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Evaluation of insect repellent and insecticide implantation techniques against *Aeolesthes sarta* Solsky in Quetta district of Baluchistan province, Pakistan

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Abstract
The aim of present study was to evaluate efficacy of the insect repellent technique with insecticide implantation technique checked against larval instars of *Aeolesthes sarta* under field conditions in Quetta district, Baluchistan Province. The reported research work was conducted at the larval emergence during the first week of April 2014 till the last week of March 2015. The insect repellent and insecticide implantation techniques were applied on red delicious apple trees (*Malus domestica*) due to high level of infestations. Aluminium phosphide showed highest mortality rate (52.43%) and least mortality rate (29.09%) was recorded on petrol plugging during insecticide implantation technique. It was concluded that insect repellant technique completely failed in controlling the population density of this pest.

Keywords: Insect repellent technique, insecticide implantation technique, replication, treatments

1. Introduction
Aeolesthes sarta (Coleoptera: Cerambycidae) commonly known as Quetta borer is polyphagous in nature. It is generally believed that it originated from Pakistan and western part of India with wide distribution in Afghanistan, Iran and up to Central Asian countries [1, 2]. It has limited distribution in Quetta, Karez Inayatullah, Kalat, Ziarat, Mastung and Zhob Districts of Baluchistan province [3].

The high level of infestation was reported in Quetta city where more than 3000 tress were dropped during the period 1904-1906 [4]. *A. sarta* shows extraordinary tendency to attack on the main trunk and large branches and reproduce successfully [5]. It can result in a decline of popular trees forest which is an important source in wood industry and can also show infestation on mountain forests [6]. Apple orchards and shelter belts were observed as highly infested areas and oviposition preference was seen on apple orchards which are the prime host for this pest. The extreme infestation results in destruction of the canopy of the tree and the infested tees completely dry out within 2 to 3 years [7]. Shelterbelts areas are also weakened by drought due to its severe infestation. It shows no infestation on coniferous species especially on pinus. Their presence can be observed in railway station, avenues or parks, small gardens and fruit forest [8].

A number of control measures are used in different region of Asia against *A. sarta*. Control strategies comprise of cultural control, use of chemical insecticides techniques and biological control. Cultural controls include burning of infested plants material after preliminary survey of the infested fruit orchards and forestland. Sometimes it involves cutting and burning of the entire trees [6]. Chemical treatments are considered as most effective method to control the adult and larval activity [9].

In Pakistan, use of insecticides and pesticides has significantly increased over a period of time, without any attention to their side effects and proper usage. Such practice results in diminished efficacy on the pest. Most of the insecticides have greater potential to control infestation of the insects on the sapwood and cambium. Insecticide implantation technique was successfully used under field condition against *A. sarta*. This method has also been used against other types of borer such as *A. sarta* Holosericea and significant output obtained against live holes [10].

The present research work was based on control measures such as insecticide implantation technique and insect repellent technique. The effectiveness of these techniques on larval activity in Quetta district of Baluchistan was examined.

2. Materials and Method

2.1 Field study: Comparative study was conducted under field condition for effective control of insect repellent and insecticide implantation techniques. For present work, 2 acre plot was selected measuring 85.3 X 94.6 m (8093.71m^2) at Killi Kasi Chasma Achozai, Quetta. The selection of this land was made because as it was not managed, poorly maintained for several years without any proper attention the larval attack of *A. sarta*. These techniques were applied against 30-35 years old red delicious (Kalla Khulu) apple trees due to their high level of infestation that was found during our preliminary survey.

2.2 Insect repellent technique: Mixture of 50% lime stone and 50% waster (w/v) was prepared for this experiment. Insect repellant technique was applied against 45 red delicious apple trees adopting fixed plot method during the larval emergence at the beginning of April 2014. This experiment was based on the comparison of counting the number of live holes in trees made by larval instars and result was obtained after peak emergence of adult beetles during the third week of March, 2015.

2.3 Insecticide implantation technique: This technique was used at the peak emergence of larvae during the second week of May, 2014. A total of 4 commercially available insecticides including aluminium phosphide (5gm), odinal (0.5g), talstar (5ml) and naphthalene ball (5gm) were tested. In addition to above chemicals one extra chemical i.e. petrol plugging (5ml) together with deionized water as the control was also used under field condition. The level of recovery was recorded after 2 weeks.

2.4 Identification and preservation: The life stages and morphological features were confirmed using taxonomic keys [3, 11]. First and second year larval stages were preserved in 5% formalin solution (Formaldehyde) and adult specimens were fixed in entomological box using entomological pins. Larval stages and adults of *A. sarta* were further confirmed in Entomology Laboratory of Agriculture Research Centre Sariab Road, Quetta, Baluchistan.

2.5 Statistical analysis: Insect repellent technique was applied using Student's t-test to count the number of pre and post live holes, which were taken as independent variables. Insecticide implantation technique was estimated at 0.05% level of confidence ($p_{\text{(one tail)}} < 0.05$) using Microsoft Excel, 2010 to construct one way analysis of variance (ANNOVA).

3. Results and Discussion

The extensive infested galleries were observed on the trunk and large branches, the dieback of entire trees were also observed (Fig. 1) due to feeding habit of first and second year larval instars of *A. sarta* (Fig. 2). The shape of live holes was round and oval most prominently on the trunk region of infested trees.

The present work is the first attempt in this region to use insect repellent technique under field condition. Field trials showed a non-significant value ($p>0.20$) with an increase +9.87% to +10.85% in the mean live holes obtained for group A and B respectively. It was recorded that control group also fall in non-significant category with highest +47.79% increase in the mean live holes (Table No. 1). Limestone has limited effective role in insect repellent technique on insect pests [12], in spite of the fact it frequently minimizes the stress condition under extreme sun light. Calcium carbonate is reasonably low priced chemical and is extensively used in combinative form with other repellents. Its use may improve the overall efficiency and mortality of the pests [13]. Sanitation includes removal of dead wood which is a sufficient method to control elm bark beetle attack [14]. Sanitation can also be a convenient method in the management and control of Dutch elm disease [15]. It was finally concluded that, this technique was not beneficial to secure the branches as well as main trunk from larval activity.

Data showed significant result ($p<0.01$) obtained after 15 days of chemical trials [9]. Aluminium phosphide tablets showed highest 52.43% mean mortality rate on each replication (Table No. 2), whereas mortality rates for other chemical are 47.49% talstar, 43.64% naphthalene ball, 40.22% odonil and 29.09% petrol plugging respectively (Table No. 3).

The highest larval mortality rate (87.34%) of the larvae were achieved in the sapwood occurred on red delicious apple trees that had been plugged with aluminium phosphide in a single replication. Our results were in close agreement with the findings reported Jammu Kashmir that aluminium phosphide showed 73.65% highest mortality rate after 21 days trail treatment [16]. Aluminium phosphide has been reported to cause higher mortality to the larvae than other insecticides using insecticide implantation technique [9]. However, efficiency of different insecticides has been observed with dose of applications as per our preliminary results.

Our result revealed that 43.64% mortality was attained on naphthalene ball and this result was in accordance with some other recorded highest efficacy of naphthalene ball (69.50%) in controlling *A. sarta* on walnut trees [17]. Aluminium phosphide tablets are cost effective and its fumigation in larval tunnels gave good control of the pest [16]. Few researchers have recommended 5-15 ml monocrotophos to achieve 60% control against *A. sarta* [18]. It may be noted that, this chemical has been banned in the United States of America and many other countries due to its carcinogenic nature [19]. In this research, petrol plugging treatment was least effective with 20.09%-28.42% in controlling the larval population. This technique has been used in reducing the population density of mango and walnut borers [20, 21]. The level of recovery followed the trend aluminium phosphide> talstar> naphthalene ball> odinal> petrol plugging> deionized water.

Table 1: Analysis of Insect repellent technique against live holes made by larval instars (N=15).

Treatment*	Mean (± SD) number of live holes		% Change **	t-value	*p*-value
	Pre-treatment	Post-treatment			
Group-A	4.66 ± 2.39	4.20 ± 2.54	+9.87	-0.84	0.20
Group-B	6.73 ± 2.27	7.46 ± 2.51	+10.85	-0.30	0.38***
Control	5.21± 2.34	7.07 ± 2.70	+47.79	-1.10	0.13

*Each treatment/group consists of 15apple trees.

** +/- trends indicate an increase in percentage infestation rate.

Table 2: Statistical analysis for insecticide implantation technique based on one way ANOVAs tested for chemical treatments (N=60*).

Source of Variation	S/Squares	d/Freedom	M/Square	F/Value	*p*-value
Between Groups	17128.96	5	1425.79	3.07	0.016*
Within Groups	25019.35	54	463.321		
Total	32148.32	59			

*N=stands for number of samples taken during experimentation.
**p*-value indicates significant calculated values ($p<0.016$).

Table 3: Comparative efficacy of various chemical treatments against *Aeolesthes sarta* on red delicious apple trees (*Malus domestica*).

			Mortality rate		PF*
Chemicals	**Trade name**	**Dose/tree**	**Minimum**	**Maximum**	**(Mean ± SE)**
Aluminium phosphide	Celphos	5gm	14.29	87.34*	52.43 ± 8.00
Odonil	Atenolol	0.5g	20.00	85.72	40.22 ± 7.42
Talstar	Bifenthrin	5ml	25.00	75.00	47.49 ± 5.73
Naphthalene ball	Kafor	5gm	20.00	83.33	43.64 ± 7.14
Petrol Plugging	-	5ml	16.66	71.66	29.09 ± 5.50
Deionized water	-	100%	0.00*	50.00	20.58± 6.69

* Aluminium phosphide tablets showed highest mortality rate
** indicates control treatment as failure.
*** PF stands for percentage efficacy of each chemical treatment.

Fig 1: Complete dieback and extensive infested galleries development on the trunk.

Fig 2: First and second year yellowish grubs larval instars of *A. sarta* along with frass.

4. Conclusion

Aluminium phosphide tablet was found cost effective and these tablets are recommended to the farmers for field use. Insect repellent technique has no impact in controlling the population density of larval emergence. The results of present study are useful in reducing the devastation caused by larval instars of *A. sarta* in apple trees.

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