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FOOD PREFERENCE OF QUETTA BORER, *AEOLESTHES SARTA* COLEOPTERA; (CERAMBYCIDAE) UNDER CONTROL CONDITION

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Abstract:

Balochistan is the largest province of Pakistan, which is blessed with four agro-ecological zones and it has unique environment condition for the production of a great variety of quality fruits, that's why the province is known as the fruit-basket of the country. Among these fruits' apple, apricot and almond are considered as important fruits of the world and Pakistan. Fruits provide nutrients and vitamins to the human. These fruits are generally grown in temperate regions of Pakistan especially in Balochistan and Khyber Pakhtunkhwa (KPK). These fruits are attacked by number of insect pests viz, codling moth, shot hole borer, aphids and san Jose scale but borers (roundhead borer and flat-headed borer) are most serious/ destructive pest and potential threat to deciduous fruit of Balochistan. Adult stages feed on the buds, cortex and causing heavy leaf defoliation. While, immature stage (larvae) bore into the tree and destroyed their xylem and phloem bundle which badly affects the yield of the tree. Round-headed borer preferred/attacked stressed trees and in case of heavy infestation and without any proper control attacked tree dry up within one or two years. Keeping in view of the pest attack to fruits present study was conducted to check the feeding preference of round headed wood borer beetles on apple, apricot and almond. The results of our findings were non-significant so it can be concluded that A. sarta can be reared in the laboratory conditions as compared to natural environmental conditions because it was also impartible to study the complete life cycle of A.sarta in its natural condition because regular tracking of feeding and boring larvae within the tree trunk and cutting of the tree for each observation till the completion of life cycle is not feasible. Therefore a need was felt to develop a simple method of rearing A.sarta in laboratory conditions in order to identify susceptible stages and feeding preference of A.sarta to effective control methods.

Key Words: *Food preference , Quetta borer, Aeolesthes sarta, coleoptera,cerambycidae*

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INTRODUCTION:

Balochistan is the largest federating unit of Pakistan, which is blessed with four agro-ecological zones and it has unique environment condition for the production of a great variety of quality fruits, that's why the province is known as the fruit-basket of the country (Fazl-e-Haider, 2008). Agriculture is the mainstay of Balochistan economy and majority of the population directly or indirectly depends on agriculture and livestock for domestic and commercial purposes. The province composes 44% of the total land area of Pakistan but only with 8.19% cultivated area compared to Sindh (17.93%), Punjab (63.43%) and Khyber Pakhtunkhwa (10.45%) (Pakistan Bureau of statistics, 2010).

Numbers of fruits, vegetables and cereals crops are grown in Balochistan. Out of cultivated area of 2512.4 thousand hectares of province, fruit crops are grown over an area of 219224 hectares with a yield of about 1078518 tons annually (ASB, 2014-15). Among fruits, deciduous fruit (apple, apricot, almond and pomegranate) occupy an area of 161,422 hectares (ASB, 2014-15). Statistics revealed that actual yield of all fruits in Balochistan is far low compared to other countries of the world (BSA, 2014-15). The actual yield of apple in Pakistan is 5391 kg/hectare compared to 6445, 7651, 12686, 21224 and 30982 kg/hectares in India, Afghanistan, Iran, Japan and USA, respectively. Similarly, per hectare yield of apricot in Pakistan is 631 kg compared to 911 and 1310 kg/hectare in Iran and Turkey, respectively (FAO, 2012). In Balochistan this yield gap attributed to number of biotic, abiotic and socio-economic factors such as low literacy rate of farming community, cultivars, and environmental factors and attacked of insect pests.

Among insect pest Quetta borer (A. sarta) (Coleoptera: Cerambycidae) cause heavy damage to drupe fruit trees viz, quinces peach, almond, apple, apricot (Janjua and Samuel, 1939, personal observation). The adult of borer owing to long antennae give them the name long horned beetles, city longhorn beetle, Uzbek longhorn beetle and *Sarta* longhorn beetle. *A. sarta* is thought to be originated in Pakistan and Western India (Orlinskii et al., 1991). It is reported from Afghanistan, India (Western Himalayas), Iran, Kyrgyzstan (south), Pakistan (north), Tajikistan, Turkmenistan, Uzbekistan but not reordered in Europe union (Orlinskii et al., 1991).

Fig 1: A view of *A. sarta* adult

The beetle is elongate, cylindrical, 3-5 cm. long, dark brown, having a fine satiny-grey pubescence, with long &well-developed antennae and legs (Figure 1).

The eggs are milky white, elliptical, about 4 mm. long and are laid in groups of 5 to 10 on living trees inside wounds in the bark or on broken ends of branches or in pita in stems. About 50 eggs are laid by one female. Hatching takes place in 10 to 14 days. A newly hatched larva is yellow, measuring about 6 mm. The head is brownish with small, black mandibles (Figure 2).

It feeds on the soft sappy bark until its mouthparts are strong enough to attack harder substances when it goes deeper down until it reaches the sap wood and commences boring out a gallery. When full grown it is large thick, yellowish, nearly 8 cm long and 15 mm in diameter. For pupation a wide tunnel is carried into the heart of the trunk or branch. In this the larva pupates and the beetle,when mature, passes along the pupal tunnel and bores out through the bark (Janjua and Samuel, 1939).

This polyphagous pest attached number of fruit trees (Ahmad et al. 1977, Orlinski 2000, EPPO 2005, Duffy 1968, Janjua, 1937 Gressitt 1951, Sengupta and Sengupta 1981, Gaffer and Bhat 1991) and forest road side trees (Orlinski 2000, EPPO 2005, Duffy 1968, Farashiani et al. 2001, Gressitt 1951, USDA 1968, Ahmad et al. 1977, Sengupta and Sengupta 1981). This borer preferred particular cultivars. Among fruit tree,s almond and peaches are attached/damaged to a lesser extent compare to apples, quinces, walnuts and apricots. In apricot varieties A. sarta preferred Charmaghz (French varieties) compared to Chagal (wild apricots) (Janjua and Samuel, 1939).

Both adult and larvae of A. sarta cause direct damage to host plant by feeding on leaves, buds and making galleries into twigs and branches, respectively (Fig 3).

Larvae are white, legless grubs (Figure 2) similar to bark beetle larvae, but the body shape is elongate, and the head area is primarily mouthparts without the more defined head capsule seen on bark beetle larvae (Solsky, 1871).

Round headed wood borer beetles attack stressed, dying, or dead trees. In case of continuous/more damaged branches(s) of affected plants dieback which can be easily detected by seeing wilting and drying leaves and gummosis. When the grub is at work, frass is frequently thrown outside on the ground below the tree. The grubs, on hatching, feed on the sappy portion of the bark and, as they grow bigger, thy work their way into the bast and sap wood of the tree with the result that the tree is ringed all round and the layer of cells through which the sap proceeds to the crown, is cut through all round until the tree dies. The grubs ultimately proceed down into the core, where pupal chambers are formed. The galleries and tunnels formed by the grub are irregular and numerous, with the result that the affected plant completely dries and the stem and branches at the point of attack become so weak that with a moderately strong wind they break off. A tree may die in three or four years or linger on for several years (Solsky, 1871). Large emergence holes in trunks and large branches, and borings at the basis of infested trees, are indications of the presence of the pest. The attacked trees are easily recognized by the presence of holes and small rotting areas on the bark of the main stem and other big branches . Large areas of the bark at such places ultimately fall off, exposing the wood beneath with the larva galleries, some of which may still be filled with large masses of chewed wood and fibrous excreta. The adult beetles are conspicuous and may be seen sitting on the trunks. Branch and tree dieback is easily detected by seeing wilting and drying leaves.

This borer is reported from mountainous regions of Afghanistan, Turkestan, western Tibet and Kashmir, is widely distributed throughout the hilly tracts of Baluchistan. It is also a serious pest in fruit orchards. The avenue and garden trees of Quetta were severely attacked by this borer in 1904, and the borer was investigated by Stebbing (1905). Since then the pest has attained notoriety throughout the province as it has considerably thinned out the avenues of Quetta, Loralai and Fort Sandeman. It is now a major pest of fruit trees as well, and the attack is particularly severe in orchards Quetta, Karez Inayatullah, Fort Sandeman, Loralai and Ziarat (janjuva Solsky, 1871).

Keeping in view of the A. sarta attack/damage to fruits trees present study was conducted with following objectives:

1. To check the feeding preference and larval life (duration) of A. sarta on almond, apple and apricot under control condition.
2. To estimate the effect of different fruits diets on the weight of round headed borer.

REVIEW OF LITERATURE:

Wilson and Waite (1982) worked on the different species of *Heliothes* and try to find out the feeding behavior of *Heliothes punctigera* and *Heliothes armigera* on the different parts of cotton crop and also search for the difference between feeding patterns of these two species. *H. punctigera and H. armigera* prefer terminals squares and bolls respectively. However, seasonal progressing and fruits abundance can affect feeding patterns of pest.

Barney and Pass (1986) checked the feeding preference of ground beetles on alfalfa under simulated field /laboratory conditions. It was observed that Evarthrus sodalis is a carnivorous that generally forages primarily on the soil surface, while the *Harpalus pennsylvanicus* is an omnivorous which was observed on the plants. Amara *cupreolata Putzeys* foraged on alfalfa foliage as well as the soil surface and was observed feeding on larvae of the alfalfa weevil, *Hyperapostica* (Gyllenhal).

Barbosa and Krischick (1987) checked the influence of Alkloids in feeding choice on the basis of growth rate of gypsy moth by using the different species of deciduous forest trees. Finally deduce that the more chemical diversity is present in the eastern deciduous forest trees qualitatively and these qualitative (alkaloids) and becomes the reason of quantitative defense and act as barrier for polyphagous herbivores.

Walt et al; (1988) studied in the field and laboratory the larval feeding choice of American bollworms on the cotton crop by using the method of surveying the field on the fixed period and also observed the damage they caused. There were indications that larvae likes to feed on flowers more readily as compare to the buds and bolls also the qualitative and quantitative losses due to falling of the fruiting bodies of the cotton.

Williamson et al; (1997) noted the feeding preference, survival rate and development of black cutworms (Agrotis ipsilon) on the different species of turf grass that is perennial ryegrass, Kentucky blue grass, creeping bent grass. Results showed that the larval development is poor on Kentucky blue grass then other species. The most preferred grass is the perennial ryegrass.

Halcomb et al; (2000) noted the feeding behavior of third instar larvae of bollworm and tobacco budworm at the different time intervals by growing the different ratios of pure and mixed stands of transgenic cotton and non-transgenic cotton. Initially after 24 hours the higher number of larvae of bollworms and budworms present on the non-transgenic cotton the transgenic cotton but final results revealed larvae of both species feed on both the transgenic and non-transgenic cotton cultivars.

Showler (2001) observed the feeding preference of different larval stages of beet armyworm on pigweed, *Amaranthus hybridus* and cotton, *Gossypium hirsutum* by using the olfacto meter and cage choice test and preference of oviposition on these two host plants. Results deduced that first instar of beet armyworm do not show any preference but the third instar of beet armyworm show the favoritism to the pigweed leaves over the cotton crop.

Kumar et al; (2008) used the different hybrids of cotton cultivar and checked the damaging potential and feeding preference of different larval stages of *Helicoverpa armigera* on the different parts of the cotton plants both in laboratory and field condition. Their results indicated that the 3rd larval instar prefer maximum HS-6 and minimum H-1098 and 5th larval instar maximum prefer to HHH-223 and minimum to HS-6.More damage was observed in the laboratory condition then field.

Dhillon and Sharma (2010) worked on the arthropod diversity, seed cotton yield and the bollworm effects on the transgenic and non-transgenic cotton under the field condition. The number of the American bollworms were more on the non-transgenic cotton then transgenic cotton and the damage done by insects higher on the non-Bt the Bt and finally the Bt cotton produced the more yield and there is no significant difference observed in the arthropodal diversity on Bt and non-Bt cotton.

Mdellel et al; (2011) carried out a field experiment to check the population distribution and behavior of brown peach aphid (Pterochloroides persicae) on various fruits trees. Five different fruits plants such as peach, apricot, apple, almond and plum were used. Two behaviors of aphid were observed during this study in which aphid were maintained on peach in irrigated orchards and sub-humid climate on four peach genus in arid and dry field climatic conditions. Aphids first seemed on the roots and then move to the trunk and where they behave differently. In this experiment adult were reared on peach, almond, plum, and apricot at differently at 15, 20 and 25 0C. The results of their findings showed 200C is the best temperature for the reproduction of *P. persicae* and peach was the best host *for P. persicae* for rearing.

Gassmann et al; (2012) examined the resistance, fitness and feeding choice and behavior for the selected laboratory strains of western corn rootworm on the Bt Maize. Noted that the growth rate of the Bt maize resistant strain faster as compare susceptible strains and fitness is not because of the resistant strains and finally the larval feeding studies showed that there is no any special preference for Bt and non-Bt Maize cultivars.

Amandeep et al; (2012) used the nine genotypes viz. C-353, G 17, G 33, AC-3545, LD 491, LD 575, B11 A, SAG-BLY (Red) and Sargosi-1 of *Gossypium hirsutum* and checked the feeding response or preference and oviposition rate of the Earias vitella after doing the proper screening of all varities of cotton. On G-17 genotype was highest rate of oviposition and feeding preference and lowest rate of oviposition and feeding preference was observed on the B11 A and proved to be the most resistant.

Gupta and Tara (2013) conducted an experiment in the laboratory to rear Apple longicorn borer, *Aeolesthes holosericea* Fabricius at temperature ranging between 10.84°C-32.87°C and relative humidity of 26%-80% on apple billets. It was observed that larvae cause considerable damage to apple trees. Larvae feeding took place on the apple about 17.23±0.21 months and 13.66±3.31 days to develop from first instar to mature larva. Adult longevity for male and females were 10.55±0.44 days, 17.23±0.21 months and 13.66±3.31 days and days, respectively. The pest has a total life span of approximately two years (25.16±1.83 months). So far, no report is available on culture of *Aeolesthes holosericea* Fabricius under laboratory conditions to facilitate evaluation of developmental stages against known control measures and the life cycle and ethology of this insect pest is indispensable for developing its control measures in the present area of study. It is also impartible to study the complete life cycle *of Aeolesthes holosericea* in its natural condition because regular tracking of feeding and boring larvae within the tree trunk and cutting of the tree for each observation till the completion of life cycle is not feasible. Therefore a need was felt to develop a simple method of rearing *Aeolesthes holosericea* in laboratory conditions in order to identify susceptible stages to effective control methods.

Arora and Shera (2014) Used the four Bt-cotton hybrids viz. MRC 6304 Bt, JKCH 1947 Bt, NCEH 6R Bt and MRC 7017 BG II and compare the larval preference and oviposition with the isogenic cotton of the spotted bollworm Earias vitella. There was no difference in the egg laying rate on any hybrid in comparison of non-Bt cotton multiple choice test explained that first instar larvae showed preference for squares the bolls of cotton and for third instar results were vice versa. At the whole there is no special difference for Bt and non-Bt cotton oviposition and larval

MATERIALS AND METHODS:

STUDY AREA AND INSECT COLLECTION

The present research work was carried out in Balochistan Agriculture College Quetta"s orchard and village Chashma during the year 2015-2016. Three fruit species viz, almond, apple and apricot were selected for experiment purpose. Almond and apricot were grown in college orchard, while apples were grown in village Chashma. The trees of almond, apricot and apple were almost 16, 15 and 16 years old, with plant to plant distance was 3x4, 2x3 and 4x4meters, respectively. From both sites, trees of each cultivar were selected randomly. After selection of trees infested branches with round headed borers of about 20 cm long were cut and brought to laboratory. The infested branches were thoroughly examined in the laboratory in order to collect the larvae from infested branches. The larvae present in infested branches were collected with the help of forceps and transfer to petri dish.

INSECT CONSUMPTION/REARING

The experiment was conducted by using three fruit trees (apple, apricot, and almond) and each fruit with three treatments (table 1) replicated four times. The collected larvae were kept/confined in petri dishes. The round headed borer larvae were feed/confined with different food viz., apple (*Malus domestica*), apricot (*Prunus armeniaca*), and almond (*Prunus dulcis*), with Fras and without Fras and with treated (fungus). After that collected larvae were observed and weighted on daily basis with the help of electronic weight balance to check the following parameters:

1- Feeding preference/consumption
2- Weight gain/loss
3- Larval life duration

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Table 1: Fruit plants and treatments

Fruit tree	Treatments	Detail of treatments
	T_1	Round-headed larvae with food (WF)
Almond	T_2	Round-headed larvae without food (WOF)
	T_3	Round-headed larvae with food treated with fungus (WFT)
	T_1	Round-headed larvae with food (WF)
Apricot	T_2	Round-headed larvae without food (WOF)
	T_3	Round-headed larvae with food treated with fungus (WFT)
	T_1	Round-headed larvae with food (WF)
Apple	T_2	Round-headed larvae without food (WOF)
	T_3	Round-headed larvae with food treated with fungus (WFT)

Larval life duration

Larval life span of larvae feeding/confined with each food source was also noted on daily basis. Larvae without movement were considered dead.

STATISTICAL ANALYSIS

The data were subjected to statistical analysis under Randomize Complete Block Design (RCBD) at 5% probability level by using software statistix-10 (trial version).

RESULTS AND DISCUSSION:

4.1. THE LARVAE WEIGHT

4.1.1. Weight loss in *A. sarta* larvae feeding on almond

Data in table 4.1 revealed that main factors, viz., food source and exposure times as well as associated interaction were non-significant ($P<0.05$).

Irrespective of food source, figure 4.1 illustrated that initially mean weight of *A. sarta* larvae exposed/confined in T1(WF), T2(WoF) and T3 (WFT) was 0.241, 0.242 and 0.335 gm, which was gradually decreased to 0.104, 0.139 and 0.244 gm, respectively in 10th weeks (Table 1).

In all treatment's maximum (45%) weight loss in *A. sarta* larvae was observed in T1 (45%) followed by T2 (34%) and T3 (21%) (Figure 4.2). The regression analysis showed that slop (x) of mean weight (mg) loss of larvae in T1, T2 and T3 was -9.99(-36%),-10.05(-37%) and -7.41(-27%) mg, respectively.

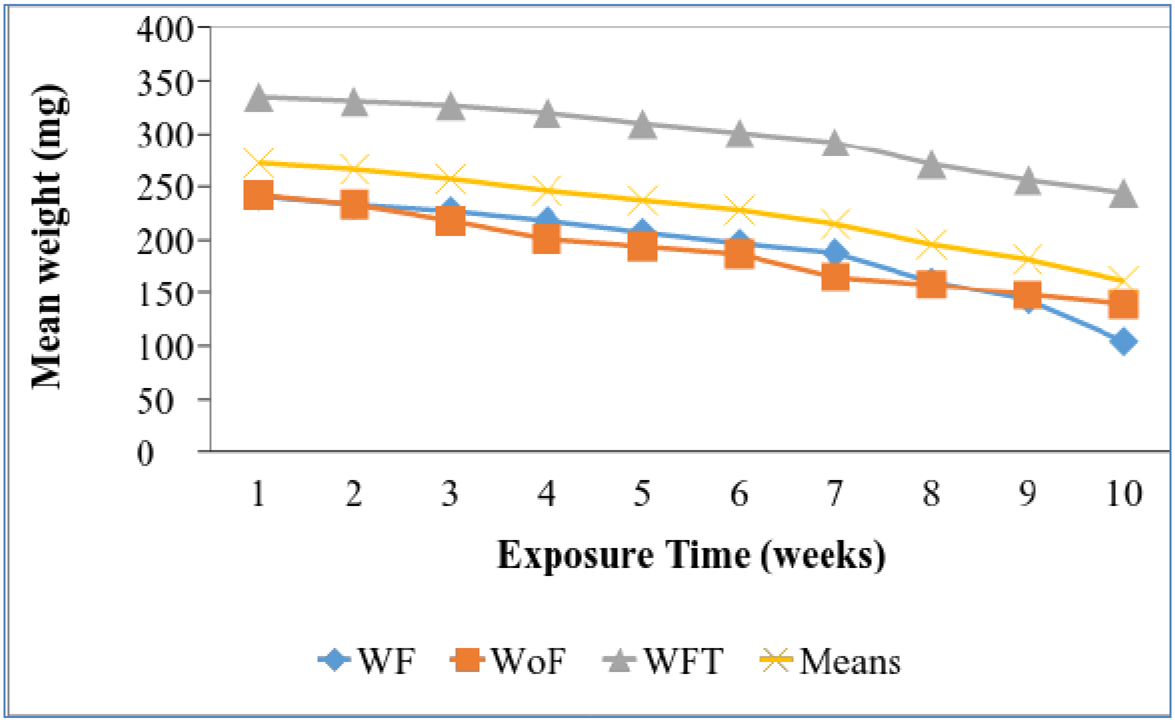

Fig 4.1: Mean weight (mg) loss trend in *A. sarta* exposed to three food regimes (WF, WOF and WFT)

Table 4.2: Linear regression analysis of mean weight gain/loss of *A. sarta* exposed to three food regimes (WF, WOF and WFT) after 10 weeks of exposure

	Regression parameters		
Treat	**Intercept (a)**	**Slope (x)**	**R^2**
WF	241 mg	-9.99 mg	82
WOF	242 mg	-10.05 mg	96
WFT	335 mg	-7.41 mg	85
Means	**272 mg**	**-9.13 mg**	**90**

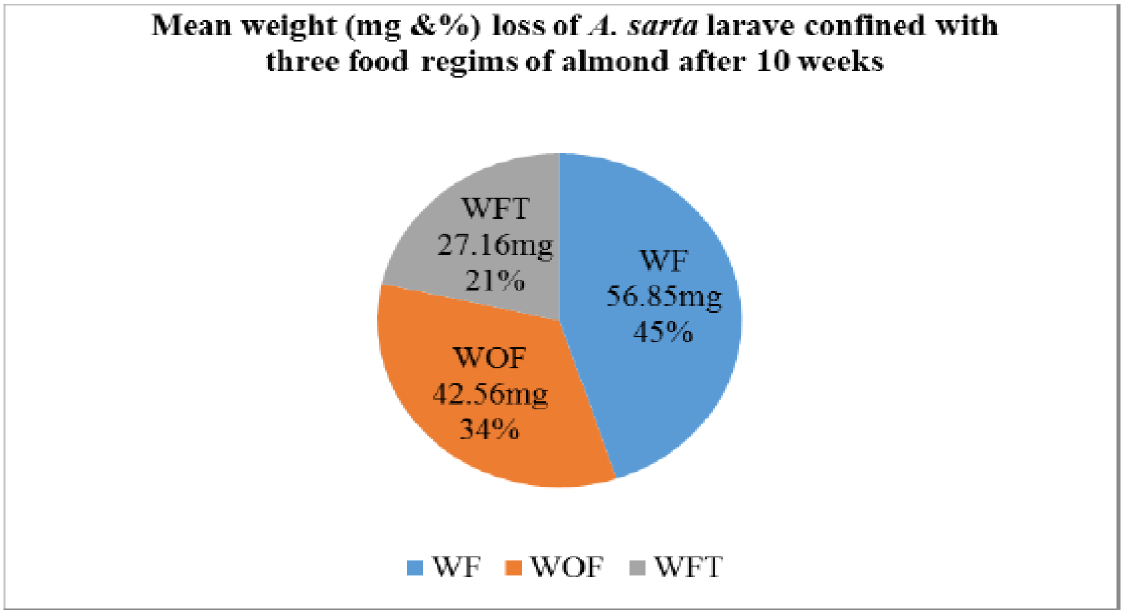

Fig 4.2: Mean weight (mg) loss trend in *A. sarta* exposed to three food regimes (WF, WOF and WFT)

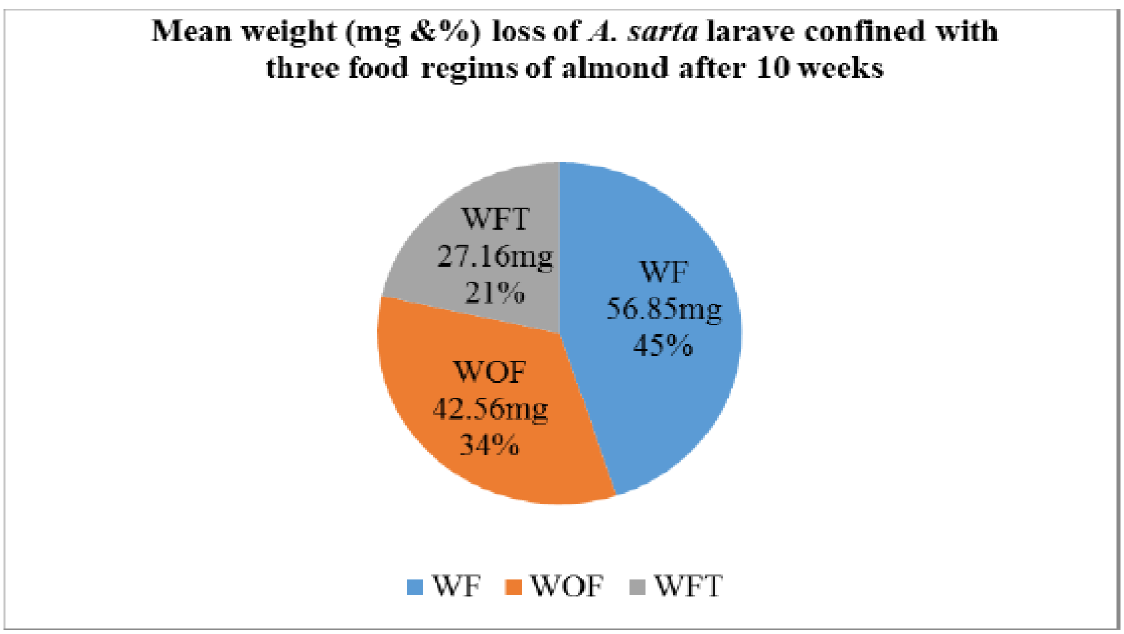

Fig 4.2: Mean weight (mg) loss trend in *A. sarta* exposed to three food regimes (WF, WOF and WFT)

Weight loss in A. sarta larvae feeding on apricot

Data in table 4.3 revealed that main factors, viz., food source and exposure times as well as related interaction were non-significant (P<0.05). Regardless of food source, figure 4.4 illustrated that initial mean weight of A. sarta larvae exposed/ confined in T1 (WF), T2 (WoF) and T3 (WFT) was 0.288, 0.213 and 0.354 gm, which was slowly decreased to 0.195, 0.115 and 0.168 gm, respectively in 10th weeks (Table 4.3).

In all treatments maximum (40%) weight loss in A. sarta larvae was observed in T3 (40%) followed by T2 (35%) and T1 (25%) (Figure 4.5). The regression analysis showed that slop (x) of mean weight (mg) loss of larvae in T1, T2 and T3 was -7.47(-24%), -8.34(-27%) and -15.44(-49%) mg, respectively (Table 4.4 and Figure 4.6

Table 4.3: **Mean weight (gm) gain/loss of *A. sarta* confined/expose to three food regimes(WF, WOF and WFT) after 10 weeks of exposure**

Treat	Weeks									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
WF	0.288	0.287	0.283	0.272	0.261	0.251	0.241	0.228	0.210	0.195
WOF	0.213	0.207	0.201	0.192	0.182	0.174	0.165	0.140	0.125	0.115
WFT	0.354	0.352	0.348	0.336	0.324	0.311	0.246	0.194	0.182	0.168
Mean	**0.285**	**0.282**	**0.277**	**0.267**	**0.256**	**0.245**	**0.217**	**0.187**	**0.172**	**0.160**
CV	**37.3**	**37.37**	**37.59**	**37.87**	**38.59**	**39.57**	**47.24**	**66.29**	**68.26**	**68.28**

Table 4.4: **Linear regression analysis of mean weight gain/ loss of *A. sarta* larvae confined with three food regimes (WF, WOF and WFT) after 10 weeks of exposure**

Treat	Regression parameters		
	Intercept (a)	Slope (x)	R^2
WF	288 mg	-7.47 mg	85
WOF	213 mg	-8.34 mg	88
WFT	354 mg	-15.44 mg	75
Means	**285 mg**	**-10.42 mg**	**81**

Table 4.4: Linear regression analysis of mean weight gain/ loss of *A. sarta* larvae confined with three food regimes (WF, WOF and WFT) after 10 weeks of exposure

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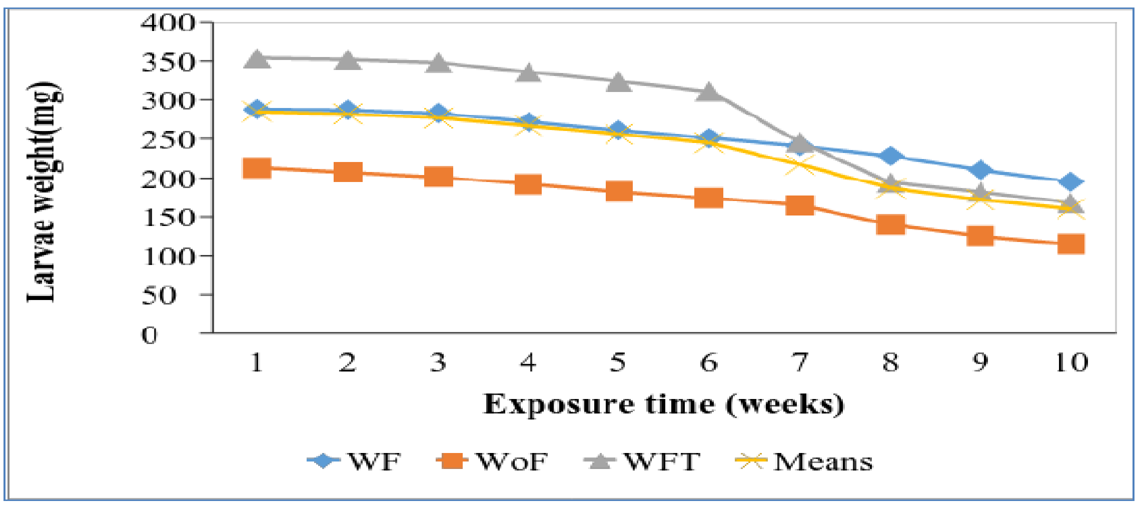
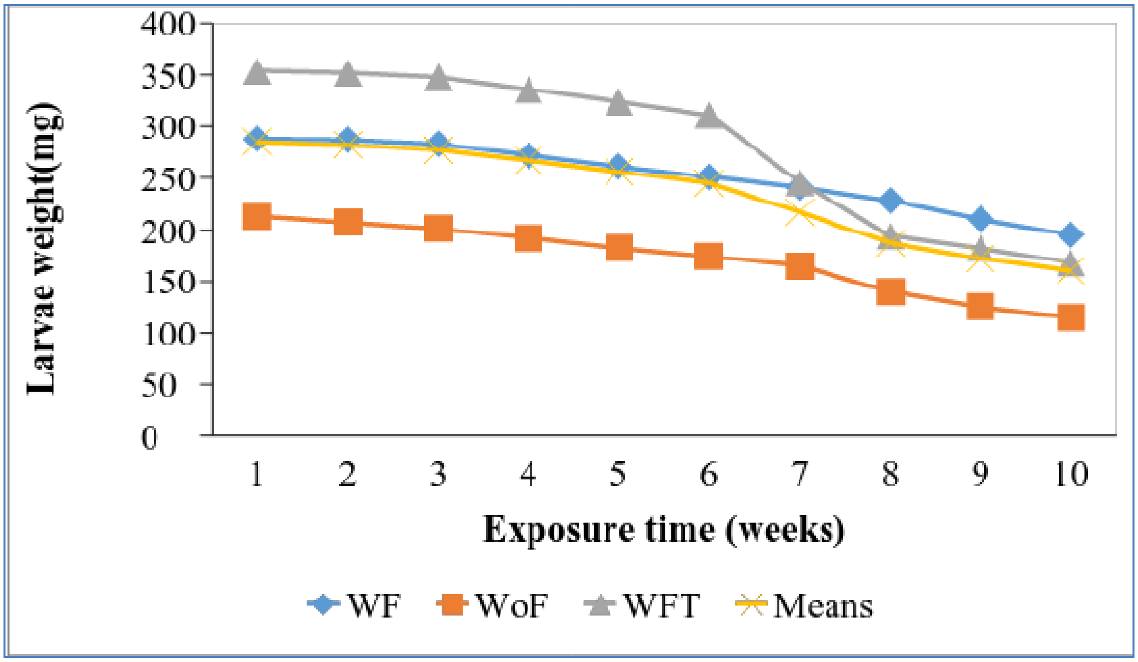


Fig 4.4: Weight loss trend in *A. sarta* exposed to three food regimes of apricot



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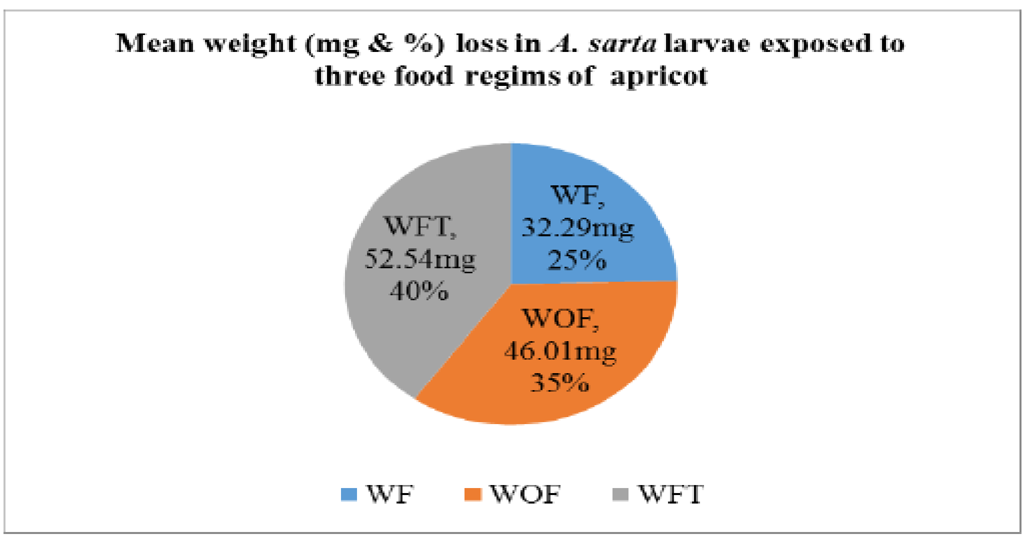

Fig 4.5: Mean weight loss (% & mg) in *A. sarta* larvae exposed/ feeding on apricot after 10 weeks

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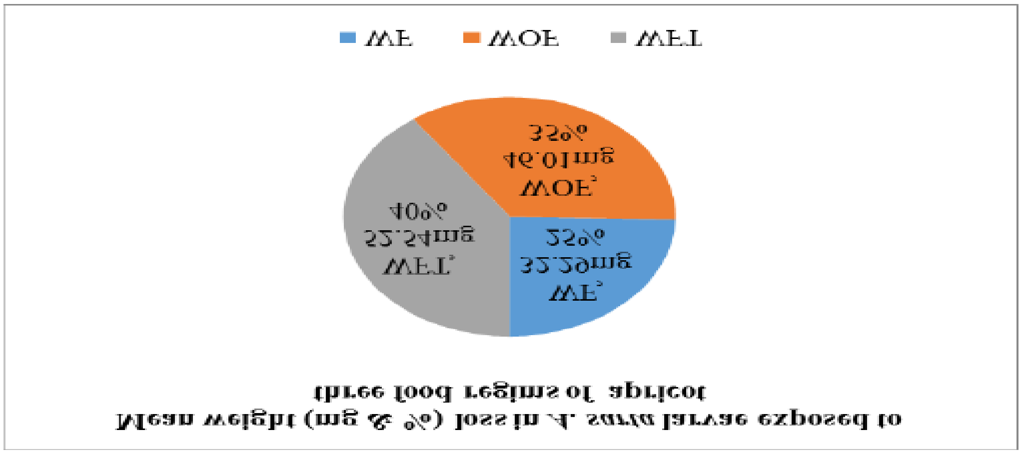

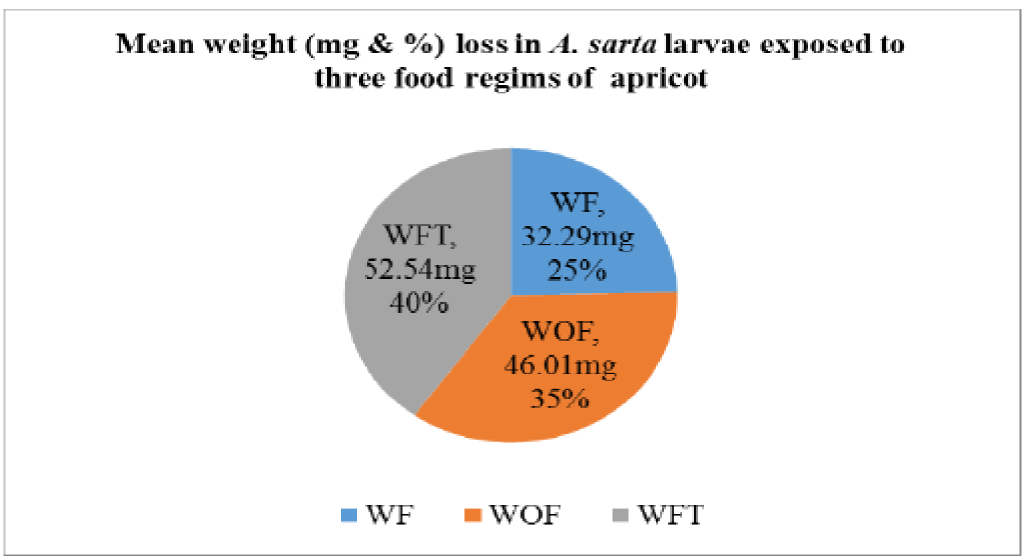

Fig 4.5: Mean weight loss (% & mg) in *A. sarta* larvae exposed/ feeding on apricot after 10 weeks

Comparative (%) mortality of *A.sarta* larval feeding on Almond, Apricot and Apple

	Treatment /weeks		
Week	Apple	Apricot	Almond
1st	0.00	0.00	0.00
2nd	0.00	0.00	0.00
3rd	0.00	0.00	8.33
4th	8.33	0.00	8.33
5th	8.33	0.00	8.33
6th	8.33	0.00	8.33
7th	33.33	8.33	8.33
8th	33.33	16.67	33.33
9th	50.00	16.67	33.33
10th	75.00	16.67	41.67
11th	**100.00**	41.67	58.33
12th		66.67	75.00
13th		83.33	75.00
14th		83.33	75.00
15th		91.67	75.00
16th		91.67	75.00
17th		**100.00**	83.33
18th			91.67
19th			91.67
20th			**100.00**

DISCUSSION:

Result showed that mean initial weight of *A. sarta* larvae collected from apricot was more compared to almond and apple. Apparently, possible reason for this difference may be due difference in *A. sarta* larval age/mass and food source. Overall our results are in line with Mazaheri *et al*., 2011 who reported that mean mass of *A. sarta* larva was lowest feeding on *P. orientalis* compared to Larvae collected from *U. carpinifolia* and *U. carpinifolia* var.

A. sarta larvae collected from apple tree died in shorter time compared to apricot and almond. Data regarding mean mortality showed that *A. sarta* larvae collected from apple, apricot and almond trees observed/started in 4th, 7th, and 3rd weeks fowling collection, respectively. Larval mortality gradually increased and completed in 11th, 17th and 20th weeks respectively. Possible reason for shorter duration of *A. sarta* feeding/ collected from apple may be food source and initial weight.

Joy *et al*., (2010) reported that life span in adult and larvae of *Aedes aegypti* were extended in case of food shortage. In our case the extended life of *A. sarta* 38

larvae feed on almond were higher than apple and apricot, we assume this may be due to restriction in diet or imbalance of food source. In other study life span in Queensland fruit fly increase as Protein: carbohydrate ratios (Fanson & Taylor, 2012) in our case the higher larval span/duration may be due to variation in protein: carbohydrate ratios. In other study reported that dietary restriction can extends in life span in many organisms (Fanson & Taylor, 2012).

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