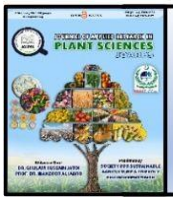
J. Appl. Res Plant Sci. Vol. 4(1), 390-408, 2023, https://doi.org/10.38211/joarps.2023.04.01.49

OPEN ACCESS

Research Article



Available on https://www.joarps.org
Journal of Applied Research in Plant Sciences
(JOARPS)
ISSN: 2708-3004 (Online), 2708-2997 (Print)

Evaluation of Different Insecticides Against Lesser Date Moth, *Batrachedra amydraula* Meyrick, 1916 (Lepidoptera: Batrachedridae) under Field Conditions

Faheem Ahmed Jatoi[1]* and Hakim Ali Sahito[1]

[1]Department of Zoology, Faculty of Natural Sciences, Shah Abdul Latif University, Khairpur Mirs, 66020 Sindh-Pakistan

Corresponding author: E-mail: faheemalda4@gmial.com,

Article Received 28-10-2022, Article Revised 15-11-2022, Article Accepted 02-12-2022

Abstract

In order to determine the toxicity of four reasonable pesticides, including a defence against *Batrachedra amydraula* in field circumstances, a two-year study was conducted in 2017 and 2018. On Aseel cultivars that were fifteen to twenty years old, pesticides were used. The distances between tree-to-tree of date palms were kept at 22sq feet for the integrated pest management spray schedule. All five treatments were replicated three times at a fortnightly interval basis. After application of all insecticides, the result depicted that, (T_1)= Lambda-cyhalothrin, exhibited reduction % in both years as, (69.14±9.44%) and (60.52±8.59%), (T_2)= Boxer, (44.63±8.18%) and (45.46±7.45%), (T_3)= Spinosad, (48.66±8.81%) and (44.10±7.97%), (T_4)= Deltamethrin, (72.85±9.04%) and (59.85±5.82%), according to prescribed as per doses on trunks, leaves, and bunches. Thus, the data was taken as pre-treatment and post-treatment after the 2nd, 5th, 7th, and 10th post-spray days. In all scheduled sprays, the Deltamethrin was found with a maximum reduction % against the lesser date moth and recommended for the abrupt population reduction of the destructive pest species.

Keywords: *Boxer, Deltamethrin, Lesser date moth, Lambda cyhalothrin, Spinosad*

Introduction

The date palm tree is one of the sweetest, full nutrient, and oldest fruit crops in North America and the Middle East, especially in North African countries and Arabian Peninsula, had been cultivated about 7000 years ago (Flower *et al.,* 2019) and have a vital character in commodities of daily life (Sallon *et al.,* 2020). These fruit-bearing oldest trees grow well in different countries around the world in severe environmental conditions (Iubied and Hamzah, 2019). In the cultural heritage of the Arab region, the date palm possesses crucial significance in history being the most ancient, cultivated crop 3300-3100 BC (Paszke, 2019). These fruits originated in Mesopotamia and then spread to different parts of the world (Metwally and Basheer, 2019). These valuable plants best grow in warmer areas, flowering and fruit development require high temperatures ideally cultivated in dry and hot areas, and climate change is expected to reduce its suitable production (Allbed *et al.,* 2017; Shahid *et al.,* 2021; Jallat *et al.,* 2022). The date palm is the most valuable tree in the Middle East and Saudi Arabia, however, the vast majority of its annual production is lost as seeds, dried fruits, and fibrous components (Faiad *et al.,* 2022). Its economic average life is forty to fifty years but some can give production still one hundred and fifty years (Chao and Krueger, 2007). Egypt is the top most date producing country around 1.6 million tons in 2019, while Saudi Arabia ranked 2nd position in date production basis in the world FAOSTAT Statistics Division (2021). Date palms are economically valuable trees used as ornamental trees within urban areas (Ahmed *et al.,* 2022), due to their tolerance capability in drought and salinity conditions (Mattar *et al.,* 2021) and there are differences in the concentrations of the date fruits due to location, date variety, soil, fertilizers, and irrigation water (Perveen and Bokahri, 2020). The date palm dry and semi-dry fruits contain both macro and micronutrients which are playing a pivotal role in the functions of the human body and are rich in vitamins, nutrients, minerals, dietary fibers proteins (Rambabu *et al.,* 2020), and a significant amount of carotenoids, phytosterols and Polyphenols (Mia *et al.,* 2020). Due to their popularity in marketing and sweet taste date fruits have received much attention (Fekry *et al.,* 2022), and are regarded as the ideal healthy food for humans (Al-Shahib and Marshall, 2003). The economy of rural areas and the use of edible plants as a food source play important roles in health improvement (Khan *et al.,* 2022). The vitamins in dates make them a valuable source of food in less developed nations where nutrient deficits are a problem (Shabani *et al.,* 2016b). Because Pakistan is an arid and semi-arid country with favourable climatic conditions, date fruits are cultivated in large

quantities there (Farooqi *et al.,* 2005). However, date palm trees are being severely affected by actinobacteria existing naturally inside the tissues of *P. dactylifera* (Alblooshi *et al.,* 2002). The productivity of date palm fruits is massively exaggerated due to climatic changes (Farooq *et al.,* 2021) and the climatic variation at large scale causing disparity in different varieties of certain plant species (Gebrewahid *et al.,* 2020). The date palm fruits are mainly infested by lesser date moths their larvae feed fruits until the end ripening stage (Ali and Hamma, 2016), and finally, the date fruit becomes dry red and fall (Masoud *et al.,* 2021). In this way, this insect pest reduces the quality and quantity of the fruits (Shaaban *et al.,* 2021). The larvae stages are the most voracious feeder (Jatoi *et al.,* 2020). In Arabian Peninsula and neighboring countries such as; Libya, Iran, Israel, Egypt, and Iraq this pest species is regarded as the most destructive agent to date fruits and their larvae bore inside the fruit, remain attached by releasing the silk-like appearance and eventually and cause considerable yield losses (Al-Yahyai and Khan, 2015). It is critically important to monitor and detect invasive pest species (Sanderson *et al.,* 2012). This insect pest species about forty-five years ago was introduced by Israel but currently, this species of pest is documented In the Middle East, North Africa, Iraq, Saudi Arabia, India, Iran, and Pakistan (Shayeteh *et al.,* 2010). In Egypt, the fruit of the date palm is massively about 30-70% attacked by several pest species (Elrehewy *et al.,* 2020). The wide application of toxic chemicals causes many problems of economic, human health, and environmental problems and also enhances the resistance power in pest insets (Abdel-Samad *et al.,* 2019). The pest insect control strategy through the use of parasitism and predators is still limited (Alrubeai, 2017). Among the biological controlling agent, the Trichogramma species egg parasitism is the most used group of natural enemies, kill the insect pest before crop damage occurs and many crop types, leaf area of the crop, and wind speed factors influence the dispersal of Trichogramma (Hassan *et al.,* 2018). Date fruits have a pivotal role in the economy of Pakistan and district Khaipur Sindh, Pakistan is the main hub of date fruits production but these valuable fruits are massively infested by the potential pest the *Batrachedra amydraula* (Jatoi *et al.,* 2019). Keeping this in view, the research study was conducted for proper findings to share the stack holder of the date palm keeping orchards of the vicinity of Queen date palm district Khairpur, Sindh.

Materials and Methods

Use of rational insecticides under field conditions: The field-based research work was performed for the management of the population of *Batrachedra amydraula* and the insecticidal efficacy of different insecticides was kept under observation. About ten to fifteen years old date palm trees were kept for insecticide application at Abdul Khalique Jatoi date palm orchards that were located at union council Mohil, Taluka, Kingri, District, Khairpur from, 2017-18. Through the application of different doses of insecticide, the reduction percentage of the pest was observed. The most recognized and economically valuable date palm variety the "Aseel" was kept under observation. This variety of the date palm is commonly cultivated in rows manner but the data was taken (RBCD) and each Aseel date palm plant has 22 sq feet of treatment size. Hence, the short life of the pest in the five treatments was replicated four times, and each spray was done at a fortnightly interval basis after the first emergence of the insect pest. In the present research study; four insecticides including control such as; (T_1) = Lambda-cyhalothrin (Karate®, Syngenta) (T_2) = Boxer™, active ingredient Emamectin Benzoate (T_3) = Spinosad, a Natural pesticide (T_4) = Deltamethrin, synthetic pyrethroid and (T_5) = Control were used against the population of lesser date moth at field conditions. At the rate of five to eight liters of water with the emulsifying recommended dose of insecticides the date palm was washed throughout such as; tree trunk, bunch, and size of per date palm Aseel tree. After the application of insecticides, the samples of each bunch from east, west, north, and south per tree sides of the observation were kept in every bioassay. Twenty damaged and undamaged branches were examined from each bunch and the percentage of infestation from each tree was evaluated. Before one day of pre-treatment, the data was taken and then after post-spray, the data of pest population was evaluated on the 2nd, 5th, 7th, and 10th days and also again on 14th day after the spray completion the data was taken as pre-treatment. After the collection of data was entered in MS, excel spreadsheet to form the graph and tabulations, later on, to obtain standard errors, means, and obtained frequencies data was exported into statistical software. The analysis of variance and mean value compared through least significant differences at ($P<0.01$). In the 8.1 USA version, SWX statistical software was used for means evaluation and Schender and Orilla formula was used for the reduction percent population of the pest.

Results

Lesser date moth population reduction percentage after 1st spray: For the purpose to examine the toxicant efficacy of four different insecticides field trials were examined against lesser date moth during, 2017. In 1st spray the Limbda showed (82.09±9.72) reduction % after the 2nd day (88.03±10.59) on the 5th day (80.24±14.12) 7th days and (79.46±8.56%) 10th day. Boxer at (96.22±10.92) 2nd day (63.81±10.55) 5th day (24.23±6.12) 7th days and (18.46±4.56) 10th days. Spinosad shows (88.31±12.83) 2nd day (9.53±2.55) 5th day (44.23±6.83) 7th day (70.112±10.56) reduction %

after 10th days. Deltamethrin recorded at (93.03±9.92) 2nd day (78.67±10.55) 5th day (92.33±12.12) 7th day (95.30±11.10) reduction % after the 10th day, respectively. The mean efficacy of Deltamethrin and Lambda insecticides was found more effective compared to Spinosad and Boxer. When the data was subjected to the analysis found with a significant differences at (DF= 3; F= 272.01; P= 0.01), (DF= 3; F= 2517.03; P= 0.02), (DF= 3; F= 477.00; P= 0.03), and (DF= 3; F= 212.05; P= 0.04) in Lambda, Boxer, Spinosad, and Deltamethrin, respectively. The reduction percentage of the pest insects was found high on the 2nd day followed by the 5th, 7th, and 10th days. The small letters show a statistical difference at (P<0.05) in one-way ANOVA, in time intervals among the treatment and capital letters in toxicity of insecticides as shown in (Fig. 1).

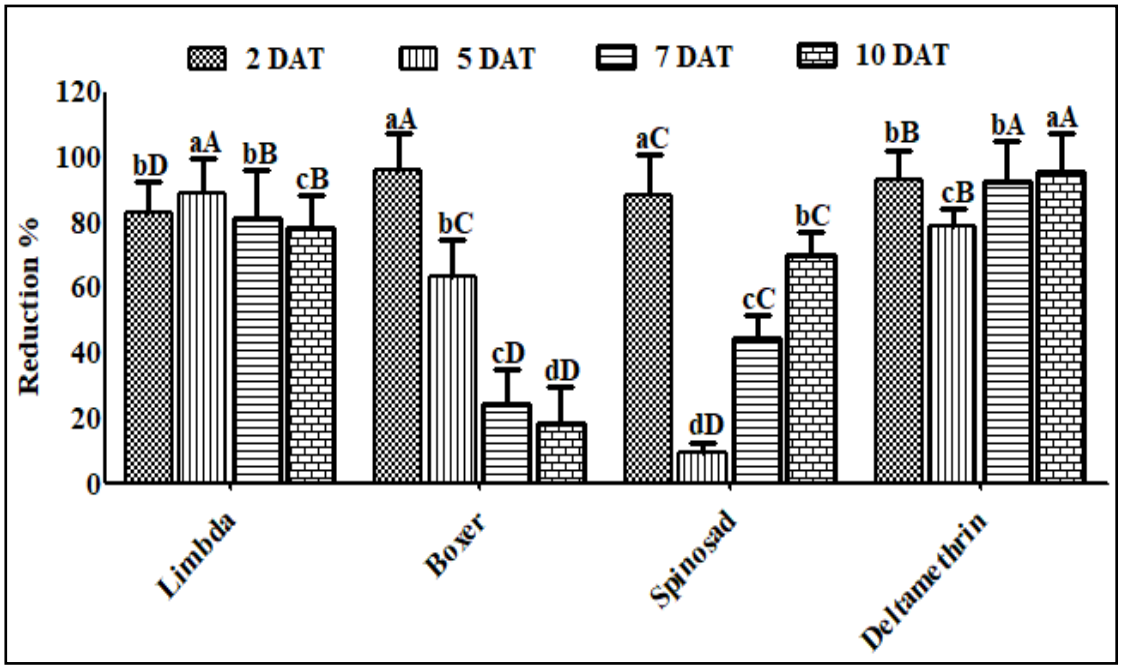


Fig. 1. The reduction % of the LDM larvae after 1st spray application of four different insecticides during, 2017

Lesser date moth population reduction percentage after 2nd spray: In 2nd spray, the Limbda was found at (72.13±9.52) 2nd-day reduction % (80.95±10.27) 5th day (75.23±13.33) 7th day and (55.42±9.68) after 10th days larvae of LDM. Boxer (83.35±22.20) % on the 2nd day, (54.68±112.15) 5th day, (27.03±4.22) 7th day, and (22.58±3.96) on the 10th day. The larvae reduction % recorded at (52.47±7.83) on the 2nd day, (66.68±9.30) on the 5th day, (46.79±6.21) on the 7th day, and (37.18±6.56) on the 10th day after the application of Spinosad. Deltamethrin showed (83.05±10.42) 2nd the day, (78.07±8.25) on 5th day, (73.43±7.14) on the 7th day, and (66.30±10.56) against larvae reduction of LDM. The Deltamethrin and Lambda were found with maximum pest larvae reduction followed by Spinosad and Boxer. The ANOVA found with a significant difference among the day's intervals in Lambda, Boxer, Spinosad, and Deltamethrin at (DF= 3; F= 274.26; P; 0.02), (DF= 3; F= 2367.94; P= 0.01), (DF= 3; F= 454.84; P= 0.04) and (DF= 3; F= 183.52; P= 0.03), respectively. In 2nd spray, insecticides were found with a maximum reduction % on the 2nd day followed by the 5th, 7th, and 10th days. The capital letters show a significant difference in the toxicant effect of insecticides and small letters in time intervals at (P<0.05), Tukeys test after compiling of way ANOVA, as shown in (Fig. 2).

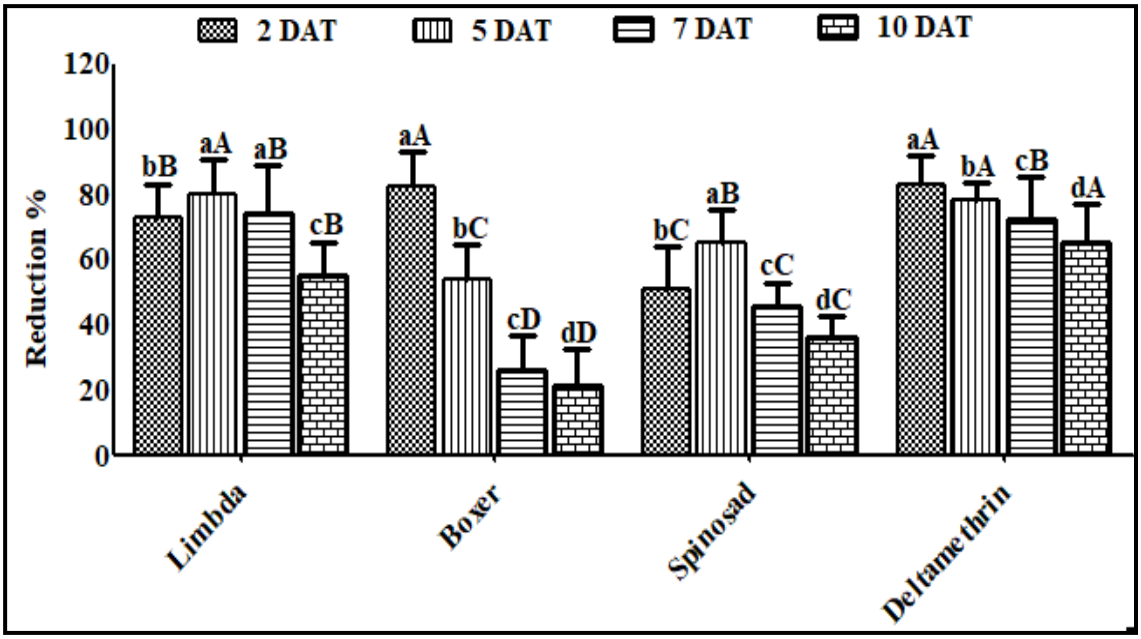


Fig. 2. The reduction % of LDM larvae after 2nd spray application of four different insecticides during, 2017

Lesser date moth population reduction percentage after 3rd spray: In 3rd spray, Lambda was found with a population reduction % at (64.12±9.46) on 2nd the day, (70.85±10.61) on the 5th day, (56.91±8.72) 7th day, and (38.46±5.75) 10th day against larvae on the population of the pest. Boxer (63.21±11.36) 2nd day, (44.04±5.19) 5th day, (37.01±5.69) 7th day, and (20.46±4.10) 10th day. Spinosad (51.31±12.33) 2nd day, (59.53±6.74) 5th day, (42.81±6.83) 7th day, and (27.24±4.40) 10th days. Deltamethrin (64.10±8.14) 2nd day, (75.10±9.26) 5th day, (53.33±9.88) 7th day, and (40.97±7.54) 10th day, respectively. The Deltamethrin and Lambda were recorded with more efficacy compared to Spinosad, and Boxer in 3rd spray. The analysis of variance found with significant difference such as; Lambda at (DF= 3; F= 625.01; P= 0.04), Boxer (DF= 3; F= 1116.35; P= 0.01), Spinosad (DF= 3; F= 609.04; P= 0.02) and Deltamethrin (DF= 3; F= 658.02; P= 0.03) among the treatments in time intervals. In the 3rd spray, the maximum reduction % was recorded 5th day followed 2nd, 7th, and 10th days of the post-spray. The small letters show the significant difference in time intervals and capital letters significant difference in the toxicant effect of the insecticides at P<0.05, Tukeys test after one-way ANOVA, the further justification given in (Fig. 3)

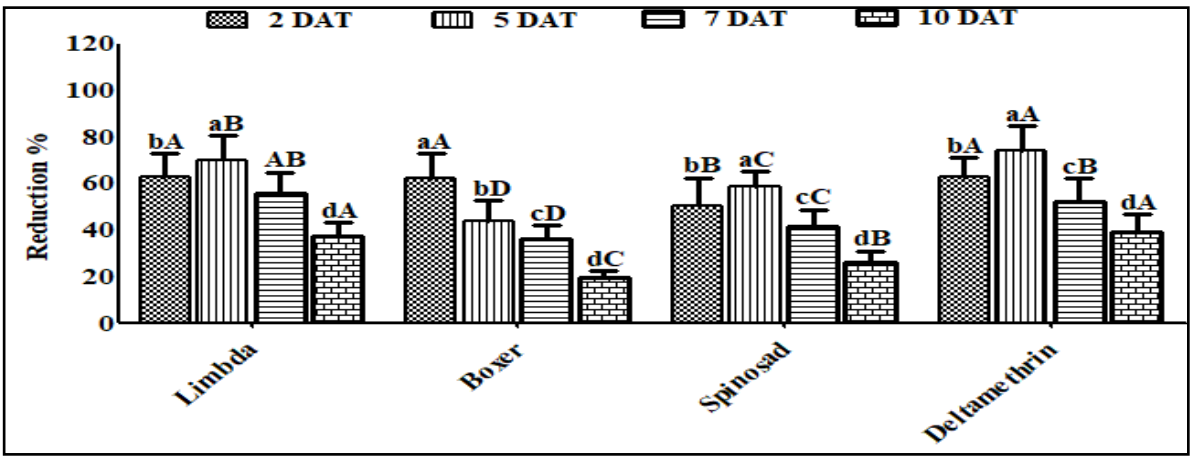


Fig. 3. The reduction % of LDM larvae after 3rd spray application of four different insecticides during, 2017

Larvae population reduction % of LDM after 1st spray: The field trials of the same chemical insecticides, Limbda, Boxer, Spinosad, and Deltamethrin were used against the larvae of LDM on date palm orchards in district Khairpur Mirs, Sindh, 2018. The data of the insect pest population was recorded 2nd, 5th, 7th, and 10th days of the post-spray. In 1st spray of the Lambda insecticide, the pest population reduction % was recorded at (52.14±8.63) on 2nd the day, (70.95±8.37) on the 5th day, (82.44±14.72) 7th day and (69.48±9.72) 10th day against LDM. Boxer (37.23±6.32) 2nd day, (54.88±8.25) 5th day, (66.04±12.62) and (46.58±7.95). Spinosad (49.34±7.44) 2nd day, (44.47±6.68) 5th day, (50.68±6.79) 7th day, and (39.68±7.25) 10th day. Deltamethrin (55.91±8.62) 2nd day, (59.07±7.85) 5th day, (73.61±11.42) 10th day, respectively. The Deltamethrin and Lambda insecticides were found with maximum toxicant power against the larvae population compared to Boxer and Spinosad. When the data was statistical analysis found significant differences in Lambda at (DF= 3; F= 464.18.; P= 0.02), Boxer (DF= 3; F= 444.63; P= 0.04), Spinosad (DF= 3; F= 83.71; P= 0.01) and Deltamethrin (DF= 3; F= 405.03; P= 0.02) among the insecticide time intervals. In 1st spray maximum reduction was observed after the 5th day followed 2nd, 7th and 10th days. The small letters indicate the statistical difference at P<0.05, in one way ANOVA in the time intervals and capital letters toxicities among the insecticides as justified in (Fig. 4)

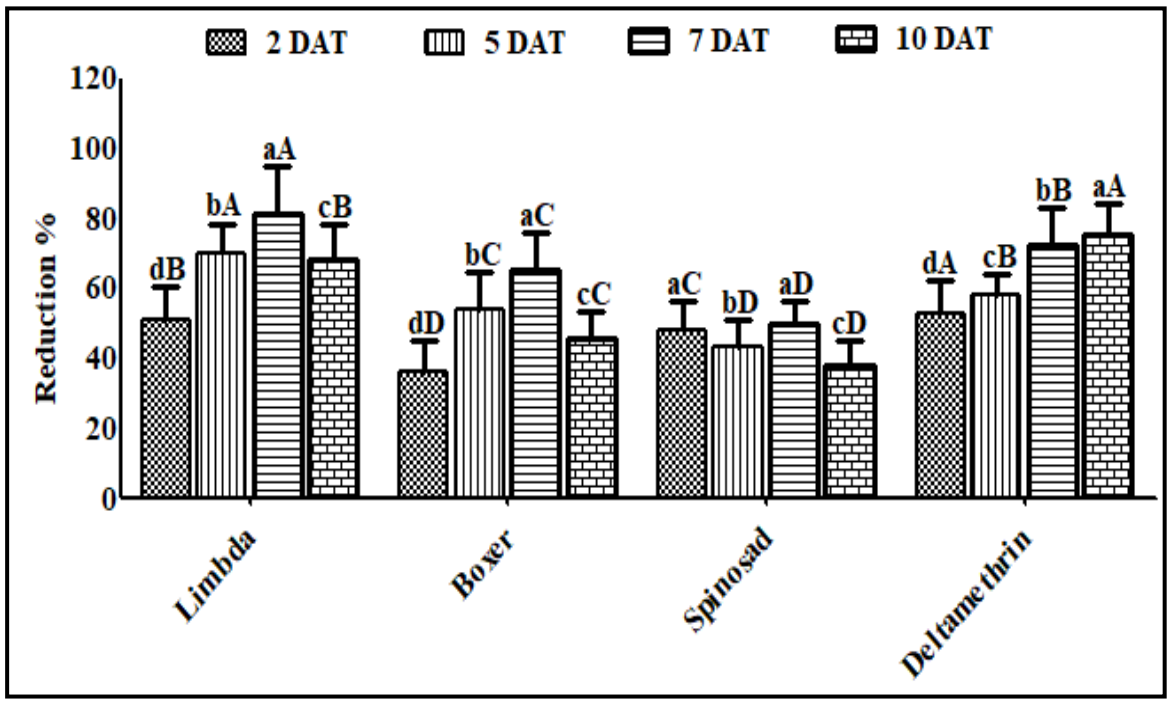
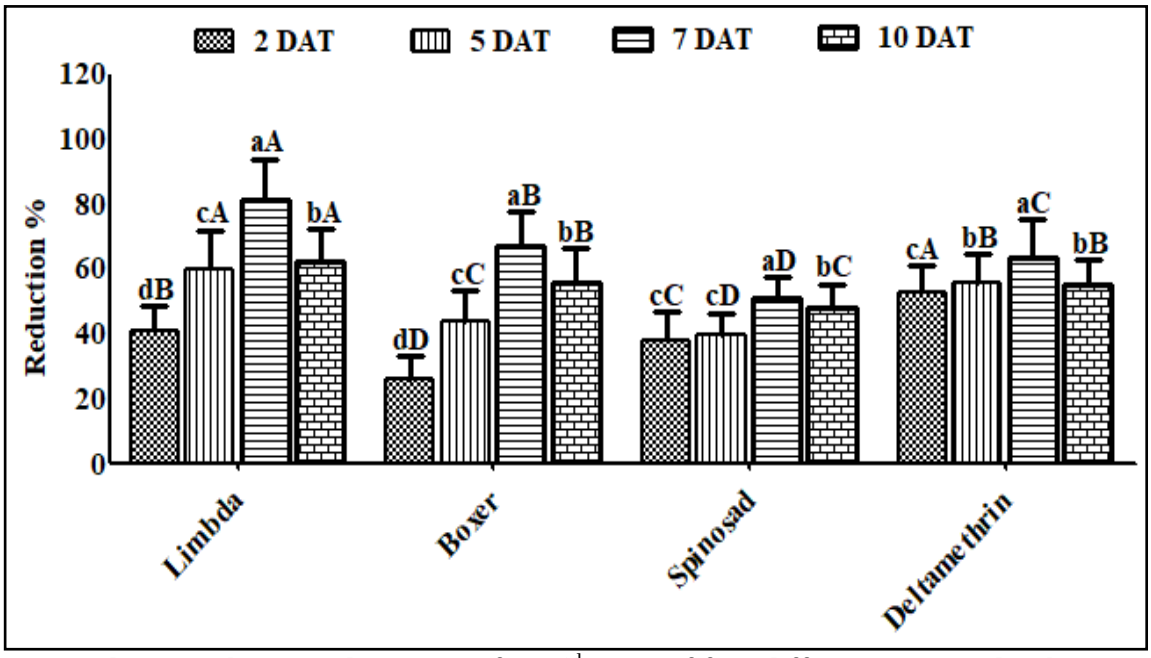


Fig. 4. The LDM larvae reduction % after 1st spray of four different insecticides during, 2018

Larvae population reduction % of LDM after 2nd spray: In 2nd spray, the population reduction % was recorded at (42.12±7.62) on 2nd the day, (58.57±7.79) on the 5th day, (80.57±12.35) on the 7th day, and (63.25±11.85) on the 10th day after the application of Lambda in 2nd spray. Boxer (27.79±5.30) on the 2nd day, (44.81±6.64) 5th day, (68.03±11.76) 7th day, and (56.28±8.35) 10th day. Spinosad (39.31±8.46) 2nd day, (40.81±6.44) 5th day, (51.57±5.67) 7th day, and (49.76±8.69) 10th day and Deltamethrin (55.46±6.67) 2nd day, (57.07±8.35) 5th day, (61.37±12.66) 7th day and (56.58±12.35) 10th day, respectively. The maximum larvae reduction % was recorded by the application of Deltamethrin and Lambda compared to Spinosad and Boxer. When the data were subjected to the analysis found with a significant difference in Lambda at (DF= 3; F= 844.04; P= 0.04), Boxer (DF= 3; F= 449.59; P= 0.01) Spinosad (DF= 3; F= 156.01; P= 0.01) and Deltamethrin (DF= 3; F= 157.02; P= 0.02) among the treatments. The population reduction % revealed high after the 7th day followed 2nd, 5th, and 10th days among four different insecticides during the 2nd spray. The capital letters represent a significant difference at P<0.05, the Tukeys test through one-way ANOVA in their toxicity power, and small letters indicate the difference in post-spray time intervals in a population reduction of LDM as described in (Fig. 5).



Fi4. 5. The LDM larvae reduction % after 2nd spray of four different insecticides during, 2018

Larvae population reduction % of LDM after 3rd spray: Similarly, in 3rd spray **a**fter the application of Lambda insecticide the reduction % of the pest population was recorded (37.12±5.73) on 2nd the day, (50.94±11.60) on 5th day, (70.23±12.56) 7th day and (64.45±12.36) 10th day in 3rd spray. Boxer (24.20±4.58) 2nd day, (39.78±7.77) 5th day, (48.02±8.68) 7th day, and (56.57±9.87) 10th day. Spinosad (40.56±5.67) 2nd day, (45.52±5.69) 5th day, (51.78±7.83) 7th day, and (49.17±7.54) 10th day and Deltamethrin (44.08±7.68) 2nd day, (50.07±9.67) 5th day, (65.30±11.55) 7th day and (65.30±14.57) 10th day, respectively. The Deltamethrin and Lambda insecticides were found most effective compared to Spinosad and Boxer against the larvae of LDM. The analysis of variance among different treatments in their toxicities and time intervals found significant difference Lambda at (DF= 3; F= 872.02; P= 0.01), Boxer (DF= 3; F= 585.01; P= 0.04), Spinosad (DF= 3; F= 67.30; P= 0.02) and Deltamethrin (DF= 3; F= 462.02; P= 0.03) among the different insecticides. Further data revealed that in all treatments the maximum reduction was reported after the 7th day followed 2nd, 5th, and 10th days in the 3rd spray, respectively. The small letters show a time interval statistical difference at P< 0.05, through the Tukeys test in one-way ANOVA within the treatments. However, capital letters insecticide effectiveness against pest population is further justified in (Fig. 6).

.

Two years overall pool data of larvae reduction % of LDM: After the application of four different insecticides at various date palm orchards of district Khairpur Mirs the pool data of the larvae of LDM was taken for the purpose to examine the reduction % and insecticides toxicant efficacy during 2017-18. The overall larvae reduction % was calculated after the application of Lambda (69.14±9.44) and (60.52±8.59) in both years of the study. Boxer (44.63±8.18) and (45.46±7.45), Spinosad (48.66±8.81) and (44.10±7.97), Deltamethrin (72.85±9.04) and (59.85±5.82), respectively. The Deltamethrin and Lambda exhibited maximum effectiveness compared with Spinosad and Boxer. The analysis of variance found a significant difference at P< 0.05 among the pool data after the application of four different insecticides in both years, Lambda at (DF= 1; F= 689.02; P= 0.03), Boxer (DF= 1; 24.59; P= 0.01), Spinosad (DF= 1; F= 228.07; P= 0.05), respectively. Furthermore, overall pooled data found with significant difference (DF= 3; F= 668.04; P= 0.03) and (DF= 3; F= 209.09; P= 0.04) between the insecticides in both years at P< 0.05. The capital letters indicate significant differences in insecticide toxicity power and small letters significant differences in time interval reduction % of pest population as shown in (Fig. 7)

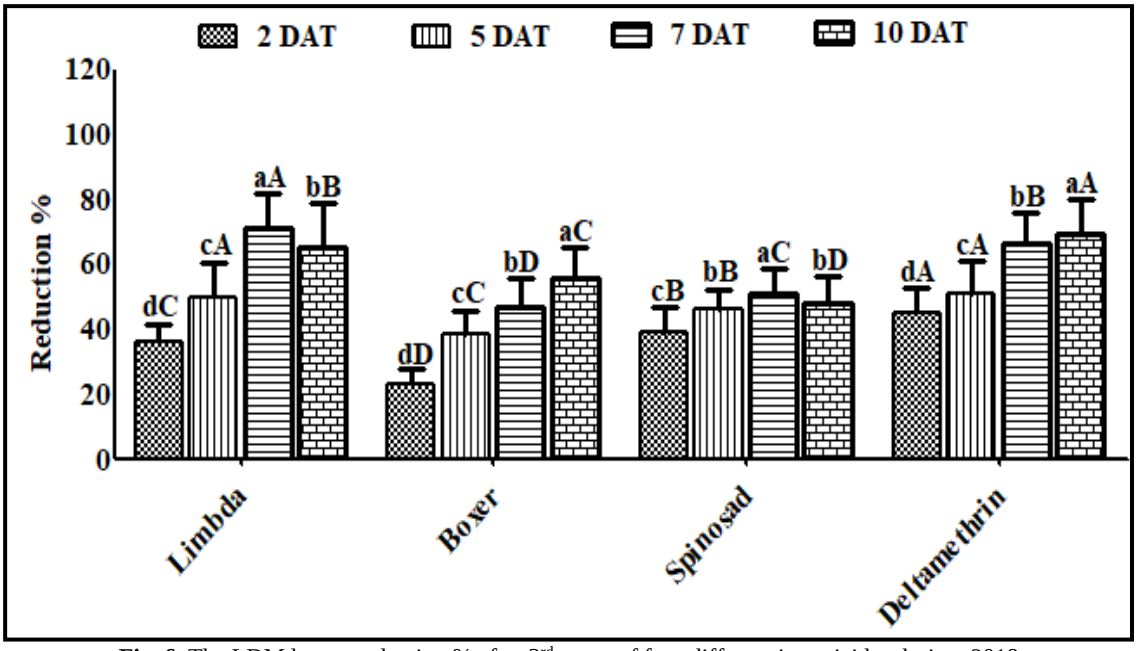


Fig. 6. The LDM larvae reduction % after 3rd spray of four different insecticides during, 2018

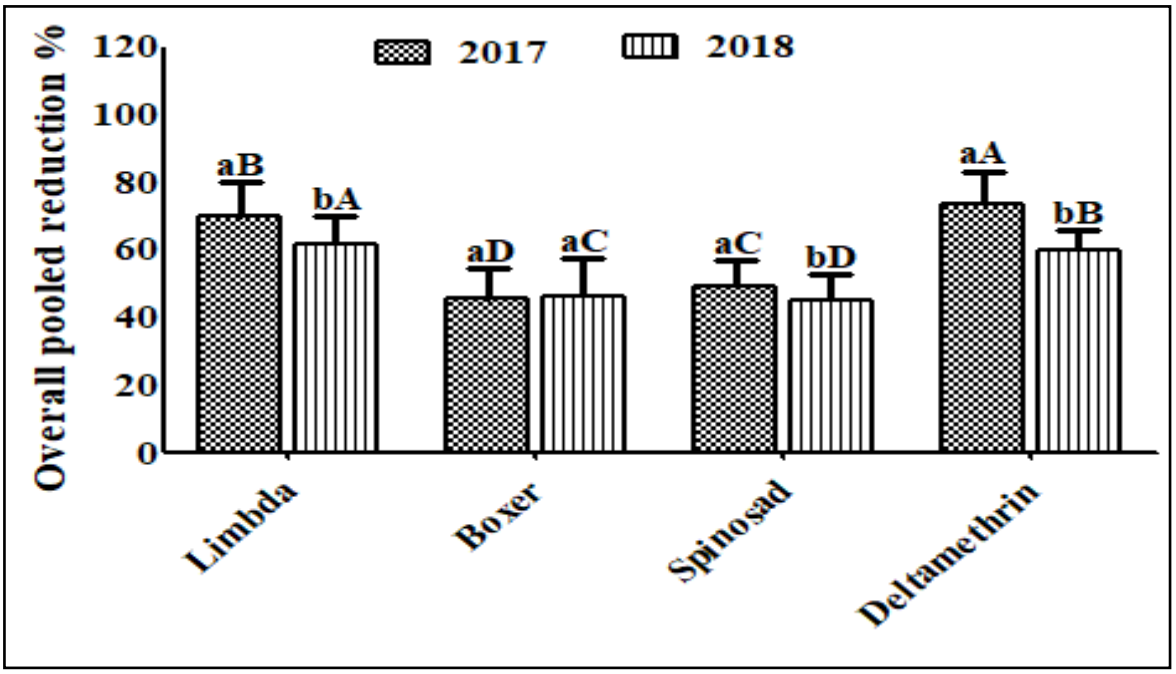


Fig. 7. Overall pool data of LDM larvae reduction % after the application of four different insecticides during, 2017-18

Discussion

District Khairpur Mirs in Pakistan is recognized as the primary center and environmentally favorable area for date cultivation with notable date palm varieties. This queen crop is consistently harmed by several pest species, but primarily by *Batrachedra amydraula* larval infestation. As described (Abul-Soad and Mahdi, 2010) that *Oryctes rhinoceros*, *Arenipes saabella*, *Rhynchophorus ferrugineus*, *Leucinodes orbonalis*, Scales, mites, and *Batrachedra amydraula* cause up to date fruit 75% loss. Nowadays, *Batrachedra amydraula* is one of the most exciting factors depressing date production causing yield losses, economic threats, and attaining high costs for their management. In the present research study, four different insecticides were applied against pest population reduction % larvae of LDM under field conditions. During the first year of the study in the first spray maximum larvae reduction % was caused by the application of Deltamethrin this is the work agreement of (Adnan *et al.*, 1989) who applied three insecticides and found fenitrothion and chlorpyrifos most effective compared to pirimiphos-methyl against the larvae of LDM. In a second spray of the first year, Deltamethrin proved to best larvae reduction on different days. In the third spray of the

first year, Deltamethrin with more toxicity power compared with Lambda, Boxer, and Spinosad. Melanie *et al.,* (2015) same findings reported that Lambda-cyhalothrin caused more than 50% of the larvae population of LDM. In the first spray of the second year the maximum pest population reduction % was recorded by the application of Lambda this is with the similar work of (Arthurs *et al.,* 2007) documented nearly 74% in *Cydia pomonella* population reduction. In the second spray, the pest population reduction % was counted by the application of Lambda, Massimo *et al.,* (2008) reported a 67% population reduction of *Ostrinia nubilalis* through the application of pyrethroid insecticides. In the third spray, Deltamethrin and Lambda were found effective on the pest population. Our results are more or less comparable with the published work of (Addisu *et al.,* 2022) they tested dimethoate, malathion, Lambda-cyhalothrin, Alpha-cypermethrin, diazinon and deltamethrin against *Spodoptera fugiperda* and all insecticides found most effective against the pest population and (Zienab *et al.,* 2022) evaluated the tree of date palm consumption. Throughout the sprays, in both years Deltamethrin and Lambda found with maximum efficacy against LDM but the wide application of insecticides enhance the resistance power in pesticides. The exploitation of biological controlling agents and biosynthetic control measures are the best protective measures.

Conclusion

To combat the larvae population of the lesser date moth, all tested insecticides, Lambda, Boxer, Spinosad, and Deltamethrin insecticide were found effective to manage the pest population reduction % of LDM. The Deltamethrin and Lambda proved with maximum efficacy power compared to Boxer and Spinosad. Under the IPM program, these mentioned insecticides are with an important role but further research has been needed to test the LDM population.

Recommendations

It is recommended that the agri-ecosystem of this area is enriched with natural enemies these biological controlling agents should be enhanced through the help of IPM fruitful strategies. This type of scientific documentary will be an informative tool for date palm growers in this area because there is a big gap in awareness regarding this potential pest. It is further suggested the pruning of date palm old branches and fallen fruits of the dates should be removed and with light clothes and mass trapping new bunches should be covered again for better management and eco-friendly techniques that should be applied against this destructive pest.

Authors contributions

The experiments designated and conceived: FA Jatoi & HA Sahito. Experiments conducted: FA Jatoi. Data analyzed: FA Jatoi & HA Sahito. Contributed materials and materials: FA Jatoi & HA Sahito. Paper wrote: FA Jatoi.

Impact statement

The majority of the local people of this area have engaged in this crop and regarded it as a pivotal source of their live hood. Unfortunately, date palm growers cannot particularly recognize this potential pest attacking date palm crops from inflorescences up to maturity and continuously facing economic losses. In this scenario, it is an immediate call to manage the LDM population through eco-friendly control measures to secure the quality and quantity of the date fruits.

Conflict of interest

There is no potential conflict of interest was reported by the authors.

Acknowledgments

The corresponding author would like to thank the team of DPRI, SALU - Khairpur for technical assistance with date palm orchards located at field conditions. The author extends thanks to all date palm growers of district Khairpur who helped when there was any need.

Funding

The authors did not receive any funding for this article.

Availability of data and materials

Due to some restrictions and ethical privacy, the data and findings of this paper are available at the corresponding author's request.

Consent for publication

The releasing material of this paper's corresponding author accepts all responsibilities.

References

Abdel-Samad SSM, Adel H & Abbas MK (2019). A new strategy for controlling three devastating pests attacking date plantations in El Bahariya and Siwa oases, Egypt through using a special group of natural enemies. *Egypt J of Agr Res* 97(1): 365-382.

Abul-Soad AA & Mahdi SM (2010). Commercial production of tissue culture date palm *P. dactylifera* L. by inflorescence technique. *J of Gen Eng and Bio* 8(2): 39-44.

Addisu S, Mulugeta N, Thangavel S & Amsalu A (2022). Determination of most effective insecticides against maize fall armyworm, *S. frugiperda* in South Western Ethiopia. *Cogt Food and Agri* 8: 2079210.

Adnan IS, Emad H, Khloud AM & Mabrouk AB (1989). The chemical control of the lesser date moth, *B. amydraula* Myer, and residue levels of organophosphate insecticides in dates. *Pes Man Sci* 25(3): 227-230.

Aisha AA, Gouthaman PP, Esam ES, Gaber AR, Saeed T, Amna SA, Khaled AT & Synan FQ (2022). Biocontrol potential of endophytic Actinobacteria against *Fusarium solani*, the

causal agent of sudden decline syndrome on date palm in the UAE. *J of funji* 8(8): 1.24.

Ali AA & Hamma NN (2016). Integrated management for major date palm pests in Iraq. *J of Food and Agri* 28(1): 24-33.

Ali DS, Mohammed HM, Abbas DS & Hussein AH (2021). Effect of interaction between pheromone traps and plant seeds of harmal, *P. harmala*, on lesser date moth, *B. amydraula* (Merck), in Basra Province. *IOP Con Ser Ear and Env Sci* 735(012025): 1-8

Allbed A, Kumar L & Shabani F (2017). Climate change impacts on date palm cultivation in Saudi Arabia. *J Agric Sci* 155: 1203-1218.

Alrubeai HF (2017). Biological control of insect pests in Iraq. An overview of parasitoids and predators research development. *Aca J of Ent* 10(2): 10-18.

Al-Shahib W & Marshall R (2003). The fruit of the date palm. It's possible use as the best food for the future. *Int J Food Sci Nutr* 54: 247-259.

Al-Yahyai R, Khan MM (2015). Date palm status and perspective in Oman. Date palm genetic resources and utilization. *Spr Netherlands* 2: 207-240.

Arthurs PS, Lawrence AL & Eugene RM (2007). Codling moth control and impact on non-target species in pear orchards. *Bio Con* 41: 99-109.

Chao CCT & Krueger RR (2007). The date palm (*Phoenix dactylifera* L.). Overview of biology, uses, and cultivation. *Hort Sci* 42: 1077-1082.

Eman SE, Nagy N & Heba MSEl-B (2020). The efficiency of the parasitoid, *Trichogramma* sp. against some date pests. *Egypt Aca J Bio Sci* 12(2): 269-275.

Faiad A, Alsmari M, Ahmed MMZ, Bouazizi ML, Alzahrani B & Alrobei H (2022). Date palm tree waste recycling. Treatment and processing for potential engineering applications. *Sustain* 14: 1134.

FAOSTAT Statistics Division (2021). Available online: http://www.fao.org/faostat/en/#data/QC(accessed on 16 October 2021).

Farooqi AB, Khan AH & Mir H (2005). Climate change perspective in Pakistan. *Pak J Met* 2(3): 11-21.

Fekry WME, Rashad YM, Alaraidh IA & 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.

Flower JM, Hazzouri KM, Gross-Balthzard MZ, Koutroumpa MK, Perrakis A, Ferrand S, Khierallah HS, Fuller DQ, Aberlenc F, Fournaraki C & Purugganan MD (2019). Cross-species hybridization and the origin of North African date palms. *Pro of the Nat Aca of Sci* 116(5): 1651-1658.

Gebrewahid Y, Abrehe S, Meresa E, Eyasu G, Abay K, Gebreab G, Kidanemariam K, Adissu G, Abreha G & Darcha G (2020). Current and future predicting potential areas of *O. abyssinica* (A. Richard) using MaxEnt model under climate change in Northern Ethiopia. *Ecol Proce* 9(6): 1-15.

Hassan KA, Hashim SM, Mostafa IMY, Sanad AS & Abdel-Hameid NF (2018). Assessment of dispersal and parasitism of the laboratory reared *T. evanescens* under field conditions. *J of Plant Pro and Pat* 9(5): 297-299.

Iubied, IA & Hamzah HA (2019). Effect of pollen grains and growth regulators on some fruit characterization of date palm *P. dactylifera* L. cultivar, Sultani. *AlQadisiyah J for Agr Sci* 9(1): 136-142.

Jallat K, Kaynat S, Sumreen A, Ahmad K, Sarfraz A, Awais Qr, Muhammad IT, Farhan AK, Nusrat S & Muther MQ (2022). Cultural and scio-economic perspective of some promising edible plants from Northern Pakistan. In: Masoodi MH & Rehman MU (eds) *Springer, Singapore* 1: 77-105. http://doi.org/10.1007/978-981-4880-9-4

Jatoi FA, Sahito HA, Kousar T & Mangrio WM (2020). Biology, morphology and taxonomy of lesser date moth, *B. amydraula* (Lepidoptera: Batrachedridae) under two different temperatures. *Pur and App Bio* 9(1): 1137-1147.

Jatoi FA, Sahito HA, Mangrio WM & Kousar T (2021). Survey and population fluctuation of lesser date moth, *B. amydraula* Meyrick (Lepidoptera: Batrachedridae) on prominent Aseel variety of date palm. *Int J of Bio* 18(4): 207-215.

Latifian M, Bagheri A, Amani M, Naseri M, Saboki E, Khademi R, & Zohdi H (2021). Determination of economic injury level of date palm lesser date moth, *B. amydraula* (Lepidoptera: Batrachedridae) on six commercial date cultivars in Iran. *J Ent Soc of Iran* 40(4): 371.383.

Massimo B, Amedeo R, Francesca V, Michelangelo P, Miriam H & Marco S (2008). Effect of sowing date and insecticide application against European corn borer (Lepidoptera: Crambidae) on fumonisin contamination in maize kernels. *Crop Prot* 27: 1432-1436.

Mattar MA, Soliman SS & Al-Obeed RS (2021). Effects of various quantities of three irrigation water types on yield and fruit quality of 'Succary' date palm. *Agronomy* 11(4): 796.

Melanie H, Annalena S, Juliane S, Lea AF & Carsten AB (2015). The effects of agrochemicals on

Lepidoptera, with a focus on moths, and their pollination service in field margin habitats. *Agr Eco and Env* 207: 153-162.

Metwally HAA & Basheer AM (2019). Sensitivity of some date palm cultivars to infestation with lesser date moth *B. amydraula*. *Wor J Agr Sci* 15(5): 310-316.

Mia MA, Mosaib MG, Khalil MI, Islam MA & Gan SH (2020). Potentials and safety of date palm fruit against diabetes. A critical review. *Foods* 9(1557): 1-21.

Paszke MZ (2019). Date palm and date palm inflorescences in the late uruk period (C. 3300 B.C.). *Bot and archaic script*. Iraq 81: 221-239.

Perveen K & Bokahri NA (2020). Comparative analysis of chemical, mineral and in-vitro antibacterial activity of different varieties of date fruits from Saudi Arabia. *Saudi J Bio Sci* 27(7): 1886-1891.

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

Sallon S, Cherif E, Chabrillange N, Solowey E, Gros-Balthazard M, Ivorra S & Aberlenc F (2020). Origins and insights into the historic Judean date palm based on genetic analysis of germinated ancient seeds and morphometric studies. *Plant Sci* 6(6):1-10.

Sanderson LA, McLaughlin JA & Antunes PM (2012). The last great forest: A review of the status of invasive species in the North American boreal forest. *Fores* 85: 329-339.

Shabani F, Kumar L, Nojoumian AH, Esmaeili A & Toghyani M (2016b). Projected future distribution of date palm and its potential use in alleviating micronutrient deficiency. *J Sci Food Agr* 96: 1132-1140.

Shahid F, Muhammad MM, Muhammad AB, Muhammad IU, Rahmat US, Hayssam MA, Dunia AF, Mohamed SE, Ashraf AH, Saqib B & Yong-Feng W (2021). Production suitability of date palm under changing climate in a semi-arid region predicted by climex model. *J of King Saud Uni Sci* 33: 101394.

Shayesteh N, Marouf A & Amir-Maafi M (2010). Some biological characteristics of the *B. amydraula* Meyrick (Lepidoptera: Batrachedridae) on main varieties of dry and semi-dry date palm of Iran. *10th Inter Wor Con on Sto Pro Pro Julius-Kühn Archiv* 425: 151-155.

Zienab FRA, Navjot K & Fatima EH (2022). Ornamental date palm and Sidr trees Fruit elements composition and concerns regarding consumption. *Inter J of Fru Sci* 22(1): 17-34.