

APPENDIX TABLE - XLIII

Dose-mortality data of larvae \underline{T} . <u>castaneum</u> (CR - I) treated with seed extract in Methanol.

Do	se m/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
/-5	, 10	x(+2)	n	r	Р			Y	У
Α.	26.04	3.416	40	40	100.0	100.0	8.09	7.69	8.03
в	2.604	2.416	40	35	87.5	86.49	6.08	6.63	5.88
C.	0.2604	1.416	40	28	70.0	67.57	5.47	5.57	5.45
D.	0 . \$2604	0.416	40	18	45.0	40.54	4.77	4.52	4.77
0.	Côntrol	-	40	3	7.5	-	-	-	-

Weighting co-eff.	Weight					<u> </u>
w'	W = w'n	ŴX	wy	wx ²	wy ²	₩ХУ
0.031	1.24	4.24	9.96	14.47	79.96	34.02
0.238	9.52	23.00	55.98	55.57	329.15	135.25
0.558	22.32	31.61	121.64	44.75	662.96	172.24
0.581	23.24	9.67	110.85	4.02	528 .7 8	46.11
-	-	-	-	-	-	-

 $\bar{x} = 1.22$

 $\overline{y} = 5.30$

y = 4.48 + 0.67x

Results : V = 0.052 m = 0.0597 $m_1 = 0.0213$ $m_2 = 0.1671$ Chi-sq. = 3.396

APPENDIX TABLE - XLIV

pose-mortality data of larvae <u>T. castaneum</u> (FSS - II) treated with seed extract in Petroleum spirit,

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Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	,₽			Y	У
A. 48.53	3.686	40	40	100.0	100.00	8.09	7.75	8.12
B. 4.583	2.686	40	37	92.5	91.18	6.34	6.79	6.14
C. 0.4853	1.686	40	32	80.0	76.47	5.71	5.82	5.72
D. 0,04853	0.686	40	24	60.0	52.94	5.08	4.86	5.07
0. Control	~	40	6	15.0	-	-	-	-

Weighting co-eff.	Weight					
w'	W = w'n	wx	wy	wx ²	wy ²	wxy
0.025	1.00	3.686	8.12	13.59	29.93	29.93
0.180	7.20	19.34	44.21	51.95	271.44	118.75
0.503	20.12	33.92	115.09	57.19	658.29	194.04
0.634	25.36	17.40	128.58	11.93	651.88	88.21
	• • -	. –	-	-	-	-
	53.68	74.34	295.99	134.66	1647.54	430.93

 $\bar{x} = 1.38$

- $\bar{Y} = 5.51$
- Y = 4.82 + 0.70x

Results : V = 0.072 m = 0.0448 $m_1 = 0.0133$ $m_2 = 0.1503$ Chi-sq. = 0.910

APPENDIX TABLE - XLV

pose-mortality data of larvae \underline{T} . <u>castaneum</u> (FSS - II) treated with seed extract in Ethyl acetate.

Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	P			Y	y y
A. 61.08	3.786	40	36	90.00	88.50	6.23	6.47	6.12
B. 6.108	2.786	40	35	87.50	85.71	6.18	5.88	6.05
C. 0.6108	1.786	40	28	70.00	65.71	5.41	5.28	5.40
D. 0.06108	0.786	40	16	40.00	31.43	4.50	4.69	4.52
0. Control	-	40	5	12.50	-	-	-	-

Weighting co-eff.	Weight	1 9 6 8				
w '	₩ = w'n	WX	wy	wx ²	wy ²	wxy
0.269	10.76	40.74	65.85	154.23	403.01	249.31
0.471	18.84	52.48	113.98	146.23	689.59	317.55
0.616	24.64	44.01	133.06	78.60	718.50	237.65
0.616	24.64	19.37	111.37	15.22	503.41	87.54
-	-	-	-	-	-	-
	78.88	156.60	424.26	394.28	2377.51	892.04
					Deculto	

 $\bar{x} = 1.99$

 $\bar{y} = 5.38$

Y = 4.23 + 0.58x

APPENDIX TABLE - XLVI

Dose-mortality data of larvae <u>T. castaneum</u> (FSS - II) treated with seed extract in Acetone,

Dose ∕ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	Р			Y	У
A. 41.63	3.619	40	39	97.50	97.06	6.88	6.63	6.83
B. 4.163	2.619	40	33	82.50	79.41	5.81	6.10	5.77
C. 0.4163	1.619	40	28	70.00	64.71	5.39	5.56	5.36
D. 0.04163	0.619	40	26	65.00	58.82	5.23	5.02	5.23
0. Control		40	6	15.00	-	-		-

Weighting co-eff.	Weight					
W	₩ = w'n	wx	wy	wx ²	wy ²	wxy
0.238	9.52	34.45	65.02	124.68	444.10	235.31
0.405	16.20	42.43	93.47	111.12	539 . 34	244.80
0.558	22.32	36.14	119.64	58.50	641.24	193.70
0.637	25.48	15.77	133.26	9.76	696.95	82.49
-	-	-	-	-	-	-
	73.52	128.79	411.39	304.06	2321.63	756.29
x = 1.75					Results : $V = 0.165$	

 $\bar{Y} = 5.60$

Y = 4.79 + 0.46x

Results : V = 0.165 m = 0.0286 $m_1 = 0.0046$ $m_2 = 0.1791$ Chi-sq. = 1.682

APPENDIX TABLE - XLVII

pose-mortality data of larvae \underline{T} . castaneum (FSS - II) treated with seed extract in Methanol.

Dose /ugm/sq.cm	Log dos e	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	p			Y	y Y
A. 26.04	3.416	40	25	62.50	51.61	5.05	5.12	5.04
B. 2.604	2.416	40	21	52.50	38.71	4.72	4.68	4.71
C. 0.2604	1.416	40	17	42.50	25.81	4.36	4.25	4.36
D. 0.02604	0.416	40	12	30.00	9.68	3.72	3.81	3.71
0. Control	-	40	9	22.50	-	-	-	-

Weighting co-eff.	Weight			1 0 0 1		
w'	₩ = w'n	ŴX	wy	wx ²	wy ²	wxy
0.634	25.36	86.63	127.81	295.93	644.18	436.60
0.616	24.64	59.53	116.05	143.83	546.62	280.38
0.532	21.28	30.13	92.78	42.67	404.52	131.38
0.370	14.80	6.16	54.91	2.56	203.71	22.80
-	-	-	-	-	-	-
	86.08	182.45	391.56	484.99	1799.03	871.15
$\bar{x} = 2.12$					Results : V = 0.000	18
$\bar{Y} = 4.55$				a	m = 15.53	9

Y = 3.66 + 0.42x

m = 15.539 $m_1 = 14.588$ $m_2 = 16.443$

Chi - sq. = 0.189

APPENDIX TABLE - XLVIII

pose-mortality data of larvae <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Petroleum spirit,

	ose m∕sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
		x(+2)	n	r	P			Y	<u>у</u>
Α.	48.53	3.686	40	40	100.0	100.00	8.09	7.99	8.30
Β.	4.853	2.686	40	39	97.5	96.88	6.88	6.95	6.84
с.	0.4853	1,686	40	33	82.5	78.13	5.77	5.92	5.77
D.	0.04853	0.686	40	24	60.0	50.00	500	4:•88	5.00
0.	Control		40	8	20.0		-		-

Weighting co-eff.	Weight		8 8 8 8 8 9			
w '	W = w'n	WX	wy	wx ²	wy ²	wxy
0.015	0.60	2.21	4.98	8.15	41.33	18.36
0.131	5.24	14.07	35.84	37.79	245.15	96.27
0.471	18.84	31.76	108.71	53.55	627.26	183.29
0.634	25.36	17.67	126.80	12.12	634.00	86.98
-	-	-	-	-		
	50.04	65.71	276.33	111.61	1547.74	384.89

 $\bar{x} = 1.31$

 $\bar{Y} = 5.52$

Y = 4.34 + 0.90x

Results : V = 0.0084 m = 0.0539 $m_1 = 0.0356$ $m_2 = 0.0817$ Chi-sq. = 1.970

APPENDIX TABLE - XLIX

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Dose-mortality data of larvae <u>T</u>. <u>castaneum</u> (CTC - 12) treated with seed extract in Ethyl acetate,

	se m∕sq.cm	Log dose	No. of insect used	No. of insect killed		Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
/ug		x(+2)	n	r	Р	Allied		Y	y y
Α.	61.08	3.786	40	31	77.5	70.79	5,55	5.61	5.55
B.	6.108	2.786	40	29	72.5	64.52	5.39	5.34	5.37
с.	0.6108	1.786	40	26	65.0	54.84	5.13	5.06	5.12
D.	0.86108	0.786	40	21	52.5	38.71	4.72	4.79	4.71
0.	Control	-	40	9	22.5	-	-	-	-

Weighting co-eff.	Weight					3
w'	W = W'n	WX	wy	wx ²	wy ²	wxy
0.558	22.32	84.50	123.88	319.93	687.51	469.01
0.616	24.64	68.65	132,32	191.25	710.54	368.64
0.634	25.36	45.29	129.84	80.89	664.80	231.89
0.627	25.08	19.71	118.13	15.49	556.38	92.85
-	-	-	-	-	-	-
	97.40	218.16	504.16	607.56	2619.23	1162,40

 $\bar{x} = 2.24$

 $\bar{Y} = 5.18$

Y = 4.55 + 0.28x

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Results : V = 0.008 m = 0.4046 $m_1 = 0.1061$ $m_2 = 1.543$ Chi-sq. = 1.582

APPENDIX TABLE - L

Dose-mortality data of larvae \underline{T} . <u>castaneum</u> (CTC - 12) treated with seed extract in Acetone

Dose /ugm/sq.c	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	Р			Y	У
A. 41.63	3.619	40	38	95.0	93.75	6.55	6.64	6.54
B. 4.163	2.619	40	36	90.0	87.50	6.18	6.03	6.83
C. 0.416	3 1.619	40	29	72.5	65.63	5.41	5.42	5.41
D. 0.041	.63 0.619	40	21	52.5	40.63	4.77	4.81	4.76
0. Contr	rol -	40	8	20.0	-	-	-	-

Weighting co-eff.	Weight					
w'	W = w'n	WX	wy	wx ²	wy ²	wxy
0.238	9.52	34.45	62.26	124.68	407.19	225.32
0.439	17.56	45.99	119.93	120.45	819.15	314.10
0.601	24.04	38.92	130.06	63.01	703.61	210.57
0.627	25.08	15.52	119.38	9.61	568.25	73.80
-	-	-	-	-	-	-
	76.20	134.89	413.63	317.75	2498.20	823.88

 $\bar{x} = 1.77$

 $\bar{Y} = 5.66$

Y = 4.32 + 0.76x

Results : V = 0.039 m = 0.0785 $m_1 = 0.0329$ $m_2 = 0.1875$ Chi-sq. = 9.654

APPENDIX TABLE - LI

pose-mortality data of larvae <u>T</u>. castaneum (CTC - 12) treated with seed extract in Methanol.

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Dose /ugm/sq.cm	Log dose	No. of insect used	No. of insect killed	% killed	Corr. % of killed	Emp. prob.	Exp. prob.	Work. prob.
	x(+2)	n	r	P			Y	У
A. 26.04	3.416	40	38	95.0	93.94	6.55	6.48	6.54
B. 2.604	2.416	40	34	85.0	81.82	5.92	6.01	5.90
C. 0.2604	1.416	40	30	75.0	69.70	5.52	5.55	5.51
D. 0.02604	0.416	40	25	62.5	54.55	5.13	5.08	5.11
0. Control		40	7	17.5	-	-	-	-

Weighting co-eff.	Weight	1 5 7 1				1 1 1 1
w۱	W = w'n	wx	wy	wx ²	wy ²	wxy
0.269	10.76	36.76	70.37	125.56	460.22	240.38
0.439	17.56	42.42	103.60	102.50	611.26	250.30
0.558	22.32	31.61	122.98	44.75	677.64	174.14
0.634	25.36	10.55	129.59	4.39	662.20	53.91
-	-	-	-	-	-	-
	76.00	121.34	426.54	277.70	2411.32	718.73

 $\bar{x} = 1.60$

 $\bar{y} = 5.61$

Y = 4.92 + 0.43x

Results : V = 0.199 m = 0.0153 $m_1 = 0.00$ $m_2 = 0.1148$ Chi-sq. = 2.836

APPENDIX TABLE-LII

Dose Strain Total Mean /ugm/sq.cm Local CR-I FSS-II CTC 12 A. 48.53 24.89 25.10 0 24.28 74.27 18.57 B.4.853 23.05 23.21 24.31 23.51 94.08 23.52 C.0.4853 22.27 22.20 22.56 22.13 89.16 22.29 D.0.04853 21.18 21.21 21.94 21.28 21.40 85.61 O.Control 20.62 20.20 21.09 20.76 82.67 20.67 Total 425.79 106.45 112.01 111.92 89.90 111.96

17.98

Analysis of variance for larval period of <u>T</u>. <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in petroleum spirit solvent,

Correction factor (CF) =	9064.86
Total sum of square (TSS) ≖	517.02
Dose sum of square (DSS) =	55.14
Strain sum of square (SSS)=	73.02

22.40

Mean

22.38

		S.S.	M.S.	F
Source	d.f.	5.5.		
Dose(D)	4	55.14	13.785	0.425
	3	73.02	24.340	0.751
Strain(S)	5		32.405	
Error	12	388.86	52.400	
Total	19	517.02		
		والمتحدث والمتحدية والمتحدية والمتحد		

85.16

22.39

21.29

APPENDIX TABLE-LIII

Analysis of variance for larval period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in ethyl acetate solvent,

Dose ∕ugm/sq.cm	t t	S	Strain		Total	Mean
/ugiii/ 39	Loca1	CR-I	FSS-II	CTC 12		
A.61.08	25.19	25.07	25.61	25.04	100.82	25.21
B.6.108	23.59	23.71	24.35	23.04	94.69	23.67
C.0.6108	22.50	. 22.53	23.48	22.46	90.97	22.74
D.0.06108	21.38	21.35	21.99	21.71	86.43	21.61
0.Control	20.62	20.20	21.09	20.76	82.67	20.67
Total	113.19	112.86	116.52	113.01	455.58	113.89
Mean	22.64	22.57	23.30	22.60	91.12	22.78

Correction factor (CF) =	10377.66
Total sum of square (TSS) $=$	52.559
Dose sum of square (DSS) =	50.06
Strain sum of square (SSS)=	1.845

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Source	d.f.	S.S.	M.S.	F	
Dose(D)	4	50.04	12.510	223.393	
Strain(S)	3	1.85	0.617	11.018	
Error	12	0.67	0.056		
Total	19	52.56			
***P<0.	001	LSD	(D) = 0.723		
F _ 0.	001	LSD	(D) = 0.664		

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APPENDIX TABLE-LIV

Analysis of variance for larval period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in acetone solvent,

Dose ∕ugm/sq.cm		Strain				Mean
/ugiii/ 5q.ciii	Local	CR-I	FSS-II	CTC 12	Total	
A. 41.63	25.48	25.13	25.60	25.41	101.62	25.41
B.4.163	24.24	23.22	24.35	24.74	96.55	. 24.14
C.0.4163	23.21	22.50	23.48	23.25	92.44	23.11
D:0.04163	22.05	21.30	21.99	22.17	87.51	21.88
0.Control	20.62	20.20	21.09	20.76	82.67	20.67
Total	115.60	112.35	116.51	116.33	460.79	115.20
Mean	23.12	22.47	23.30	23.27	92.16	23.04

Correction factor (CF) =	10616.37
Total sum of square (TSS) =	57.92
Dose sum of square (DSS) =	55.13
Strain sum of square (SSS)=	2.256

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	55.13	13.783	313.250 ***
Strain(S)	3	2.26	0.753	17.114
Error	12	0.53	0.044	•
Total	19	57.92		1
*** P<0.001			LSD(D) = 0.64	0
			LSD(S) = 0.58	9

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APPENDIX TABLE-LV

				nanol solv	ent.	
Dose /ugm/sq.cm			1			
	Local	CR-I	FSS-II	CTC 12	Total	Mean
A-26.04	24.70	25.15	25.02		i 	
B,2.604	23.72	22.64		24.83	99.70	24.93
		23.61	23.65	23.26	94.24	23.56
C,0.2604	22.34	22.46	22.42	22.44	89.66	22.42
D,0.02604	21.10	21.19	21.36	21.82	85.47	21.37
0.Control	20.62	20.20	21.09	20.76		
Total	112.48	112.61	113.54		82.67	20.67
Mean				113.11	451.74	112.94
	22.50	22.52	22.71	22.62	90.35	22.59

Analysis of variance for larval period of \underline{T} . <u>Castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in methanol solvent.

Correction factor (CF) =	10203.45
Total sum of square (TSS) =	47.43
Dose sum of square (DSS) 📼	46.47
Strain sum of square (SSS)=	0.143

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	46.47	11.618	170.853
Strain(S)	3	0.143	0.048	0.706
Error	12	0.817	0.068	
Total	19	47.43		1
*** P<0.001			LSD(D = 0.7	796

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APPENDIX TABLE-LVI

Analysis of variance for pupal period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in petroleum spirit solvent.

Dose	1 1	Strain			Total	Mean
/ugm/sq.cm	Local	CR-I	FSS-II	CTC 12		1 1 1
A. 48.53	6.88	6.85	0	7.12	20.85	5.21
B. 4.853	6.68	6.69	6.73	6.82	26.92	6.73
C.0.4853	6.37	6.21	6.32	6.42	25.32	6.33
D. 0.04853	6.07	5.92	5.92	6.19	24.10	6.03
0.Control	5.81	5.61	5.43	5.91	22.76	5.69
Total	31.81	31.28	24.40	32.46	119.95	29.99
Mean	6.36	6.26	4.88	6.49	23.99	5.99

Correction factor (CF) $=$	719.40
Total sum of square (TSS) -	41.93
Dose sum of square (DSS) =	5.43
Strain sum of square (SSS)=	8.47

Source	d.f.	S.S.	M.S.	F	
Dose(D)	4	5.43	1.358	0.581	
Strain(S)	3 ້	8.47	2.823	1.208	
Error	12	28.03	2.336	•	
Total	19	41.93		/	

APPENDIX TABLE-LVII

Analysis of variance for pupal period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in ethyl acetate solvent,

Dose /ugm/sq.cm		S	train		Total	Mean
	Local	CR-I	FSS-II	CTC 12		T T T T
A, 61.08	6.80	6.79	6.66	7.06	27.31	6.83
B.6.108	6.52	6.53	6.41	6.77	26.23	6.56
C-0.6108	6.26	6.17	.6.05	6.47	24.95	6.24
D.0.06108	5.95	5.76	5.73	6.12	23.56	5.89
0.Control	5.81	5.61	5.43	5.91	22.76	5.69
Total	31.34	30.86	30.28	32.33	124.81	31.20
Mean	6.27	6.17	6.06	6.47	24.96	6.24

Correction factor (CF) $=$	778.88
Total sum of square (TSS) =	3.96
Dose sum of square (DSS) 📼	3.48
Strain sum of square (SSS)=	0.449

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Source	d.f.	S.S.	M.S.	F
Dose(D)	4	3.48	0.870	310.714
Strain(S)	3	0.449	0.149	53.214
Error	12	0.031	0.0026	
Total [°]	19	3.96		
****P≪0.001		LSD(D) = 0.156	
		LSD(S) = 0.143	

APPENDIX TABLE-LVIII

Analysis of variance for pupal period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in acetone solvent.

Dose	1	S	Total	Mean		
ugm/sq.cm	Local	CR-I	FSS-II	CTC 12		
A. 41.63	6.83	6.86	6.81	6.95	27.45	6.86
B.4.163	6.65	6.45	6.57	6.60	26.27	6.57
C.0.4163	6.45	6.18	6,26	6.40	25.29	6.32
D.0.0413	6.14	5.91	5.73	6.16	23.94	5.99
0,Control	5.81	5.61	5.43	5.91	22.76	5.69
Total	.31.88	31.01	30.80	32.02	125.71	31.43
Mean	6.38	6.20	6.16	6.40	25.14	6.29

Correction factor (CF) =	790.15
Total sum of square (TSS) =	4.15
Dose sum of square (DSS) 🔳	3.44
Strain sum of square (SSS)=	0.225

Source	d.f.	S.S.	M.S.	F	
Dose(D)		3.440	0.860	21.500*	
Strain(S)	3	0.225	0.075	1.875	
Error	12	0.485	0.040		
 Total	19	4.15			
***	· · · · · · · · · · · · · · · · · · ·		LSD(D) = 0.611		

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P<0.001

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APPENDIX TABLE-LIX

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Analysis of variance for pupal period of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in methanol solvent,

Dose ugm/sq.cm		S	train		Total	Mean
	Local	CR-I	FSS-II	CTC 12		7 8 1
A. 26.04	6.76	6.91	6.74	7.16	27.57	6.89
B,2.604	6.50	6.54	6.47	6.77	26.28	6.57
C.0.2604	6.23	6.29	6.19	6.52	25.23	6.31
D. 0.02604	6.08	5.85	5.81	6.23	23.97	5.99
0. Control	5.81	5.61	5.43	5.91	22,76	5.69
Total	31.38	31.20	30.64	32.59	125.81	31.45
Mean	6.28	6.24	6.13	6.52	25.16	6.29

Correction factor (CF) =	791.41
Total sum of square (TSS) $=$	4.05
Dose sum of square (DSS) 📼	3.56
Strain sum of square (SSS)=	0.402

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	3.560	0.890	*** 121.918 ***
Strain(S)	3	0.402	0.134	18.356
Error	12	0.088	0.0073	
Total	19	4.05		
****P<0.001			LSD(D) =	0.261
			LSD(S) =	0.240

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APPENDIX TABLE-LX

Analysis of variance for fecundity of <u>T</u>. <u>castaneum</u> among different Strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Petroleum Spirit solvent.

Dose Augm/sq.cm	t t t	S	train		Total	Mean
	Local	CR-I	FSS-II	CTC 12	-	;
A 48.53	4.14	3.71	0	0	7.85	1.96
B 4.853	7.14	6.71	8.00	4.71	26.56	6.64
C 0.4853	10.71	9.43	11.86	7.71	39.71	9.93
D 0.04853	14.00	14.57	16.57	12.14	57.28	14.32
0 Control	22.43	21.86	24.00	21.14	89.43	22.36
Total	58.42	56.28	60.43	45.70	220.83	55.21
Mean	. 11.68	11.26	12.09	9.14	44.17	11.04

Correction factor (CF) =	2438.29
Total sum of square (TSS) -	1012.62
Dose sum of square (DSS) =	967.371
Strain sum of square (SSS)≖	25.827

Source	d.f.	S.S.	M.S.	F
Dose(D)	i4	967.371	241.843	149.378
Strain(S)	3	25.827	8.609	5.317
Error	12	19.422		····
Total	19	1012.62		
	and *** P<	0.001	LSD(D) = 3.	.885
P~0.00			LSD(S) = 1	.753

APPENDIX TABLE-LXI

Analysis of variance for fecundity of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Ethyl acetate solvent.

Dose /ugm/sq.cm	Strain			Total	Mean	
	Local	CR-I	FSS-II	CTC 12	-	1 2 1 1 1
A. 61.08	4.71	4.43	6.57	7.29	23.00	5.75
B. 6.108	9.43	7.57	10.86	11.57	39.43	9.86
C. 0.6108	13.00	11.86	14.14	15.75	54.75	13.69
D. 0.06108	16.14	16.14	19.43	19.57	71.28	17.82
0. Control	24.14	23.71	24.29	25.14	97.28	24.32
Total	67.42	63.71	75.29	79.32	285.74	71.44
Mean	13.48	12.74	15.06	16.86	58.14	14.54

Correction factor (CF) =	4082.37
.Total sum of square (TSS) =	859.883
Dose sum of square (DSS) =	824.011
Strain sum of square (SSS)=	30.563

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	824.011	206.003	466.070
Strain(S)	3	30.563	10.188	23.050
Error	12	5.309	0.442	
 Total	19	859.883		
*** P< 0.001			LSD(D) =	2.030
			LSD(S) =	1.816

APPENDIX TABLE-LXII

Dose /ugm/sq.cm		Strain				Mean
	Local	CR-I	FSS-II	CTC 12	4	
A. 41.63	4.14	. 7.29	6.86	7.71	26.00	6.50
B. 4.163	7.57	10.57	10.29	11.57	40.00	10.00
C. 0.4163	11.71	13.86	13.86	16.00	55.43	13.86
D. 0.0416 3	17.71	18.71	19.14	19.43	74.99	18.75
0. Control	23.42	24.43	24.57	26.00	98.42	24.61
Total	64.55	74.86	74.72	80.71	294.84	73.71
Mean	12.91	14.97	14.94	16.14	58.96	14.74

Analysis of variance for fecundity of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Acetone solvent:

Correction factor (CF) =	4346.53
Total sum of square (TSS) =	848.938
Dose sum of square (DSS) 📼	818.090
Strain sum of square (SSS)=	27.051

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	818.090	204.523	647.225
Strain(S)	3	25.051	9.017	*** 28.535
Error	12	3.797	0.316	
Total	19	848.938		
***P<	0.001		LSD(D) =	1.716
			LSD(S) =	1.535

APPENDIX TABLE-LXIII

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extraction	extraction of <u>A</u> . <u>squamosa</u> in Methanol solvent.									
Dose /ugm/sq.cm	Strain				Total	Mean				
/ugii/ sq•ciii	Loca1	CR-I	FSS-II	CTC 12						
A. 26.04	6.43	6.71	4.57	7.43	25.14	6.29				
B• 2.604	8.57	10.29	8.43	10.86	38.15	9.54				
C. 0.2604	13.29	13.86	13.71	15.57	56.43	14.11				
D. 0.02604	19.29	18.43	18.43	19.71	75.86	37.93				
0. Control	25.71	25.14	23.57	24.14	98.56	24.64				
Total	73.29	74.43	68.71	77.71	294.14	73.54				
Mean 🤺	14.66	14.89	13.74	15.54	58.83	14.71				

Analysis of variance for fecundity of <u>T. castaneum</u> among different strains and different doses of treatment with

Correction factor (CF) =	4325.92
Total sum of square (TSS) =	875.211
Dose sum of square (DSS) =	859.230
Strain sum of square (SSS)=	8.311

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				1	
Source	d.f.	S.S.	M.S.	F	
Dose(D)	4	859.230	214.808	336.163	· .
Strain(S)	3	8.311	2.770	4.335	
Error	12	7.670	0.639		•
Total	19	875.211			
	05 and *** P	<0.001	LSD(D) =	2.441	
	•		LSD(S) =	1.102	

APPENDIX TABLE-LXIV

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Analysis of variance for hatching percentage of \underline{T} . <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa in</u> Petroleum Spirit solvent.

Dose /ugm/sg.cm	1 1 1	Strain				Mean	
	Local	CR-I	FSS-II	CTC 12		7 7 7 7	
A. 48.53	43.06	46.67	0	0	89.73	22.43	÷
B. 4.853	46.94	51.50	45.34	46.77	190.55	47.64	
C. 0.4853	55.95	59.23	51.23	53.08	219.49	54.87	
D. 0.04853	61.94	63.50	56.37	59.34	241.15	60.29	
0. Control	100.00	96.61	98.44	100.00	395.05	98.76	
Total	307.89	317.51	251.38	359.19	1135.97	283.99	
Mean	61.58	63.50	50.28	51.84	227.20	56.80	

Correction factor (CF) =	64521.39
Total sum of square (TSS) =	14281.77
Dose sum of square (DSS) =	674.65
Strain sum of square (SSS)≖	12167.23

Source	d.f.	5.5.	M.S.	F
Dose(D)	 4	12167.23	3041.808	25.350*
Strain(S)	3	674.65	224.883	1.874
Error	12	1439.89	119.991	
Total	19	14281.77		

*** P∠0.001

LSD(D) = 33.446

APPENDIX TABLE-LXV

Analysis of variance for hatching percentage of <u>T</u>. <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Ethyl acetate solvent.

Dose	;		,	1		
ugm/sq.cm		د 	train		Total	Mean
	Local.	CR-I	FSS-II	CTC 12		i I
A. 61.08	44.55	44.36	50.41	51.77	191.09	47.77
B. 6.108	50.97	49.64	55.05	54.36	210.02	52.51
C. 0.6108	58.19	52.86	60.01	58.83	229.89	57.47
D. 0.06108	62.86	60.27	64.72	65.49	253.34	63.34
0. Control	100.00	98.70	99.10	100.00	397.80	99.45
Total	316.57	305.83	329.29	330.45	1282.14	320.54
Mean	63.31	61.17	65.86	66.09	256.43	61.11

Correction factor (CF)	£	82194.15
Total sum of square (TSS)	æ	6893.64
Dose sum of square (DSS)	in.	6780.65
Strain sum of square (SSS)	*	81 .38

Source	d.f.	5.S.	M.S.	·F
Dose(D)	4	6780.65	1695.16	643.569
Strain(S)	3	81.38	27.127	10 . 299
Error	12	31.61	2.634	
Total	19			
** P<0.01	and *** P	<0.001	LSD(D) = 4.	955
			LSD(S) = 3.	136

APPENDIX TABLE-LXVI

Analysis of variance for hatching percentage of <u>T</u>. <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Acetone,

Dose ⁄ugm/sq.cm	Strain				Total	Mean
	Local	CR-I	FSS-II	CTC 12		9 9 9
A• 41.63	40.69	50.48	51,99	53.17	196.33	49.08
B. 4.163	44.68	53.59	53.01	55.85	207.13	51.78
C. 0.4163	53.66	58.06	55.73	59.48	226.93	56.73
D. 0.04163	63.43	64.05	61.44	65.11	254.03	63.51
0. Control	100.00	99.59	98.90	100.00	398.49	99.62
Total	302.46	325.77	321.07	333.61	1282.91	320.73
Mean	60.49	65.15	64.21	66.72	256.58	64.15

Correction factor (CF) =	82292.90
Total sum of square (TSS) =	6971.88
Dose sum of square (DSS) 📼	6774.86
Strain sum of square (SSS)=	105.04

Source	d.f.	s.s.	M.S.	F
ose(D)	4	6774.86	1693.715	220.967**
train(S)	3	105.04	35.013	4.568
Error	12	91.98	7.665	
otal	19	6971.88		·····
* P < 0.05 and ***P<0.001		LSD(D) = 8	•453	
- P _ 0.05			LSD(S) = 3	•815

APPENDIX TABLE_LXVII

Dose		t 9 9	S	Total	Mean		
Jug	m/sg.cm	Local	CR-I	R-I FSS-II CTC 12			1
٨.	26.04	42.02	48.38	49.03	50.69	190.05	47.51
B∙	2.604	46.06	51.97	53.88	.52.64	204.55	51.14
C.	0.2604	50.54	56.40	60.03	56.39	223.36	55.84
D.	0.02604	58.77	60.33	63.32	61.08	243.50	60.88
0.	Control	99.71	98.70	99.64	100.00	398.05	99.51
То	tal	297.10	315.71	325.90	320.80	1259.51	314.88
Me	an	59.42	63.14	65.18	64.16	251,90	62.98

Analysis of variance for hatching percentage of <u>T</u>. <u>castaneum</u> among different strains and different doses of treatment with extraction of <u>A</u>. <u>squamosa</u> in Methanol.

Correction factor (CF) $=$	79318.27
Total sum of square (TSS) =	7215.51
Dose sum of square (DSS) ≖	7078.09
Strain sum of square (SSS)=	99.66

Source	d.f.	S.S.	M.S.	F
Dose(D)	4	7078.09	1769.52	562.288**
Strain(S)	3	99.66	33.22	10.556*
Error	12	37.76	3.147	
Total	19	7215.51		
	and	*** P<0.001	LSD(D) =	5.416
**P<0.01			LSD(S) =	3.485 ≩aj hoto og tilbodag ∰rø til og tilbodag

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