

SCREENING OF JUJUBE VARIETIES AGAINST *EUPROCTIS FRATERNA* MOORE

Imtiaz Ahmed Nizamani*, Maqsood Anwar Rustamani**, Muhammad Ibrahim Khaskheli*, Aslam Bukero**, Imran Khatri**, and Shafique Ahmed Nizamani*

*Department Of Plant Protection, Sindh Agriculture University Tandojam

**Department Of Entomology, Sindh Agriculture University Tandojam

Corresponding Author: Dr. Imtiaz Ahmed Nizamani, Email:imtiaz69nizamani@gmail.com

ABSTRACT: Jujube, *Ziziphus mauritiana* is one of the most important fruit crops of Pakistan and consumed for its nutritional and medicinal purpose. However, the occurrence of foliage insect pests is the major threat to reduce the quality and quantity of fruits, ultimately causing tremendous economic loss to the growers. The present study is the first comprehensive attempt on the Screening of jujube varieties against *Euproctis fraterna* of Jujube. The mean population density 100^{-1} leaves. Two peaks of *E. fraterna* were noted, first on 15th July, then declined and second peak on 15th September and the gradually declined on Golden Gola variety. Whereas, the population on White Kherol variety crossed the ETL (2.5 *E. fraterna* 100^{-1} leaves) in the beginning of June and then declined after 15th July. The infestation percentage of *E. fraterna* recorded from different jujube orchards viz: Hyderabad, Tando Allahyar, Matiari, T. Muhammad Khan and Mirpur Khas showed the significant variability in the percentage. Significantly higher infestation percentage recorded in Mirpur khas and lower infestation in Matiari. Black Gola, Lootari Gola, Soofi Umran and Golden Gola were found MR, however, White Gola showed the variability in the resistance potential against *E. fraterna* based on the mean infestation.

KEYWORDS: Jujube varieties, Screening, Localities, *Euproctis fraterna*

INTRODUCTION

Jujube is one of the most important fruit crop of Sindh(Pakistan). It is known as the King of arid region fruits, because it can adapt and tolerate the biotic and abiotic stresses prevailing in the rain fed areas [1]. Jujubes are the species of the genus *Ziziphus* belongs to the family Rhamnaceae [2, 3]. *Z. mauritiana* possess greater genetic diversity and thought to occur in nearly every continent of the world. It has ability to grow even an excessive drought and is believed to be the dominant component of the natural vegetation of the India and Pakistan deserts; therefore, it is quoted as an example of extreme drought-hardy species of the world [4]. Well-drained sandy loam soils are considered as best suited for Jujube cultivation, but it can be successfully grown in many types of soils, even high alkaline soils [5, 6, 7]. In addition, jujube can also adopt harsh conditions of temperatures as high as 49-50 °C. However, fruit set adversely affected at temperatures above 35 °C [8, 9]. It has been reported that fruit quality can be obtained best under hot, sunny and drought conditions, but a rainy season may support vegetative growth and flowering, ideally providing enough residual moisture of soil to develop the fruit to maturity [10]. Sindh province is peculiar in many varieties of Jujube including Golden Gola, White Gola, Black Gola, Lootari Gola, Soofi Umran and White Kherol are cultivated commercially throughout province [11]. However, district Hyderabad, Tando Allahyar, Mirpurkhas, Tando Muhammad Khan and Matiari are the largest commercially jujube producing regions of Sindh province. Jujube is known to attack by 23 different species of insect pest [12]. Among all the insect pests Jujube Hairy caterpillar, *Euproctis fraterna* Moore is considered as a serious pest of Jujube [13,14]. Polyphagous hairy caterpillars are also destructive to Jujube during summer. The caterpillars feed gregariously on the epidermal tissues of the leaves from lower surface and also feeds on fruits [15,16] observed that the larvae of Hairy caterpillar damage the jujube plant by scraping the

chlorophyll content of leaves, resulting in skeletonization of the leaves. There is a great need for advanced research to produce reliable planting materials of selected superior germplasm especially with excellent fruit characteristics, adaptation of germplasm to stress conditions, and protecting from insect pests. In addition, there is a need of applied research to adapt available techniques to planting systems for particular agro ecological and climatic zones.

MATERIALS AND METHODS

Seven different varieties of Jujube viz; Golden Gola, White Gola, Black Gola, Lootari Gola, Soofi Umran, White Kherol and Jangri were selected to screen out the resistant potential against foliage insect pest. All the varieties have been selected on the bases of their genetic potential and popularity in the local market.

Screening methods

Screening for the resistance against most important foliage insect pest of Jujube was evaluated using a direct count of infested leaves by various insect pests. Five trees of each variety were tagged and kept under observation. The total number of damaged and healthy leaves out of 100 randomly selected leaves/branches in each tree of all varieties were examined. Calculation of percentage of damage leaves was described by as follows:

Percent Infestation = Number of damaged leaves / Total number of observed leaves*100

The resistance potential of all varieties against foliage insect pest also confirmed in five different localities, including Hyderabad, Tando Allahyar, Tando Muhammad Khan, Mirpur Khas and Matiari. Based on the percent incidence, jujube varieties have classified through infestation scales for Jujube Hairy caterpillar as mentioned in (Table 1).

Table .1 Scale for the screening for resistance against *Euproctis fraterna* in jujube.

Scale	Per cent leaf damage	Reaction	Acronym
0	0 %	Highly resistant/Immune	HR
1	1-4%	Resistant	R
3	4.1-7%	Moderately resistant	MR
5	7.1-11%	Susceptible	S
7	>11%	Highly Susceptible	HS

RESULTS

Population density of Hairy caterpillar

Diversity of insects observed with Jujube agro-ecosystem analysis (JAESA) at district Hyderabad through different insect scouting methods during 2007 and 2008. During observation, it was noticed that *E. fraterna* was attacked on all of these varieties. There was also variability in the infestation percentage of different insect pests for White Kherol and Golden Gola varieties (Table.1, Figure.1). However, the mean population percentage of insect pests during 2007 and 2008 indicates the highest percentage for Hairy caterpillar in White Kherol, whereas, Golden Gola was severely infested and showed maximum percentage of Hairy caterpillar (Figure.1). The population density of pest observed in the month of March, peaked in June and then gradually declined from July to August. The second peak of all observed insect pests was noticed in the mid of September and then declined from October to December of 2007 and 2008 (Figure .2). It is also important to mention here that jujube growers of Sindh province every year after harvesting the fruits are following the practice of pruning in the month of March to emphasize the new foliage that ultimately increase the production for next season. In this practice, all the foliage of jujube tree is cut and new foliage is grown gradually. It was observed that pruning practice also completely reduced the pest population. The results indicate that in the month of January and February, the population density of pests was negligible that may be due to the high tannin content in the leaves that makes them harder. With reference to jujube phenology, the population of foliage insect pest started to increase with the growth of primary shoots, which started to grow in the last week of March and lasted in the end of April. The growth of secondary shoots, started from May and lasted in the end of July favored the development of population density. The peak population of various insect pests was observed in the secondary shoots. It was declined gradually with the growth of tertiary leaves and when the leaves became mature, hard in structure compared to the tender leaves. However, the population was fluctuating in the tertiary and mature leaves until the pruning. The population density 100⁻¹ leaves of Hairy caterpillar (*Euproctis fraterna*) on White Kherol and Golden Gola was fluctuating during the period of observation. Signification difference was observed for two varieties, however, no significant difference was observed for both years of observations, 2007 and 2008. The increase in the population of *E. fraterna* was seen from the month of April and which crossed the ETL (2.5 *E. fraterna* 100⁻¹ leaves) in the beginning of June and then declined in the month of October on Golden Gola variety. Results further indicate that the population showed decline below the ETL only after 15th August to 15th September, however, in the rest of the months

(April to October) it was remained above the ETL. The results regarding the Kherol variety, the ETL was crossed in the beginning of June and then declined after 15th July. The highest peak of *E. fraterna* was seen after 15th July and then declined. The second peak of *E. fraterna* was noticed after 15th September and the gradually declined. The peak population of *E. fraterna* was recorded in the first 15 days of July 2007. During 2008, the boosting time of *E. fraterna* was also same, however, the population density was little lower compared to 2007.

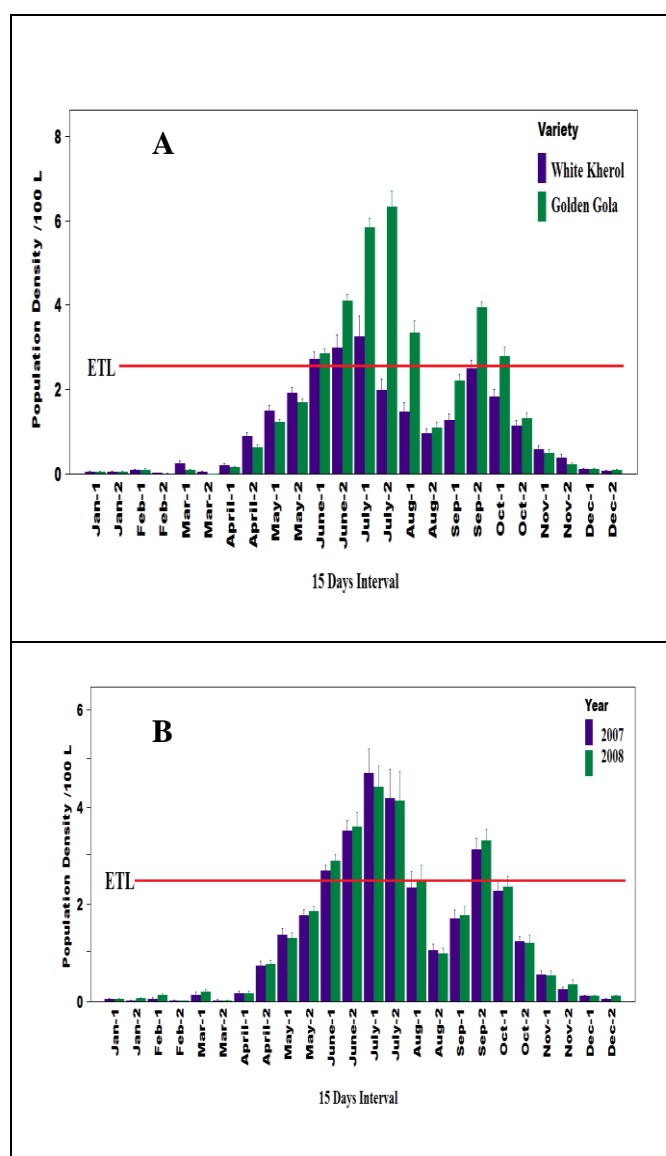


Figure 1: Population ion density of Hairy caterpillar during 2007 and 2008 in resistant and susceptible varieties of *Ziziphus mauritiana*

Evaluation of jujube cultivars against Hairy caterpillar (*Euproctis fraterna*)

The Infestation percentage of Hairy caterpillar observed during the study period of 2007 and 2008 showed the significant differences for all varieties. The mean infestation percentage of Hairy caterpillar was also significantly varied for all observed varieties, however, no significant difference was observed for two years of observations. The infestation percentage of *E. fraterna* on Black Gola variety was significantly higher in the beginning of July (18.60%) of 2007 and on the 15th June (15.60%) of 2008. It reduced in the month of August (4.80 and 2.60%); however, the infestation was increased on 15th September (9.40 and 9.00%) of both years, 2007 and 2008, respectively. In the later months it was gradually reduced. Furthermore, from January to March, no infestation of this pest was found on Black Gola variety. The infestation percentage of *E. fraterna* on Golden Gola variety was a significantly higher infestation on 15th July (26.20 and 26.80%) for both years, 2007 and 2008, however, there was no significant difference was observed for both years. The infestation percentage was reduced in the beginning of August (13.20 and 8.00%) of 2007 and 2008, however, it was increased on 15th September (18.40 and 18.80%) of both year, 2007 and 2008, respectively. In the later month, the infestations percentage gradually decreased. Furthermore, from January to March, no infestation of *E. fraterna* was found on Golden Gola variety (Figure 3)

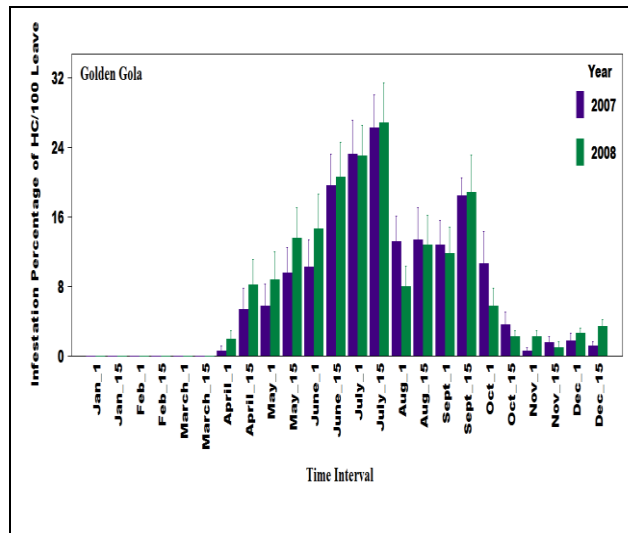


Figure 3. The infestation percentage of Hairy caterpillar (*E. fraterna*) on Golden Gola variety evaluated during 2007 and 2008.

However, no significant difference was observed for both years. The infestation percentage was reduced on August (4.20 and 3.60%) and against increased on 15th September (10.00 and 11.60%) of both years, 2007 and 2008, (Appendix-5.1) respectively. In the later months, the infestation percentage gradually decreased. Furthermore, with respect to the infestation of Hairy caterpillar, this variety remained throughout the year, except the pruning month, March of both years (Figure 5). The infestation percentage of *E. fraterna* on White Gola variety was higher than the other varieties, however, it was lower than White Kherol and Jangri varieties. Significantly higher infestation was recorded in the beginning of July (31.60 and 38.20%) for both years, 2007 and 2008, respectively; however, there was no significant difference was found for both years. The infestation percentage was reduced on 15th August to 5.60 and 6.80% and again increased on 15th September (20.20 and 21.20%) of both years, 2007 and 2008, respectively. Gradually it was decreased in the later months, however, from January to March, no infestation of this pest was found on White Gola variety (Figure 6). The results further showed that infestation percentage of *E. fraterna* on White Kherol variety. It was fluctuating round the year, however, compared to other varieties the infestation percentage was higher (Figure 6). Significantly higher infestation was recorded on 15th of July (30.00 and 32.40%) for both years, 2007 and 2008, respectively; however, there was no significant difference was found in both years. The infestation percentage of Hairy caterpillar was reduced to 4.60% on 15th August, 2007 and 5.20% in the beginning of August, 2008. In the later month, the infestations percentage was lower. Furthermore, with respect to the infestation of Hairy caterpillar, this variety was remained throughout the year except the pruning month, March of both years. Results regarding the resistance screening against *E. fraterna* for Jangri variety is presented in figure 8. It was fluctuating throughout the year and compared to other varieties, the infestation percentage was higher in the Jangri variety, however, no significant difference was found in Jangri and White Kherol varieties (Figure 6.16).

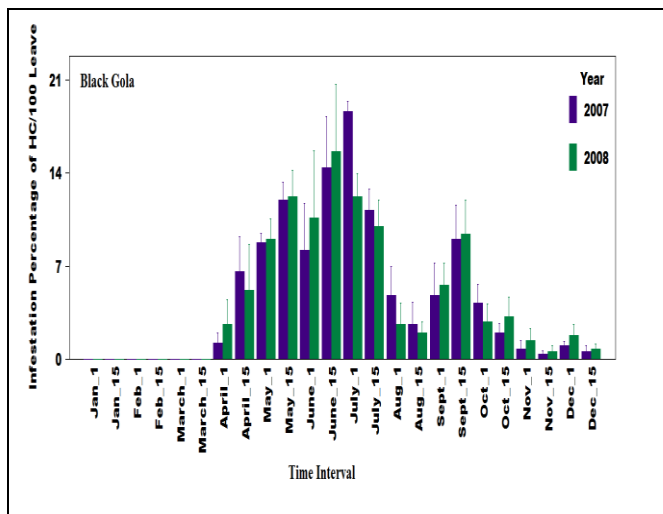


Figure 2: The infestation percentage of Hairy caterpillar (*E. fraterna*) on Black Gola variety evaluated during 2007 and 2008.

The higher infestation (16.00 and 14.00%) of *E. fraterna* on Lotari Gola variety was recorded in the beginning of July, 2007 and 15th June, 2008, respectively. The infestation of Hairy caterpillar was reduced to 3.80 and 4.00% on 15th August, however, it was increased on 15th September (9.00 and 9.40%) for both years, 2007 and 2008, respectively (Figure 4). The infestation percentage of *E. fraterna* on Soofi Umran variety was significantly higher in the whole month of July, 2007 (16.60%) and on 15th July, 2008 (15.40%).

Significantly higher infestation was recorded on 15th of July, 2007 (25.20%) and 15th June, 2008 (27.60%), respectively; however, no significant difference was found for both years. The infestation percentage of Hairy caterpillar was reduced to 10.2% in the beginning of August, 2007 and 8.20% on 15th August, 2008 (Figure 8). In the later months, the infestations percentage was lower. Furthermore, the infestation of Hairy caterpillar on Jangri variety same as White Kherol was remained throughout the year. Overall mean infestation percentage of all varieties observed during 2007 and 2008. Based on overall mean infestation, Black Gola (4.63 and 4.48 %), Lootari Gol (4.55 and 4.61%), Soofi Umran (4.68 and 5.04%) and Golden Gola (7.40 and 7.75%) for 2007 and 2008, respectively, were found MR against *E. fraterna*, however, there was no significant difference in the infestation percentage Black Gola, LootariGola and Soofi Umran varieties. The performance of a White Gola variety showed the variability in the resistance potential. In 2007, it showed MR, however, in 2008 it performed as susceptible against Hairy caterpillar. The variety White Kherol (8.89 and 9.22%) and Jangri (8.72 and 9.63%) were ranked as susceptible (S) against *E. fraterna* based on the mean infestation of two years, 2007 and 2008, respectively, that was higher than the other varieties, however, no significant difference was noticed between White Kherol and Jangri (Figure 9).

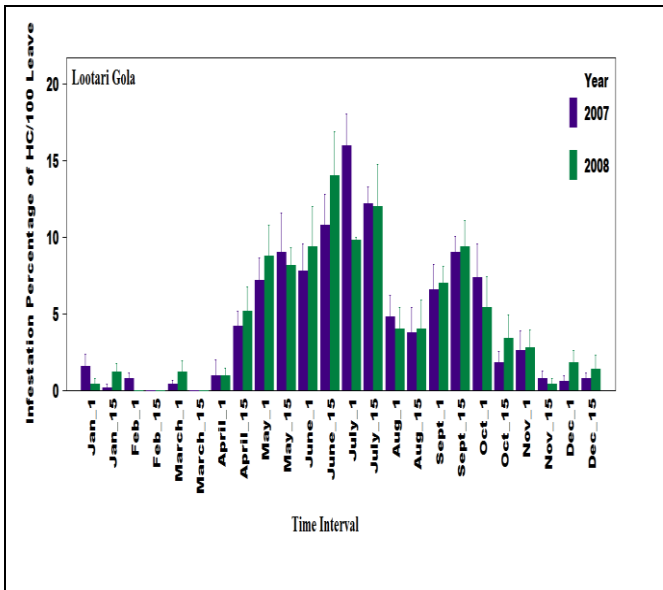


Figure 4. The infestation percentage of Hairy caterpillar (*E. fraterna*) on Lootari Gola variety evaluated during 2007 and 2008.

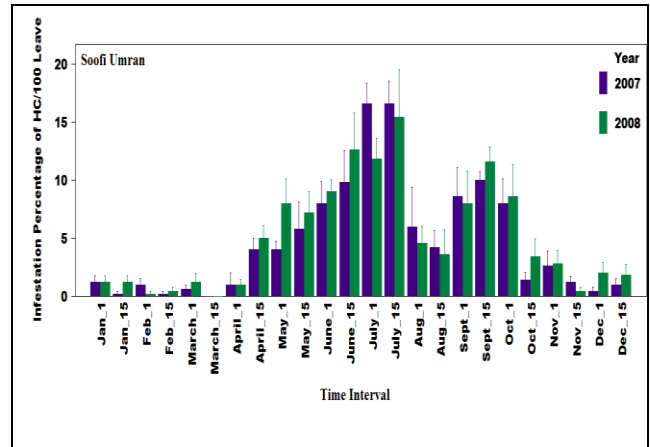


Figure 5. The infestation percentage of Hairy caterpillar (*E. fraterna*) on Soofi Umran variety evaluated during 2007 and 2008.

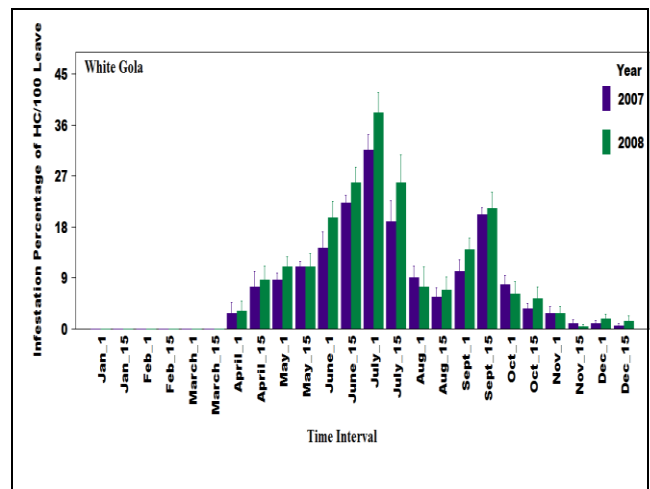


Figure 6. The infestation percentage of Hairy caterpillar (*E. fraterna*) on White Gola variety evaluated during 2007 and 2008.

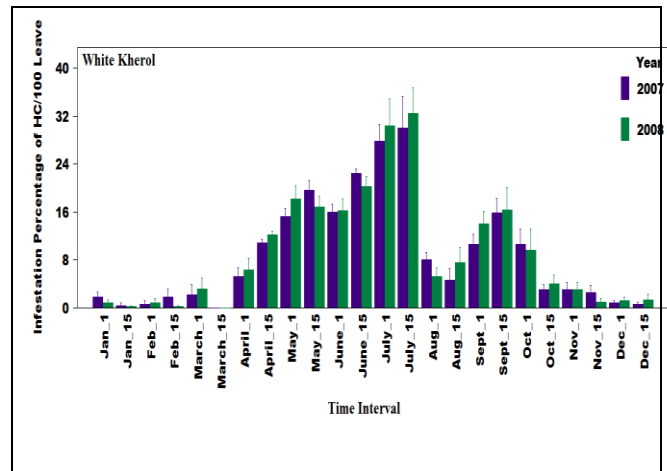


Figure 7. The infestation percentage of Hairy caterpillar (*E. fraterna*) on White Kherol variety evaluated during 2007 and 2008.

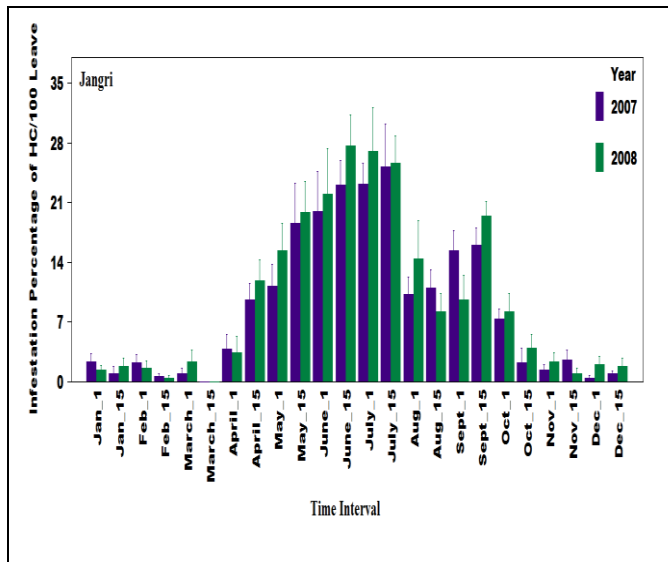


Figure 8. The infestation percentage of Hairy caterpillar (*E. fraterna*) on Jangri variety evaluated during 2007 and 2008.



Figure 9. Mean infestation percentage of Hairy caterpillar (*E. fraterna*) for all jujube varieties evaluated during 2007 and 2008.

DISCUSSION

Jujube, *Ziziphus mauritiana* is one of the most important fruit, consumed worldwide for its nutritional and medicinal purpose [17, 18]. Beside its economic value, several biotic and abiotic factors are influencing on the production and quality. Currently in the jujube ecosystem, occurrence of insect pest is the major threat to reduce the quality and quantity of fruits, ultimately causing tremendous economic loss to the growers. It also reported that sometime these insect pests may reduce up to the 100 percentage of crop yield. However, the literature on *Z. mauritiana*, especially in Pakistan, indicates very negligible work done over this important fruit tree, especially, on the protection of plant from these injurious insect pests. There are only two reports available in the literature for the insect pests of jujube in Pakistan. In the first it is mentioned that about 23 different species of insect pests, however, out of these 13 species attack on the foliage right from sprouting to fruit harvest of jujube tree [12]. In the second report, the infestation of fruit fly and lower infestation of caterpillars, weevils, beetles, and mite on jujube tree was reported by [19]. However, no further details are reported in this study that can be used as indicators

for insect pest management. The current study is the first comprehensive study on the screening of Jujube varieties against Hairy caterpillar, which is the main threats for this most important fruit tree. In addition, documentation of foliage insect pests and natural enemies, and integrated approaches for the foliage insect pest management are also highlighted here. The results so far achieved, on different objectives of the current study, are discussed here. In Pakistan, jujube is attacked by 23 species of insect pests out of these 13 species attack on the foliage right from sprouting to fruit harvest [12]. In another study, [19] reported some species of insect pests (fruit fly, caterpillars, weevils, beetles, and mite) of jujube trees causing considerable damage. The other research results also revealed that number of foliage insect species are found on jujube such as, *Euproctis fraterna*, *Synclera univocalis* [20, 21,22,23,24,25]. Others [23], further recorded *Euproctis lunata*, *E. fraterna*, *Tarucus indica*, *Castalius rosimon*, *Oacassida pudibunda*, *O. cruenta*, *Xanthochlelus fainus*, *Mylocerus undecimpistulatus*, *Crinorrhinos crassirostris*, and *Perissopneumon tamarindus* for the first time as pests of *Z. mauritania* in Gujarat, India. Elsewhere [24], authors reported that in jujube orchard, *Apis florea* was the most common insect visitor. Other major pollinators were *Stomorhina discolor*, *Chrysomya megacephala*, *Eristalinus arvom* and *Camponotus compressus*. Among the foliage insect pests of Jujube Hairy caterpillar is considered as a serious pest [23;14.27] reported seven main pests of Indian jujube such as *Synclera univocalis*, *Adoretus spp*, *Panonychus citri*, *Inderbela tetraonis*, *Amrasca devastans*, *Taucus theophrastus*, and *Porthesia Taiwan*, *Euproctis fraterna*. In the current study, we also identified 13 different insect pests. Similar to above mentioned reports, *Ancylis sativa*, *Euproctis fraterna* and *Adoretus pallens* were identified as major foliage insect pest of jujube in Pakistan. Similarly, hairy caterpillar is widely distributed in India and Pakistan [12]. This is polyphagous in nature and is reported as a destructive pest to Jujube especially during summer season [16]. In the current study, Hairy caterpillar (*Euproctis fraterna*) was a major and important insect pest infesting on both, White Kherol and Golden Gola. Two peaks of *E. fraterna* was noted, first after 15th July, then declined and second peak after 15th September and then gradually declined. The population of *E. fraterna* crossed the ETL (2.5 *E. fraterna* 100⁻¹ leaves) in the beginning of June and then declined in the month of October, however, in Kherol variety, population crossed the ETL in the beginning of June and then declined after 15th July. This variability may be due to the varietal response as well as due to the influence of abiotic factors on the insect pest population. [19] reported different insect pest fauna on some jujube trees causing considerable damage to matured plants. Their findings showed highest infestation of fruit fly, however, amongst other beetles and Hairy caterpillar were also recorded.

CONCLUSIONS

The current study is the first comprehensive research on the **Screening of jujube varieties against *Euproctis fraterna* moore**, which is threat for this promising fruit of Pakistan.

Two peaks of *E. fraterna* was noted, on 15th July, then declined and second peak on 15th September and then gradually declined. The infestation percentage of Hairy caterpillar was significantly higher in Mirpur Khas followed by Tando Muhammad Khan compared to Hyderabad, Tando Allahyar and Matiari districts. The cultivar screening for the resistance against *A. sativa*, *E. fraterna* and *A. pallens* that Jangri variety was found high resistant (HR) against Jujube leaf roller. White Kherol, Black Gola, Soofi Umran and Lootari Gola was ranked as resistant (R), whereas, Black Gola, Lootari Gola, Soofi Umran and Golden Gola were found (MR) against *E. fraterna*, however, White Gola variety showed the variability in the resistance potential. The variety White Kherol and Jangri were ranked as susceptible (S). Golden Gola and Lotari Gola has been ranked as susceptible, whereas, Black Gola and Soofi Umran were ranked as MR, respectively.

LITERATURE CITED

- [1] Anbu, S., S. Balasubramanyan, K. Venkatesan, M. Selvarajan, and R. Duarisingh (2009). Evaluation of Varieties and Standardization of Production Technologies in Ber (*Ziziphus mauritiana*) under Rainfed Vertisols. International Jujube Symposium, Acta Horticulturae. 840:55-60.
- [2] Mishra, T, M.Khullar, A. Bhatia (2011). Anticancer potential of aqueous ethanol seed extract of *Ziziphus mauritiana* against cancer cell lines and Ehrlich ascites carcinoma, Evidence-Based Complementary and Alternative Medicine, doi:10.1155/2011/765029. Source: <http://dx.doi.org/10.1155/2011/765029>.
- [3] Radha T and Mathew L. (2007). Fruit Crops. New India Publ. Agency. Singh HP, Negi JP and Samuel JC. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.
- [4] Razi, Muhammad Fakhar-ud-Din; Anwar, Raheel, Basra, S. M. A. Khan, Muhammad Mumtaz and Khan, Iqar A. (2013). Morphological characterization of leaves and fruit of jujube (*Ziziphus mauritiana* Lamk.) germplasm In Faisalabad, Pakistan. Pakistan Journal of Agricultural Sciences. 50(2): 211-216.
- [5] Rao, G. G. and M. K. Khandelwal, (2001). Performance of ber (*Ziziphus mauritiana*) and pomegranate (*Punicagranatum*) on sandy loam saline and saline black soils. Indian Journal of Soil Conservation. 29: 59-64.
- [6] Pandey, A., E. Sharma and L. Palni, (1998). Influence of bacterial inoculation on maize in upland farming systems of the sikkim Himalaya. Soil Biology and Biochemistry 3, 379-384.
- [7] Hooda, P. S., S. S. Sindhu, P. K. Mehta and V. P. Ahlawat (1990). Growth, yield and quality of ber (*Ziziphus mauritiana* Lamk.) as affected by soil salinity. Journal of Horticultural Science. 65(5): 589-593.
- [8] Pareek, O. P. (1983). The Ber. Indian Council of Agricultural Research, New Delhi, India.
- [9] Pareek, S., S. Mukherjee and R. Paliwal. (2007). Floral biology of Ber - a review. Agricultural Reviews 28:277-282. [
- [10] Orwa, C., A. Muta, R. Kindt, R. Jamnads and S. Anthony. (2009). Agroforestry Database : a reference and selection guide version 4.0 (<http://www.orl DAGROFORESTRY.ORG/SITES/TREDBS/TREDBASE.ASP>).
- [11] JRS (2013). Jujube Research Station (JRS) Sindh Horticultural Research Institute, Mirpurkhas, Sindh, Pakistan.
- [12] Khan, A.A. (1994). Insect pest management horticultural and forest crops. Pak. Agri. Res. Council (PARC) Islamabad, Pakistan. pp.664.
- [13] Shah, A.H., R.C. Jhala, Z.P. Patel, R.L. Patel and G.M. Patel (1990). First record of some pest on ber *Ziziphus mauritiana* Lamark cultivated in South Gujarat, India. Journal of Entomology Research. 52(1): 161-163.
- [14] Mann, G.S. and A.K. Kansal (1999). Development of *Euproctis fraterna* Moore on jujube *Ziziphus mauritiana* Lamk. Pest Manag. Econ. Zool., 41-2: 111-113.
- [15] Kavitha, Z. and P. Savithri (2002). Documentation of insect pests on ber. South Indian Horticulture. 50(1/3): 223-225.
- [16] Kavitha, Z. and P. Savithri (2001). Seasonal abundance of leafhopper, *Qadria pakistanika* Ahmed and lacebug, *Monostera* sp. on ber. Journal of Applied Zoological Researches. 12(2/3): 99- 102.
- [17] H.A. Kassem, R.S. Al-Obeed, M.A. Ahmed and A.K.H. Omar (2011). Productivity, Fruit Quality and Profitability of Jujube Trees Improvement by Preharvest Application of Agro-Chemicals Department of Plant Production, College of Food and Agriculture Science, 1 King Saud University, Kingdom of Saudi Arabia Department of Horticulture (Pomology), 2 Faculty of Agriculture, Kafrelsheikh University, Egypt Middle-East Journal of Scientific Research 9 (5): 628-637, 2011 ISSN 1990-9233 © IDOSI Publications, 2011.
- [18] Padmanabhan, S. S. Vishwanatha; K. Narasimhamurthy and SV. Rao (1993). Effect of feeding ber (*Ziziphus mauritiana* Lam.) juice on growth, blood composite. International Journal of Food Sciences and Nutrition. 44(2): 91-94.
- [19] Sarwar, M. (2006). Incidence of Insect Pests on Ber (*Ziziphus jujube*) Tree. Pakistan Journal of Zoology. 38(4):261-263.
- [20] Singh, D. and G. S. Mann (1982). Behavioral studies of the mobile forms of *Synclerau nivocalis* on jujube, *Ziziphus mauritiana*. Phytoparasitica. 10(3):201-204.
- [21] Wang, T., X. Yan, C. Liu and Y. Dang (2002). The leading insects of jujube in northern jujube producing area of Shaanxi province. China Fruits. 46 (2): 43-44.
- [22] Mann G.S. (1981). Chemical control of *Synclera univocalis* on jujube *Ziziphus Mauritian* at Ludhiana India. Indian Journal of Agricultural Sciences: 517-520.
- [23] Bhatnagar, P. and R. K. Lakra (1992). Biology and control of hairy caterpillar, *Euproctis fraterna* Moore (Lepidoptera: Lymontriidae) on jujube (*Ziziphus mauritiana* Lamk.). In Bio-ecology and Control of Insects Pests: Proceedings of the National Symposium on Growth, Development and Control Technology of Insect Pests. pp. 150-155.

- [24] Verma, A. N., R. Singh, and A. D. Khurana, (1972) Chemical control of hairy caterpillar. Indian Journal of Agricultural Science, 42(10): 928-931.
- [25] Shah, A.H., R.C. Jhala, Z.P. Patel, R.L. Patel and G.M. Patel (1990). First record of some pest on ber *Ziziphus mauritiana* Lamark cultivated in South Gujarat, India. Journal of Entomology Research. 52(1): 161-163.
- [26] Jothi, B.D. and P.L. Tandon (1993). Insect pollinator activity on ber *Ziziphus mauritiana* Lamark. Proc. Inter. Symp. Bangalore, India. Pp. 210-211.
- [27] Lei, X. and X. Zang (2000). The main pest Indian jujube and their control. South China fruits. 29 (6): 43-44.