*Pak. J. Biotechnol. Vol. 21(2), 305-311, **2024.*** http://doi.org/10.34016/pjbt.2024.21.02.926

Research Article

OPEN ACCESS

Available on http://www.pjbt.org
Pakistan Journal of Biotechnology
(PJBT)
(P-ISSN: 1812-1837 and E-ISSN: 2312-7791)

POPULATION DENSITY OF LESSER DATE MOTH ON MOST PROMINENT DATE PALM CULTIVARS AT KHAIRPUR MIRS

Faheem Ahmed Jatoi[1]*, Hakim Ali Sahito[1] and Abdul Manan Shaikh[2]

[1]Department of Zoology, Faculty of Natural Sciences, Shah Abdul Latif University Khairpur, Sindh-Pakistan
[2]Department of Zoology, Government College University Hyderabad, Sindh-Pakistan
*Corresponding Authors E-mail: faheem.jatoi@salu.edu.pk

Article Received 06-02-2024, Article Revised 21-03-2024, Article Accepted 10-04-2024.

ABSTRACT

Pakistan is a more peculiar and hearty zone for almost all types of date palm cultivars but only District Khairpur Mirs of Sindh is regarded as "Khajeen jo dees". The field survey-based research study was conducted at Taluka Kingri, District Khairpur during, 2017-18. The present study was sought on viz., Aseel, Nar-aseel, Fasly, Karbalian, Otakin, Daki-wari, Asul-kurh, Kashoo-wari, Asul-khurmo, Dedhi-wari, Lessoro, Begun-wari, Gajar-wari, Noori-wari and Nakul-kurh date palm varieties. All the novel already cultivated varieties were observed through random selection against the population density of *Batrachedra amydraula*. The pest data was taken every week from April, May and June months in both years of the study period. The pest data was gathered from 15 acres of cultivated *Phoenix dactylifera* orchards and prohibited to any insecticides. The maximum suspected pest infestation was found on Fasli cultivar whereas; the minimum infestation was recorded on Aseel. This commercial high-priced variety is found with high tolerance capability against salinity, drought, and upper range temperature conditions and hence recommended for cultivation. In the present study, it was frequently observed the appearance of the *Batrachedra amydraula* on all novel cultivars. The "Khajoor" is the cash crop and the main economic source of livelihood of this region but for a few decades, LDM has leads productivity reduction in terms of quantity and quality. The food security and socio-economic status of date palms are poorly documented in Pakistan. In this context for date palm crop security, more work should be carried on against population reduction of LDM.

Keywords: *Aseel, Batrachedra amydraula, Fasly, Khajoor, Phoenix dactylifera.*

INTRODUCTION

The *Phoenix* meaning red fruit, *dactylifera* means finger-like appearance, is one of the oldest fruit crop cultivated in the Middle East, Arabian Peninsula and North African more prominent in Saudi Arabia, Iraq, Egypt, UAE, and Algeria (Abdul- Hamid *et al*., 2020). The valuable date palm fruit is described in many religious books and historical evidence indicates that date palms were cultivated about 7000 years ago (Manzoor *et al.*, 2022). Pakistan exports dry and semi-dry date fruits to other countries but especially to India, where dates are not only used for fasting in the Holy month of Ramzam Shareef but also for worship purpose of Parsaad of Bhagwan Krishna Artee time for sweet happiness (Kousar *et al*., 2022). Pakistan ranks 6th position in date producing countries and date fruits have the most economic value after mango throughout the country, but more than 90% of fruit production only comes from Sindh and Balochistan (Adul-Soad *et al*., 2015).

The arid regions of Pakistan are regarded as fruitful for the development of date palm cultivars but "Assel" is the most commercial variety, a high-priced item due to its fruitful taste, yield production and insect pest resistance power (Fatima *et al*., 2016). Thousands of years ago humans realized the importance of date fruit's with positive effects on human physiology (Saqib *et al*., 2020). Date palms are evergreen plants with potential power and sufficiently grow under arid and semi-arid climatic conditions, hence called the symbol of life in desert regions (Mattar *et al*., 2021). The dry and semi-dry fruit of date palm is the sweetest, full of nutrients, polyphenols, phytosterols, carotenoids, proteins, minerals, and rich in vitamins (Rambabu *et al*., 2020). Date fruit is widely used in pharmaceutical, ornamental purposes and food industries, hence received much attention and is also regarded as the ideal healthy food for man (Fekry *et al*., 2022). The *Phoenix dactylifera* L. is the cash crop of this district and has been cultivated on more than 100,000 acres with a total production of 293,000 tons (Sahito *et al*., 2017), as the bounded district Naushahro Feroze in its west is a more popular hub and robust zone for *Citrus limon* cultivars (Mangrio *et al.*, 2024).

The study area is rich in date palm varieties but Aseel, Karbalian, Fasli, Kupro, and Dadhi are the most commercial varieties of a region about ash,

moisture and sugar content (Mallah *et al*., 2107). The date palms locally are called Khajoor which is the main economic source of livelihood of this region (Kousar *et al*., 2020), this crop is the cash crop of upper Sindh, and thousands of families and labor force are engaged in dates industry in this region (Kubar *et al*., 2017). Sindh share 83.33% of which 34% of date fruits only come from the district Khairpur (Jatoi *et al*., 2020). The demand for date fruit consumption is increasing due to its delicious taste, but the quality of this fruit mostly depends on handling and post-harvest temperature, insect infestation and storage processing (Sarraf *et al*., 2021). The date palm is the main crop, but the orchards and fruit of this economic crop are infested by a variety of pest insect species, which leads to reduced productivity in terms of quantity and quality (Alsaedi, 2022). The majority of insects are serving as destructive agents that threaten food and food crops globally and by suppressing toxins activation in their midgut, immune system modification and mutation of toxin receptors they develop their resistance power (Abdel-banat and Ei-shafie, 2019).

The *Phoenix dactylifera* L. fruit is invaded by many pest species, but recently the *Batrachedra amydraula* Meryrick in date-producing countries serving as a key pest of date fruits (Alyousuf, 2022). Here in Pakistan, this potential insect pest is known as the most destructive insect of date palm varieties (Khan *et al*., 2018). The larvae of most species of insects are voracious feeders (Mangrio *et al*., 2020). The smut fungus infects grains at flowering creates a fishy smell, blackening of seeds and unlikely to be public consumption (Imadi *et al*., 2018). Likely larvae of LDM harm from the inflorescences, up to the ripening stage, by making hole like appearance near the calyx of the fruit, and starting to feed the soft pulp of immature seeds, finally, the fruit becomes dry red or darkened and ultimately fall (Alemu and Taye, 2020).

This key pest species of insets, generally called 1st harvested pest insect, starts infestation from date palm plants and towards the dry and semi-dry storage dates by causing up to 75% total loss (Sahito *et al*., 2017). The first flare of the LDM arose in 1998 at the Khairpur region and control measures were taken through aerial spray but since then no proper insecticide or biological control provided better remedy against this vigorous pest. Thus, this pest was found to loss up to 70% of the raw fruit because no work on screening of different date palm varieties has been done. The date palm growers of this area are unaware of the wide-ranging negative effects of the LDM and there is no meticulous efforts have been taken to secure the date palm cash crop of this region. Keeping in view the above facts, this research study was performed to know about the injurious facts of LDM and make an effort to get rid of this potential pest in this region.

MATERIALS AND METHODS

Study site: Here, in Khairpur, more than 300 registered cultivar date palm varieties. Out of them, only 15 prominent date palm varieties were screened out for the population dynamics and infestation densities of LDM during, 2017-18. The observation was made on Aseel, Karbalian, Nar-aseel, Daki-wari, Fasly, Kashoo-wari, Otakin, Dedhi-wari, Asul-kurh, Asul-khurmo, Gajar-wari, Lessoro, Nakul-kurh, Begum-wari and Noori-wari date cultivars. For the observation of LDM population fluctuation, 15 acres of date palm were kept under observation at Prof. Dr. Abdul Khalique Jatoi farm located at 27.85168^0N, 68.61301^0E, Kingri and insecticides were prohibited at the data collection point. Randomly, 20 plants were observed from each acre in every week of April, May and June.

Study plan strategy: Mostly date palm bear 12 to 20 bunches from which only 5 bunches were randomly examined and throughout bunches the damaged fruits were counted. The data of the pest population was counted inflorescence up to the maturity of the fruit. The population dynamics of the LDM on different varieties of date palm cultivars were observed as the described methodology of (Khajehzadeh and Latifian, 2013).

Statistical analysis: ANOVA of the gathered data of the pest population was statistically analyzed by the application of the student package SWX software 8.1 USA. The mean and least significant difference of the pest population on date palm cultivars were measured at ($P< 0.05$) and figures were made with the help of Origin 2017, 64Bit software.

RESULTS

Batrachedra amydraula **population fluctuation on 15 novel date palm cultivars:** During the research work, the population of LDM was recorded from fifteen date palm varieties, 2017. The maximum mean population of the pest was recorded (95.00) on Fasli/Totoo, (91.00) Otakin, (89.00) Gajr wari, (81.00) Kashoo wari, (80.00) Nakul kurh, (78.00) Karbalian, (76.00) Dakiwari, (73.00) Nar aseel, (72.00) Asul khurmo, (68.00) Lessoro, (65.00) Dedhi wari, (63.00) Asul kurh, (61.00) Begun wari, (59.00) Noori wari, and (47.00) Aseel varieties, respectively. When recorded insect pest data was subjected to the analysis, the least significant difference of the pest population was found on different prominent date palm cultivars. The LSD of *P. dactylifera* Fasli/Totoo variety (DF= 14, 11; F= 55.00; P= 0.03), Otakin (DF= 14, 11; F= 112; P= 0.01), Gajar wari (DF= 14, 11; F=253; P= 0.05), Kashoo wari (DF= 14, 11; F= 95; P= 0.02), Nakul kurh (DF= 14, 11; F= 88; P= 0.02), Karbalian (DF= 14, 11; F= 105; P= 0.04), Daki wari (DF= 14, 11; F= 126; P= 0.02), Nar aseel (DF= 14, 11; F= 78; P= 0.01), Asul khurmo (DF= 14, 11; F= 88; P= 0.05), Lessoro (DF= 14, 11; F= 114; P= 0.03), Dedhi wari (DF= 14, 11; F= 78; P= 0.01), Asul kurh

(DF= 14, 11; F= 95; P= 0.04), Begun wari (DF= 14, 11; F= 67; P= 0.02), Noori wari (DF= 14, 11; F= 122, P= 0.04), and Aseel (DF= 14, 11; F= 78; P= 0.03), were recorded. The LSD difference of insect pest population comparison on different date palm cultivars was found at ($P< 0.05$), as shown in (Figure. 1).

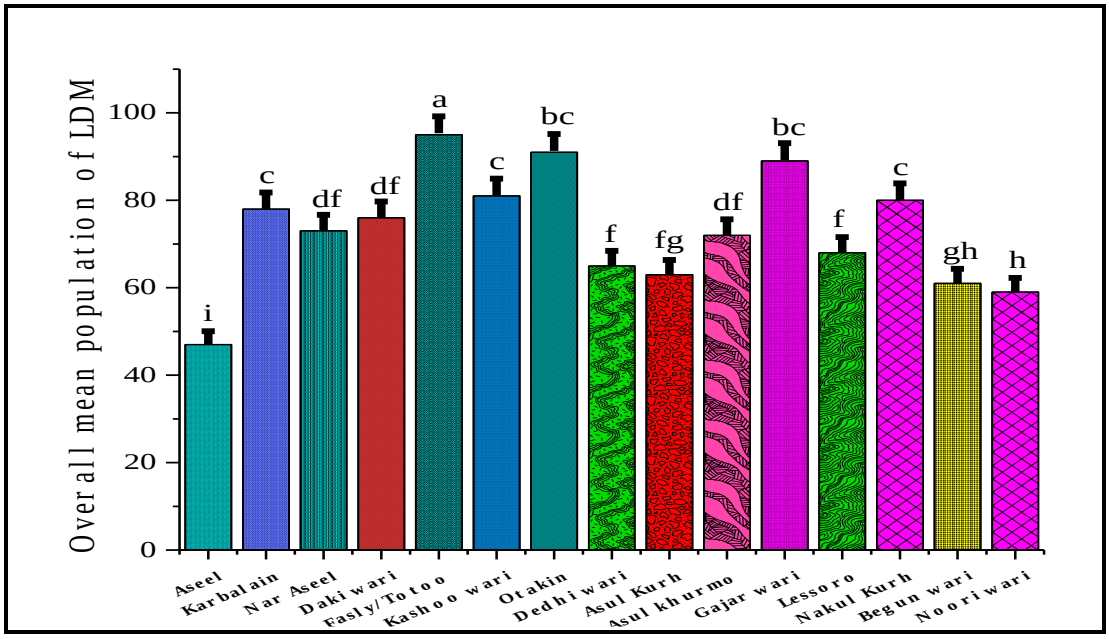

Figure. 1. Overall mean population of LDM on different *Phoenix dactylifera* cultivars, 2017

***Batrachedra amydraula* population fluctuation on 15 novel date palm cultivars:** The population of the lesser date moth was recorded from fifteen date palm varieties, 2018. The maximum mean population of the insect pest species was found at (87.00) on Fasli/Totoo, (85.00) Otakin, (81.00) Gajar wari, (77.00) Kashoo wari, (73.00) Nakul kurh, (71.00) Dakiwari, (68.00) Karbalian, (61.00) Nar aseel, (57.00) Asul khurmo, (55.00) Lessoro, (54.00) Dedhi wari, (52.00) Asul kurh, (51.00) Begun wari, (46.00) Noori wari, and (38.00) Aseel date palm cultivars, respectively. When the collected data of the pest population was statistically analyzed, found with significant difference on different date palm cultivars. The LSD of the pest species on Fasli/Totoo (DF= 14,

Overall mean population of *Batrachedra amydraula* on 15 different date palm varieties

The population of the LDM species was recorded high in first year of the study as compared to next year. The overall maximum mean population in both year of the study found at (91.00) on Fasli/Totoo, (88.00) Otakin, (85.00) Gajarwari, (79.00) Kashoo wari, (76.50) Asul kurh, (73.00) Daki wari, (73.00) Karbalian, (67.00) Nar aseel, (64.50) Asulk hurmo, (61.50) Lessoro, (59.50) Dedhi wari, (57.00) Asul kurh, (56.00) Begun wari, (52.00) Noori wari, and (42.50) Aseel, respectively. When the data of the insect pest population was statistically analyzed, found with significant difference in both year of the study. The LSD of pest population was recorded on Fasli/Totoo date palm cultivar at (DF= 29, 23; F= 55.05; P= 0.02), Otakin (DF= 29, 23; F= 98; P= 0.05), 11; F= 62.05; P= 0.02), Otakin (DF= 14, 11; F= 95; P= 0.05), Gajar wari (DF= 14, 11; F= 211; P= 0.01), Kashoo wari (DF= 14, 11; F= 88; P= 0.04), Nakul kurh (DF= 14, 11; F= 78; P= 0.02), Karbalian (DF= 14, 11; F= 95; P= 0.03), Dakiwari (DF= 14, 11; F= 115; P= 0.01), Nar aseel (DF= 14, 11; F= 68; P= 0.04, Asul khurmo (DF= 14, 11; F= 76; P= 0.05), Lessoro (DF= 14, 11; F= 95; P= 0.02), Dedhi wari (DF= 14, 11; F= 66.05; P= 0.04), Asul kurh (DF= 14, 11; F= 77; P= 0.01), Begun wari (DF= 14, 11; F= 55.05; P= 0.03), Noori wari (DF= 14, 11; F= 115; P= 0.01), and Aseel (DF= 14, 11; F= 65.15; P= 0.04), on prominent date palm varieties. The pest population the least significant difference was taken at ($P< 0.05$), further justification is given in (Figure. 2).

Gajar wari (DF= 29, 23; F= 105.02; P= 0.01), Kashoo wari (DF= 29, 23; F= 75.08; P= 0.04), Nakul kurh (DF= 29, 23; F= 75.04; P= 0.01), Karbalian (DF= 29, 23; F= 88.06; P= 0.03), Daki wari (DF= 29, 23; F= 98.07; P= 0.05), Nar aseel (DF= 29, 23; F= 65.28; P= 0.02), Asul khurmo (DF= 29, 23; F= 73.28; P= 0.04), Lessoro (DF= 29, 23; F= 88.36; P= 0.01), Dedhi wari (DF= 29, 23; F= 62.24; P= 0.03), Asul kurh (DF= 29, 23; F= 72.34; P= 0.05), Begun wari (DF= 29, 23; F= 52.12; P= 0.04), Noori wari (DF= 29, 23; F= 109.11; P= 0.02), and Aseel (DF= 29, 23; F= 62.22; P= 0.01), on different date palm cultivars. The least significant difference of pest population fluctuation was taken at ($P< 0.05$) in both years of the study, as justified in (Figure. 3).

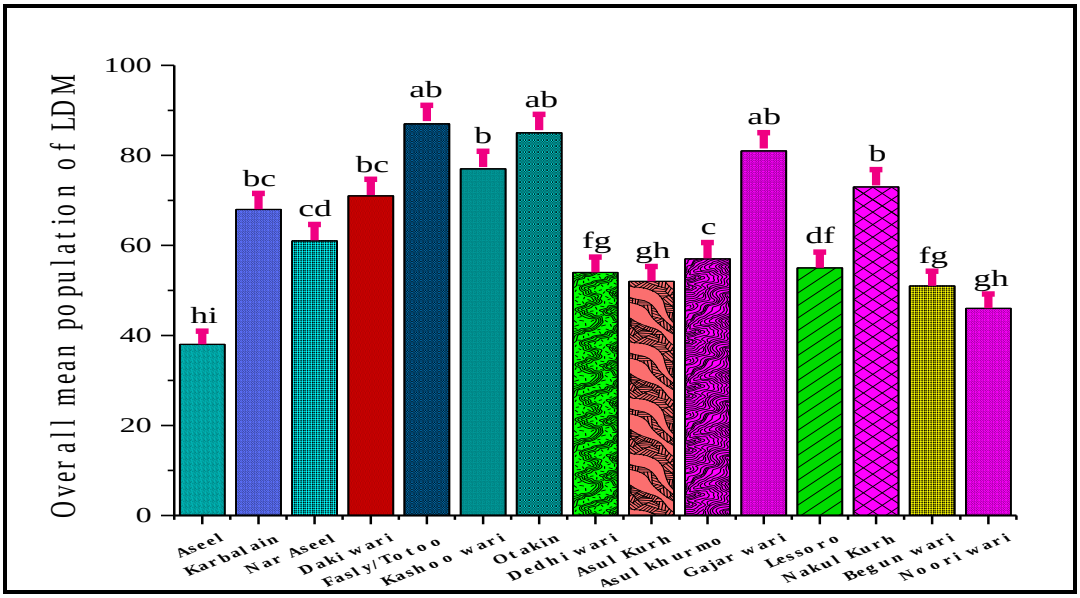

Figure. 2. Overall mean population of LDM on different *phoenix dactylifera* cultivars, 2018

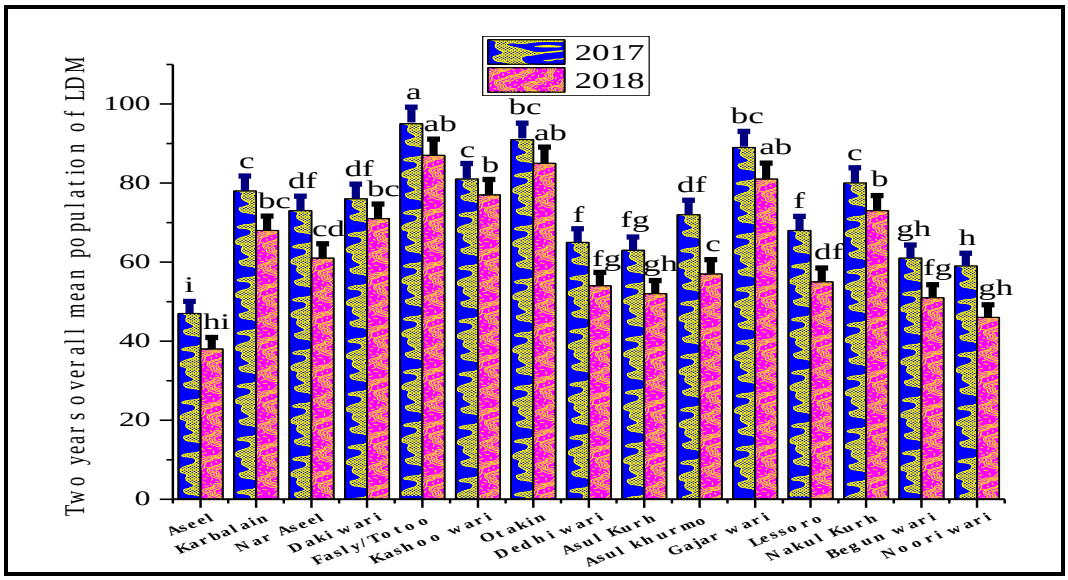

Fig. 3. Overall mean population density of LDM on different *Phoenix dactylifera* cultivars 2017-18

DISCUSSION

Our result is with the work similarity of Latifian *et al*., (2021) recognized that six date palm cultivars are massively infested by the lesser date moth in five provinces of Iran and this pest species of the insect causes extent injury level, increase damage rate, decrease productivity. Jatoi *et al*., (2021) documented that the larvae of the lesser date moth attack the soft pulp of the fruit, and fruit becomes green to darker and finally falls on the surface of the ground. Mahidi and Khalaf, (2022), conducted the research work against the population density of *Batrachedra amydraula* L. on Khastawi date palm cultivar at the Ramadi region, and found that the peak population of this pest in the 2nd week of April, 4th week of May, and 3rd week of June month. Alsaedi, (2022), observed the population fluctuation of lesser date moths on Halawi, Sayer, and Barhi date palm cultivars in Iraq, and the highest population of this pest was found on Barhi compared to Halawi and Sayer.

Our results are more or less comparable with the published work of Mangrio *et al*., (2024), who applied four bio insecticides against LDM in the same region. Khan *et al*., (2018), monitored the population of lesser date moths, scale insects, rhinoceros beetle and red palm weevil on Aseel, Muzwati, Begun Jangi and Shakri varieties of date palm by the application of pheromones traps. Khajehzadeh and Latifian, (2013), randomized evaluated nine different date palm cultivars viz., Shahani, Kabkab, Mezafati, Piarom, Khasi, Khazravi, Haj-Mohammadi, Gantar, Zahedi to

find out the population dynamics of lesser date moth, and Khasi cultivar found with maximum infestation of the pest. Manzoor *et al*., (2022) documented the infestation of another potential insect pest, the red palm weevil on Denda, Aseel, Zaidi, Hillawi, Kobra, Mozawati, Zeri, Kechanr, Dhaki, Khudravi and Shamrani varieties and found maximum infestation on Hillawi and minimum on Denda and Kobra. Ali *et al*., (2019) reported the population dynamics of lesser date moth on Khalas, Barhee, NabbutSeif, Medhjoul varieties of date palm cultivars in Syria, and Medhjoul variety found with maximum infestation followed by NabbutSeif, Khalas and Barhee varieties. El-Shafei and Attia, (2023) described the population of date palm scale on Samani, Bartamda, Siwi date palm cultivars and the maximum population fluctuation of the pest species found on Siwi followed by Bartamoda and Samani. Kinawy *et al*., (2015), recognized that continuously attack after four weeks of *Batrachedra amydraula* L. the branches of date palm stop growing ultimately turned into dry and un-ripen fruits may fall, which causing more than 75% yield loss.

CONCLUSION AND RECOMMENDATIONS

The population dynamics of LDM was observed on different 15 cultivated date palm cultivars to observe their population fluctuation. The maximum population density was found on Fasli date palm cultivar, while minimum on Aseel cultivar. The *Batrachedra amydraula* L. from few decades continuously harming the *Phoenix dactylifera* cultivars in upper region of Sindh-Pakistan. The majority of local people of this region are engaged in date palm crop as their economic source of thousand families' livelihood. When pest insects hit the date palm and reach to the un-ripen fruits, they cause extensive damage and the fruit fall on the ground. The present findings will be an informative and beneficial scientific documentary for date palm growers to know about the severe effects of the LDM. It is the general call for date palm growers should recognize the presence of the pest earlier, in case of the initial appearance of the LDM population, immediately adopt certain control measures to enhance and secure the quality and quantity of the dry and semi-dry date fruits.

AUTHOR'S CONTRIBUTION

F.A. Jatoi: is the main author of this research manuscript, who designated, conceived and arranged the research tools, observed pest population, collected and analyzed data, and wrote the research paper. **H.A. Sahito:** supervised point by point throughout the completion of this study. **A.M. Shaikh:** helped in article review.

IMPACT STATEMENT

There are more than 250 registered varieties of date palm but "Aseel" cultivar is the outstanding and most commercial variety of this region. Khairpur Mirs is regarded as the main hub for date palm productivity amongst all other districts of Sindh. But date palm growers are facing massive economic losses due to the destructive effects of LDM.

ACKNOWLEDGMENTS

The authors are sincerely grateful to thank date palm growers for their jolly support, from which insect pest data on different date palm cultivars was gathered.

PUBLICATION CONSENT

The corresponding author accepts all responsibilities regarding the release of this scientific work.

AVAILABILITY OF DATA AND MATERIALS

There is ethical privacy and restrictions, the findings of this research manuscript available at the request of the corresponding author.

REFERENCES

Abdel-Banat, B.M.A., & El-Shafie, H.A.F. (2019). Expression profiling, phylogenetic, and structural analyses of a laccase gene from the red palm weevil, *Rhynchophorus ferrugineus*. *African Journal of Biotechnology*, **18**(31): 978-990.

Abdul-Hamid, N.A., Mustaffer, N.H., Maulidiani, M., Mediani, A. Ismail, I.S., Tham, C.L., Shadid, K., & Abas, F. (2020). Quality evaluation of the physical properties, phytochemicals, biological activities and proximate analysis of nine Saudi date palm fruit varieties. *Journal of the Saudi Society of Agricultural Sciences,* 1**9:** 151-160.

Abul-Soad, A.A., Mahdi, S.M., & Markhand, G.S. (2015). Date palm status and perspective in Pakistan. *Date palm genetic resources and utilization*, **2:** 153-205.

Alemu, Z., & Taye, W. (2020). Survey of date palm (*Phoenix dactylifera* L.) insect pest at afar region of Ethiopia. *International Journal of Agriculture and Biosciences*, **9**(4): 194-198.

Ali, H., Metwally, A., & Basheer, A.M. (2019). Sensitivity of some date palm cultivars to infestation with lesser date moth *Batrachedra amydraula*. *World Journal of Agricultural Sciences*, **15**(5): 310-316.

Alsaedi, G.F. (2022). The infestation percentage and the population density of the lesser date moth, *Batrachedra amydraula* Meyrick (Cosmopterygidae: Lepidoptera) on cultivars date palm trees in Basrah governorate. *Texas Journal of Agriculture and Biological Sciences*, **7**: 25-31.

Alyousuf, A.A. (2022). Integrated management of key insect pests of date palms, *Phoenix dactylifera* L. in Basrah Southern Iraq. *Basrah Journal for Date Palm Research*, ***21***(1): 1-34.

El-Shafei, W.K.M., & Attia, S.A. (2023). Ecological and toxicological studies on date palm scale,

Fioriniaphoenicis Balachowsky (Hemiptera-Diaspididae) infesting three date palm cultivars with reference to anatomical and chemical analysis of palm cultivars leaflets at Giza Governorate, Egypt. *Academic Journal of Entomology,* ***16***(2): 70-83.

Fatima, G., Khan, I.A., & Buerkert, A. (2016). Socio-economic characterisation of date palm (*Phoenix dactylifera* L.) growers and date value chains in Pakistan. *Springerplus,* ***5***(1): 12-22.

Fekry, W.M.E., Rashad, Y.M., Alaraidh, I.A., & Mehany, T. (2022). Exogenous application of melatonin and methyl jasmonate as a pre-harvest treatment enhances growth of barhi date palm trees, prolongs storability, and maintains quality of their fruits under storage conditions, *Plants,* **11**(96): 1-16.

Imadi, S.R., Amir, R., Lodhi, S.S.D., John, P., Kazi, A.M., & Gul, A. (2018). Kernal bunt resistance in synthetic Hexaploid/Bread wheat derivatives. *NUST Journal of Natural Sciences,* **4**(1): 83-99.

Jatoi, F.A., Sahito, H.A., Kousar, T., Mangrio, W.M., & Shah, Z.H. (2020). Biology, morphology and taxonomy of lesser date moth, *Batrachedra amydraula* (Lepidoptera: Batrachedridae) under two different temperatures. *Pure and Applied Biology,* ***9***(1): 1137-1147.

Jatoi, F.A., Sahito, H.A., Mangrio, W.M., & Kousar, T. (2021). Survey and population fluctuation of lesser date moth, *Batrachedra amydraula* (Lepidoptera: Batrachedridae) on prominent Aseel variety of date palm. *International Journal of Biosciences,* **18**(4): 207-215.

Khajehzadeh, Y., & Latifian, M. (2013). Response of different date palm cultivars to lesser date moth (*Batrachedra amydraula* Meyr.) under natural infestation in Behbahan. *Seed and Plant Improvement Journal,* ***29***(2): 311-330.

Khan, D., Shahab-u-din., Lanjar, A.G., Umer, M., Ahmed, N., Mengal, M.A., & Ahmed, S. (2018). Insect pests associated with date palm cultivars at district Kech, Balochistan. *Pure and Applied Biology,* **7**(4): 1177-1185.

Kinawy, M.M., Arissian, M., & Guillon, M. (2015). First field evaluation of mass trapping system for males of the lesser date moth *Batrachedra amydraula* (Meyrick) (Lepidoptera: Batrachedridae) in sultanate of Oman. *International Journal of Agriculture: Research and Review,* **3**(5): 223-232.

Kousar, T., Memon, Z.N., Sahito, H.A., Mangrio, W.M., Jatoi, F.A., & Shah, Z.H. (2020). Biology, morphology, and varietal distribution of saw-toothed grain beetle, *Oryzaephilus surinamensis* (L) on date palm dry and semi-dry dates at district: Khairpur, Sindh-Pakistan. *Pure and Applied Biology,* **10**(3): 539-548.

Kousar. T., Sahito, H.A., Jatt, T., Mangrio, W.M., Mal, B., Mastoi, A.H., Jamali, Y.A., & Jatoi, F.A. (2022). Control strategy of saw-toothed grain beetle, *Oryzaephilus surinamensis* (L. 1758) through a methyl bromide gas fumigation system on date fruits. *Annals of the Romanian Society for Cell Biology,* ***26***(1): 1169-1183.

Kubar, W.A., Sahito, H.A., Kousar, T., Mallah, N.A., Jatoi, F.A., Shah, Z.H., & Mangrio, W.M. (2017). Biology of red palm weevil on different date palm varieties under laboratory conditions. *Innovative Techniques in Agriculture,* **1**(3): 130-140.

Latifian, M., Bagheri, A.N., Amani, M., Naseri, M., Saboki, E., Khademi, R., & Zohdi, H. (2021). Determination of economic injury level of date palm lesser moth, *Batrachedra amydraula* (Lepidoptera: Batrachedridae) on six commercial date cultivars in Iran. *Journal of Entomological Society of Iran,* **40**(4): 371-387.

Mahidi, S.M., & Khalaf, R.H. (2022). The economic loss of the date palm, the Khastawi variety was caused by *Batrachedra amydraula* Meyrick in the Ramadi city. *International Journal of Agricultural and Statistical Sciences,* ***18***: 2315-2320.

Mallah, N.A., Sahito, H.A., Kousar, T., Kubar, W.A., Jatoi, F.A., Shah, Z.H., & Mangrio, W.M. (2017). Varietal analyze of chemical composition moisture ash and sugar of date palm fruits. *Journal of Advanced Botany and Zoology,* **5**(1): 1-5.

Mangrio, W.M., Sahito, H.A., Chandio, N.H., Kousar, T., Shah, Z.H., Khaskheli, N.A., & Jatoi, F.A. (2020). Food and feed consumption of lemon butterfly, *Papilio demoleus* under laboratory conditions. *Pure and Applied Biology,* ***9***(1): 340-351.

Mangrio, W.M., Sahito H.A., Jatoi. F.A., & Sahito. F.I. (2024). Assessment and economic returns of lemons at district Naushahro Feroze, Sindh-Pakistan. *Pakistan Journal of Agricultural Research,* **37**(1): 48-55.

Mangrio, W.M., Jatoi, F.A., H. A. Sahito., F.I. Sahito., B. Mal., & N. Qureshi. (2024). Efficacy of botanical insecticides against, *Batrachedra amydraula* on *Phoenix dactylifera* at field conditions. *Pakistan Journal of Agricultural Research,* **37**(1): 79-87.

Manzoor, M., El-Shafie, H., Shafiq, M., Hamza, A., Rehman, A., Ahmad, J.N., Ali, M., Ahmad, S., Tariq, M.R., & Haider, M.S. (2022). Olfactometer response of red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) and its biology for the evaluation of resistance in the commercially grown date palm *Phoenix dactylifera* L. cultivars in Pakistan. *Journal of Applied Research and Plant Sciences,* ***3***(2): 294-302.

Mattar, M.A., Soliman, S.S., & Al-Obeed, R.S. (2021). Effects of various quantities of three

irrigation water types on yield and fruit quality of 'Succary' date palm. *Agronomy*, **11**(4): 796

Rambabu, K., Bharath, G., Hai, A., Banat, F., Hasan, S.W., Taher., H., & Mohd, Z.H.F. (2020). Nutritional quality and physico-chemical characteristics of selected date fruit varieties of the United Arab Emirates. *Processes*, **8**(3): 256.

Sahito, H.A., Mallah, N.A., Kousar, T., Kubar, W.A., Shah, Z.H., Jatoi, F.A., & Mangrio, W.M. (2017). Life table parameters of saw toothed grain beetle, *Oryzaephilus surinamensis* (L.1758) on different varieties of stored date palm fruits infested under laboratory conditions. *Journal of Entomology and Zoology Studies*, **5**(1): 95-99.

Sahito, H.A., Kubar, W.A., Kousar, T., Mallah, N.A., Jatoi, F.A., Mangrio, W.M., & Ghumro, B.D. (2017). Feeding potentional of red palm weevil, *Rhynchophorus ferrugineus* on different date palm, *Phoenix dactylifera* verities under field conditions. *Current Research in Agricultural Sciences*, **4**(4): 84-90.

Saqib, S., Zaman, W., Ayaz, A., Habib, S., Bahadur, S., Hussain, S., Muhammad, S., & Ullah, F. (2020). Postharvest disease inhibition in fruit by synthesis and characterization of chitosan iron oxide nanoparticles. *Biocatalysis and Agricultural Biotechnology*, ***28*****:** 101729.

Sarraf, M., Jemni, M., Kahramanoglu, I., Artes, F., Shahkoomahally, S., Namsi, A., Ihtisham, M., Brestic, M., Mohammadi, M., & Rastogi, A. (2021). Commercial techniques for preserving date palm (*Phoenix dactylifera*) fruit quality and safety: *A review. Saudi Journal of Biological Sciences*, **28**: 4408-4420.