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Seasonal Population Dynamics of Red Palm Weevil (Rhynchophorus ferrugineus Olivier) in Relation to Climatic Factors and Date Palm Varietal Susceptibility in Panjgur, Balochistan, Pakistan

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Abstract

The red palm weevil (Rhynchophorus ferrugineus Olivier) is a serious pest of date palm (Phoenix dactylifera L.) worldwide and has become a major threat to date growers in the Makeran Division, Balochistan, especially in the Panjgur district. This study monitored RPW population dynamics and seasonal activity over 26 weeks (April–September 2025) in the district of Panjgur, using pheromone-baited plastic bucket traps. Weekly adult counts, sex ratio, and climatic data (temperature and relative humidity) were recorded. RPW adults were present throughout the observation period, showing two population peaks: an early-season peak and a late peak around weeks 24–26, with the lowest activity recorded at week 18. Mean adult catches were 7.65 ± 0.38 weevils per trap. Females were captured in greater numbers, 4.60 ± 0.25, than males, 3.04 ± 0.15, weevils per trap, indicating strong pheromone attraction. The mean temperature in district Panjgur was 27.25 ± 0.36°C, and the mean relative humidity was 26.73 ± 0.49%. Variety-wise infestation showed the Mozawati with the highest infestation, 11.33 ± 1.33, and Shakar with 6.67 ± 0.66. The infestation rate of RPW adults and larvae varies in different sample varieties; the average adult catches in all varieties were 3.02 ± 0.35, and the mean larval catches were 4.16 ± 0.44. These results suggest that pheromone trapping, combined with other control measures and timed to climatic windows, can improve sustainable RPW management and date palm production in Makeran Division.

Keywords: Rhynchophorus ferrugineus; date palm; population dynamics; pheromone trapping; temperature; varietal susceptibility

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Introduction

The red palm weevil (RPW), Rhynchophorus ferrugineus (Coleoptera: Curculionidae), is a globally invasive pest of palms. First described by Olivier in 1790, it initially attacked coconut palms. (Lefroy 1906) and later date palms (Brand 1917). By the mid-1980s, RPW had spread to the Middle East, facilitated by the movement of infected planting materials. (Faleiro et al. 2012, Guerri-Agullo et al. 2010). Since then, it has rapidly expanded across Asia, Africa, Europe, and the Americas. (Al-Ajlan 2008, Giblin-Davis et al. 2013). Due to its destructive potential, FAO considers RPW a major threat to food security and has emphasized international cooperation for its management. (El-Shafie and Faleiro 2020, FAO. 2017). RPW attacks nearly 30 palm species worldwide, causing substantial economic losses (Faleiro and Ashok 2008, Hoddle, M.S. et al. 2024). Its larvae tunnel inside palm trunks, making early detection difficult and complicating control efforts.(El-Juhany 2010, Wakil et al. 2015). Infestation can occur in both healthy and stressed palms. (Abdel-Baky et al. 2022), Larvae feed on soft tissues for 1–3 months, pupate for 14–21 days, and emerge as reddish-brown adults with a lifespan of 1–5 months (Dembilio and Jacas 2011, Leon-Quinto et al. 2020) Pheromone-based monitoring and management, particularly with ferrugineol (4-methyl-5-nonanol) (Antony et al. 2021), remain effective, especially when combined with attractants like fermented dates and ethyl acetate (Abdel-Azim et al. 2019, Vacas et al. 2017) with male-released pheromones attracting females to oviposit in wounds or natural fissures (Abdel-Azim et al. 2019, Chakravarthy et al. 2014, El-Wahab et al. 2021). Population studies indicate varietal differences in susceptibility.(Salman et al. 2020). They reported that environmental factors such as temperature and humidity significantly influence RPW activity, suggesting management strategies must consider climatic windows. (Ikhlaq et al. 2024, Salman et al. 2020). The date palm (Phoenix dactylifera L.), a member of the Arecaceae family, is an important fruit crop in arid and semi-arid areas of the world. Archaeobotanical evidence suggests that it was domesticated in the Middle East almost 5,000 years ago and spread to Egypt, India, North Africa, and southern Europe in the next millennia (Gros-Balthazard et al. 2018, Krueger et al. 2023). According to FAO (2021) Pakistan produces 9.51 million metric tons annually, while Balochistan contributes a 57% share.

RPW infestation poses a serious threat to the sustainability of date palm production in the Makeran Division, Balochistan. Limited knowledge of RPW life cycle, population dynamics, and varietal susceptibility constrains effective pest management. Farmers in the region frequently report RPW attacks. RPW is an emerging and destructive pest of date palms in Balochistan, particularly in the district of Panjgur. The lack of detailed information on its population dynamics, climatic influences, varietal susceptibility, and effective management strategies threatens the economic stability of local date production.

The study was conducted to assess the population density, effect of climatic factors, and varietal susceptibility of Rhynchophorus ferrugineus in the districts of Panjgur, Makeran Division, Balochistan, Pakistan.

Materials and Methods

Study Area

The monitoring of Red Palm Weevil (RPW), locally known as Togh, was carried out from April to September 2025, in the district of Panjgur, which is the secondlargest date-producing area in Balochistan. The RPW (Rhynchophorus ferrugineus) (Olivier) is consistently being reported for severe attack on date palm in the district. For this research 3 date fields were selected, every field with approximately 1 hectare.

Figure 1: Map showing the district Panjgur, Balochistan, Pakistan.

Pheromone Trapping and Data Collection Method

Commercially available ferrugineol pheromone lures, a blend of 4-methyl-5-nonanol (31.5%) and 4-methyl-5-nonanone (3.5%) in a 9:1 ratio, were used in combination with a slow-release polymeric synergist to attract both male and female adults. Bucket traps baited with ferrugineol pheromone were installed at a density of 10 traps per hectare following an RCBD layout. Traps were placed approximately 10–15 m apart and positioned in shaded areas near date palm trunks. Each trap was partially buried so that the trap opening remained at ground level to enhance adult RPW capture. Food bait (fermented dates) and water were added as kairomone attractants and refreshed weekly, along with lure monitoring. Weekly inspections were conducted, and captured weevils were counted and sexed using morphological identification of the rostrum and genitalia. The male and female were placed separately.

Visual inspection of date palm trees

The visual random inspection was done during the trial period. Every month, 100 palm trees were inspected and examined for symptoms of RPW infestation. During the visual inspection, the infestation characteristics have been observed, such as oozing of fluid, frond damage, wilting, drying, or discoloration of the plant, which is usually caused by internal tissue attack by RPW. The empty pupal cocoons around the plant are also an indication of an attack by pests. This direct observation technique helped to find out the infestation severity in the field.

Destructive Sampling and Specimen Collection

Destructive sampling was conducted twice at 3-month intervals (April and July 2025). Five commonly cultivated date palm varieties from each district were selected based on visible infestation symptoms. Infested trunks were dissected using field tools to assess internal damage and collect RPW specimens. The numbers of larvae and adults were recorded separately for each variety to determine infestation intensity and stage distribution.

Figure 2: Field diagnosis and specimen collection of Red Palm Weevil, (A) The infected date palm being examined for signs of RPW attack; (B) Adult and larval stages of RPW collected from the infected palm trunk.

Climatic Data Collection

Daily temperature (°C) and relative humidity (%) data were recorded using reliable meteorological online sources, i.e., NASA Power Data Access Viewer (DAV). Mean weekly and monthly values were used in the correlation and regression analyses to assess the influence of climatic factors on the RPW population.

Statistical Analyses

To quantify the infestation levels, the infestation rate (%) for each location and date palm variety was calculated using the following formula:

$$\text{Infestation Rate (\%)} = \frac{\text{Number of Infected Trees}}{\text{Total Number of Trees Observed}} \times 100$$

This calculation provided a standardized measure of RPW prevalence in each study site. The

Statistical analysis was done by using the software SPSS v20. The means of the RPW population were computed for population density, sex ratio, and infestation rate.

Analysis of variance (ANOVA) was used to calculate the level of significance, and a post hoc test was done to compare the population among different treatments. The population and weather data correlation analysis test was done by multiple linear regression.

For multiple linear regression, the following formula was used:

$$Y=a+b1X1+b2X2+e$$

Where:

Y = Mean population density of Rhynchophorus ferrugineus

a = Intercept (constant)

b_1 = Regression coefficient for mean temperature

b_2 = Regression coefficient for mean relative humidity

X_1 = Mean temperature (°C)

X_2 = Mean relative humidity (%)

e = Random error term

Results

Population Density of Red Palm Weevil (RPW) in District Panjgur

The mean population of Rhynchophorus ferrugineus (RPW) adults trapped weekly in the district Panjgur was 7.65±0.38 weevils per trap. There were significant differences in RPW captured on a weekly, the first week shows the highest number of RPW catches with 19.67±0.88 weevils per trap. After the first week, a gradual decrease in the number of RPW catches was seen in week 16 with 4.67±0.66 weevils and week 18 with 4.33±0.33 weevils. Then a progressive increase till week 26 with 9.33±1.2 weevils. The ANOVA result showed highly significant temporal fluctuations with an F value of 11.995 and a p value < 0.001; the result confirmed that the population was not changing randomly. Tukey HSD test indicated that the early period from week 1 to week 5, with p value < 0.01 were significantly different from the middle period of the trial from week 12 to week 18. Figure 3.

Annexure(A)

Effect of Weather Parameters on RPW Population in District Panjgur

The results showed that the weather also affected the RPW population in District Panjgur during the trial period. The average mean temperature in district Panjgur was recorded as 27.25±0.36°C, and the average mean relative humidity was 26.73±0.49%. The Correlation analysis shows that temperature played a crucial role in RPW density. The Pearson coefficient between total RPW and temperature was with an r value –0.621 and p value < 0.01, showing a negative and significant correlation. The result showed that whenever the temperature increases, the number of RPW population decreases, while the relative humidity did not show a significant relationship with RPW population. The result shows the correlation between rpw and relative humidity, with an r value of +0.095 and a p value > 0.05. Regression test revealed that temperature and humidity both showed a negative relation with r value –0.346 and p < 0.01. The multiple linear tests was showed significant with an F value of 19.855 and p value < 0.001, and explained 44.6 %, $R^2 = 0.446$ of the variation in RPW catches. These relationships demonstrate that temperature acts as the limiting environmental factor for RPW in Panjgur. Moderate temperatures (25–28 °C) favour activity and trap response, whereas heat above 30 °C curtails weevil movement and longevity. Humidity has a stabilizing but less decisive role. Figure 4.

Annexure(B)

Infestation Rate of RPW on Different Date Palm Varieties in District Panjgur

The 5 varieties of date palm, i.e., Haleeni, Jowansohr, Mozawati, Shakar, and Zard, were surveyed and examined for infestation ratio. Mozawati shows the highest infestation, 11.33±1.33, and Shakar 6.67±0.66; the other three varieties are Haleeni 2.66±0.66, Jowansohr 3.33±0.66, and Zard 5.46±0.66. The ANOVA test confirmed there are significant varietal differences, with an F value of 18.562 and a p value of 0.000. Levene's test shows a p-value of 0.171, indicating equal variances. Tukey HSD results showed there is a significant difference between Mozawati and other observed varieties, with a p-value < 0.05. Figure 5.

Annexure(C)

Infestation rate of RPW (adult and larvae) on date palm in District Panjgur

The infestation rate of RPW adults and The infestation rate of RPW adults and larvae varies in different sample varieties. The average mean adult catches in all verities was 3.02±0.35, and the mean larval catches were 4.16 ± 0.44; these results show the larvae are slightly more numerous than adults. The ANOVA test was done separately for adults and larvae; both show non-significant effects, and the result shows the equal presence of adults and larvae in all sample sites. The larvae presence was higher than that of adults in most sample sites.

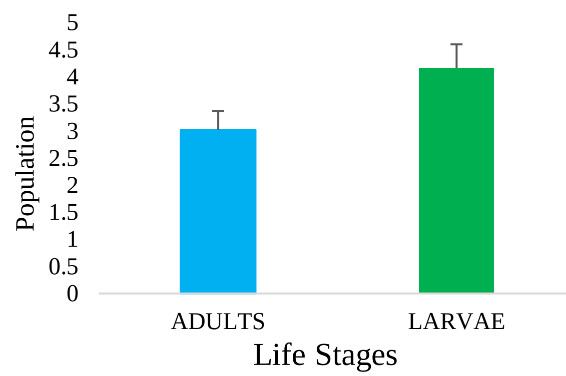

Figure 6: Bar Chart showing Adult and Larvae population on Date Palm in District Panjgur

Figure 7: Adults and Larvae of RPW. (A) Trap showing multiple adult RPWs attracted to pheromone lure, (B) adult and larval RPWs collected from the trap during field monitoring.

Discussion

The current study aimed to explore the seasonal population dynamics of red palm weevil (RPW), Rhynchophorus ferrugineus (Coleoptera: Curculionidae) under local climatic conditions of District Panjgur, Makran Division. The continuous detection of RPW during the entire period of observation of 26 weeks (April-September) confirms its year-round activity and permanent establishment in the date palm orchards of the district. The continuous occurrence of the pest shows that the pest is multivoltine in the Panjgur region and can complete more than two generations in a year in field conditions. The average population of RPW recorded during the monitoring period was 7.65 ± 0.38 weevils per trap. The population showed a clear bimodal activity pattern. The population density was highest in the first weeks of monitoring (in April) and progressively decreased to the lowest value at Week 16 (July). A subsequent rebound was observed in the last weeks of the study (Weeks 24-26) in September. This bimodal pattern is consistent with the population dynamics reported for other subtropical regions, where, generally, two annual peaks in RPW populations are observed, influenced by temperature and humidity thresholds (Arafa & Barakatt, 2021; Faleiro & Ashok Kumar, 2008).

The macroclimate of Panjgur District is cooler and drier than the coastal date-growing belts. The mean temperature and relative humidity during the study period were 27.25 ± 0.36°C and 26.73 ± 0.49%, respectively. These environmental parameters exerted a strong influence on pest activity and development. Reduced egg viability and suppressed larval survival in palm tissues, likely resulting from reduced humidity in the lower atmosphere and long periods of drought, thus preventing rapid, exponential population increases. The persistence of RPW during the study period suggests that this population has successfully adapted to semi-arid ecosystems. Seasonal analysis confirmed a strong association between weekly adult abundance and climatic variables. A temperature range of 25–32°C showed higher adult activity, while temperatures above 35°C caused a significant reduction in trap catches. Relative humidity was also found to be an important regulating factor, with moderate humidity favoring field activity and extreme aridity depressing adult movement and reproductive success. These results confirm a similar trend reported by Al-Dosary et al. (2010) and Hoddle et al. (2015) that ambient temperature controls the metabolic rate, fecundity, and developmental period of RPW. Also, moderate humidity levels are important for reducing desiccation of sensitive eggs and early instar larvae in host trunks (Bream et al., 2001; Pu et al., 2019).

In correlation and regression analyses, we found that climate played a leading role, and significant trap catches were observed. The statistical effect of relative humidity on population fluctuations was relatively less impact. Our climatic studies agree with the findings of Cheong and Azmi (2020), who observed that the RPW populations increase with temperature up to an optimum physiological threshold, beyond which increased thermal stress causes a decline in the population. As we observed, the population decline from

Week 2 to Week 16 coincided with increasing daytime temperatures and sharp drops in humidity. These harsh conditions likely reduced oviposition, egg survival, and larval establishment. However, the secondary increase in population over Weeks 24–26 points to the beginning of a new cohort of adults. These adults developed from earlier infestations and emerged as microclimatic constraints eased. Similar patterns of delayed resurgence are well documented throughout Egypt and the Arabian Peninsula, whereby a change in humidity or precipitation induces a synchronous emergence of adults documented by (Arafa & Barakatt, 2021; Dembilio et al., 2012). During the data collection, sex ratio analysis showed that a significant number of the female population were captured. This pattern was widely reported globally for pheromone-mediated trapping systems (Abdel-Azim et al., 2019; Chakravarthy et al., 2014). We observed that aggregation pheromone traps attract both sexes at the same time, which make easier for researchers to catch both sexes a same time with a single trap installation. Abdel-Hameid 202 and Leon-Quinto et al. (2020) observed similar results and documented great ecological utility for the integrated pest management, and reported that one fertilized female can lay over 200 eggs under ideal conditions. Continued removal of females provides a powerful way to suppress future waves in the generations. The field infestation assessment confirmed the presence of both adults and larvae in the sampled orchards, indicating the active reproduction and successful establishment of the pest in the research field. The average larval ratio (4.16 ± 0.44) was significantly higher than the average adult ratio (3.02 ± 0.35), suggesting a high density of cryptic, internal infestation pressure. ANOVA analysis indicated no statistically significant differences in pest density among the evaluated geographic sites, but the wide presence of larvae indicates that internal damage is still occurring. The study also indicated different susceptibility of local cultivars in field observations. Interestingly, the prominent susceptibility and infestation of the Mozawati variety could be structurally associated with its physical characteristics. The inside trunk tissues of the Mozawati date palm are very soft compared to other local varieties. This tissue structure probably minimizes mechanical resistance and allows for much easier burrowing, feeding, and establishment of more extensive feeding galleries within the host by neonate larvae. The present research supports that 26 weeks of monitoring demonstrate that synthetic pheromone trapping works as an extremely efficient diagnostic and suppression tool for managing RPW in the district of Panjgur. It has the bonus of draining the breeding pool while giving reliable data on population monitoring through continuous trapping. This dual-purpose fits in with the findings laid out by Antony et al. (2021), and Guarino et al. (2011) supported the use of pheromone trapping as an integral part of early detection and population suppression incorporated within regional IPM programs. Temperature is the main factor driving red palm weevil numbers in the district of Panjgur. Even though the local climate is quite dry, the pest has adapted remarkably well, staying active year-round with multiple overlapping generations. Because of this, pest control programs in the region cannot rely on rigid, pre-set calendar schedules. Instead, management strategies need to be flexible and guided by actual seasonal trends and weather forecasts. Setting up pheromone traps, cleaning orchards, and applying targeted treatments right before expected population peaks will make control efforts much more effective and protect Panjgur's date palm industry.

Conclusion

The study demonstrates that red palm weevil populations in Panjgur districts exhibit clear seasonal fluctuations influenced by climatic factors and palm variety susceptibility. Early-season peaks in April coincided with moderate temperatures and humidity, while mid-season declines, particularly in July, were associated with higher temperatures and extreme humidity. Female RPWs were consistently more abundant than males, highlighting strong reproductive activity. Varieties such as Mozawati and Shakar were more susceptible across both districts, indicating varietal preference by RPW. Overall, RPW population dynamics are driven by a combination of climatic conditions, seasonal trends, and host variety, emphasizing the need for timely, climate-informed pest management strategies in date palm orchards. By understanding these climatic relationships, the local farmers of Makeran Division can adjust management measures to periods of high risk rather than applying them uniformly throughout the year. The data from the study can serve as a baseline for further studies on forecasting models, risk mapping, and optimization of pheromone trap networks. Future studies should focus on assessing degree day requirements for development under local conditions and on identifying climatic thresholds for population suppression of RPW. The population density of the red palm weevil in Balochistan displays clear seasonal patterns influenced by climatic factors such as temperature and humidity. The annual cycle showed the two major peaks in the RPW population. 1st peak was at the early period of the study, and the 2nd peak was at the end of the study period. Both peak seasons show normal climatic conditions, while the middle duration of the study recorded higher temperatures, causing low activity of the pest. The female dominance across the region shows uniform ecological conditions. These findings highlighted the potential for climate-based forecasting and pheromone-guided management to form the backbone of an effective IPM strategy for date palm protection in Balochistan. By aligning monitoring and control actions with observed population trends, local farmers of the region can achieve sustainable suppression of R. ferrugineus while conserving environmental and economic resources.

References

Abdel-Azim, M. M.; S. A. Aldosari and P. Shukla. (2019). Factors Influencing Mating Behavior and Success in the Red Palm Weevil, Rhynchophorus Ferrugineus Olivier (Coleoptera: Dryophthoridae). Neotrop Entomol, 48(1), 25-37.

Abdel-Baky, N. F.; M. A. Aldeghairi; M. I. Motawei; L. A. M. Al-Shuraym; A. A. S. Al-Nujiban; M. T. M. Alharbi and M. Rehan. (2022). Monitoring of Infestation Percentages of the Invasive Red Palm Weevil, Rhynchophorus Ferrugineus (Coleoptera: Curculionidae), and Management Tactics: A Six-Year Study. Braz J Biol, 82, e263707.

Al-Ajlan, A. M. (2008). Current Status of Red Palm Weevil in the Middle East. Arab Journal of Plant Protection, 26(2), 236–239.

Antony, B.; J. Johny; N. Montagne; E. Jacquin-Joly; R. Capoduro; K. Cali; K. Persaud; M. A. Al-Saleh and A. Pain. (2021). Pheromone Receptor of the Globally Invasive Quarantine Pest of the Palm Tree, the Red Palm Weevil (Rhynchophorus Ferrugineus). Mol Ecol, 30(9), 2025-39.

Brand, A R. (1917). Red Palm Weevil Attack on Date Palms. Agricultural Journal of India, 12, 423–425.

Chakravarthy, A. K.; M. Chandrashekharaiah; S. B. Kandakoor and D. N. Nagaraj. (2014). Efficacy of Aggregation Pheromone in Trapping Red Palm Weevil (Rhynchophorus Ferrugineus Olivier) and Rhinoceros Beetle (Oryctes Rhinoceros Linn.) from Infested Coconut Palms. J Environ Biol, 35(3), 479-84.

Dembilio, O. and J. A. Jacas. (2011). Basic Bio-Ecological Parameters of the Invasive Red Palm Weevil, Rhynchophorus Ferrugineus (Coleoptera: Curculionidae), in Phoenix Canariensis under Mediterranean Climate. Bull Entomol Res, 101(2), 153-63.

El-Juhany, L. I. (2010). Date Palm Status and Rpw Damage Assessment. Agricultural and Environmental Science, 1(1), 32–41.

El-Shafie, H. A. and J. R. Faleiro. (2020). Integrated Management of Red Palm Weevil: Global Action Plan and Prospects. Journal of Plant Protection Research, 60(4), 345–355.

El-Wahab, A. S. A.; A. Y. A. El-Fattah; W. K. M. El-Shafei and A. A. E. Helaly. (2021). Efficacy of Aggregation Nano Gel Pheromone Traps on the Catchability of Rhynchophorus Ferrugineus (Olivier) in Egypt. Braz J Biol, 81(2), 452-60.

Faleiro, J.R. and Kumar Ashok, J. (2008). A Rapid Decision Sampling Plan for Implementing Area-Wide Management of the Red Palm Weevil, Rhynchophorus Ferrugineus, in Coconut Plantations of India. J Insect Sci, 8, 15.

Faleiro, J.R.; S.B. Balijepalli and M. El Saadi. (2012). Is Policy Paralysis on Quarantine Issues in the Near East and North Africa Region Leading to the Buildup and Spread of Rhynchophorus Ferrugineus? Arab Journal of Plant Protection, 30(2), 89-100.

FAO. (2021). Https://Tdap.Gov.Pk/Wp-Content/Uploads/2025/01/Dates-Production-Consumption-Exports-Potential.Pdf.

FAO. (2017). Rome Declaration on the Red Palm Weevil. Food and Agriculture Organization of the United Nations.

Giblin-Davis, R. M; J. R Faleiro; N Soto and J Peña. (2013). Biology and Management of the Red Palm Weevil. Florida Entomologist, 96(4), 1851–1860.

Gros-Balthazard, M.; K. M. Hazzouri and J. M. Flowers. (2018). Genomic Insights into Date Palm Origins. Genes, 9(10).

Guerri-Agullo, B.; S. Gomez-Vidal; L. Asensio; P. Barranco y L.V. Lopez-Llorca. (2010). Infection of the Red Palm Weevil (Rhynchophorus Ferrugineus) by the Entomopathogenic Fungus Beauveria Bassiana: A Sem Study. Microsc Res Tech, 73(7), 714-25.

Hoddle. M.S.; Antony. B.; El-Shafie. H. A. F.; Chamorro. M.L.; Milosavljevic. I. Lohr. B. e Faleiro. J. R. (2024). Taxonomy, Biology, Symbionts, Omics, and Management of Rhynchophorus Palm Weevils (Coleoptera: Curculionidae: Dryophthorinae). Annu Rev Entomol, 69, 455-79.

Ikhlaq, Muhammad; Waqar Jaleel; Ammara Noreen; Muhammad Ammar Amjad; Rashid Azad; Lubna Altaf; Bilal Akram; Muhammad Faraz Ayoub Khan; Aqib Nawaz Mughal; Kashif Shabir; Muhammad Azhar Bashir; Kashif Bashir; Abdul Manan Saeed and Saqib Ali Ateel. (2024). Monitoring, Population Dynamics, and Infestation Rate of Red Palm Weevil in Different Local Date Palm Varieties in Bahawalpur. Agricultural Sciences Journal.

Krueger, R. R.; Al-Khayri, J. M.; Jain S M and Johnson D V. (2023). Introduction: The Date Palm Legacy. In J. M. Al-Khayri, S. M. Jain, D. V. Johnson, & R. R. Krueger (Eds.), Date Palm (Pp. 1-21). (Crop Production Science in Horticulture; No. 19). Cabi. Https://Doi.Org/10.1079/9781800620209.0001 .

Lefroy, H. M. (1906). Insect Pests of Date Palm and Coconut in India. Agricultural Journal of India, 1, 46-49.

Leon-Quinto, T.; A. Fimia; R. Madrigal and A. Serna. (2020). Morphological Response of the Red Palm Weevil, Rhynchophorus Ferrugineus, to a Transient Low Temperature Analyzed by Computer Tomography and Holographic Microscopy. J Therm Biol, 94, 102748.

Salman, T A A; Al-Ayedh, H; Abdel-Azim, M, and (2020). (2020). Population Fluctuations of Red Palm Weevil across Date Palm Varieties. Journal of Plant Diseases and Protection, 127, 625–634.

Vacas, S.; O. Melita; A. Michaelakis; P. Milonas; R. Minuz; P. Riolo; M. K. Abbass; P. Lo Bue; S. Colazza; E. Peri; V. Soroker; Y. Livne; J. Primo e V. Navarro-Llopis. (2017). Lures for Red Palm Weevil Trapping Systems: Aggregation Pheromone and Synthetic Kairomone. Pest Manag Sci, 73(1), 223-31.

Wakil, W; Faleiro J R and Miller T A. (2015). Sustainable Management of the Red Palm Weevil: Integrated Approaches. Springer.

Annexure(A)

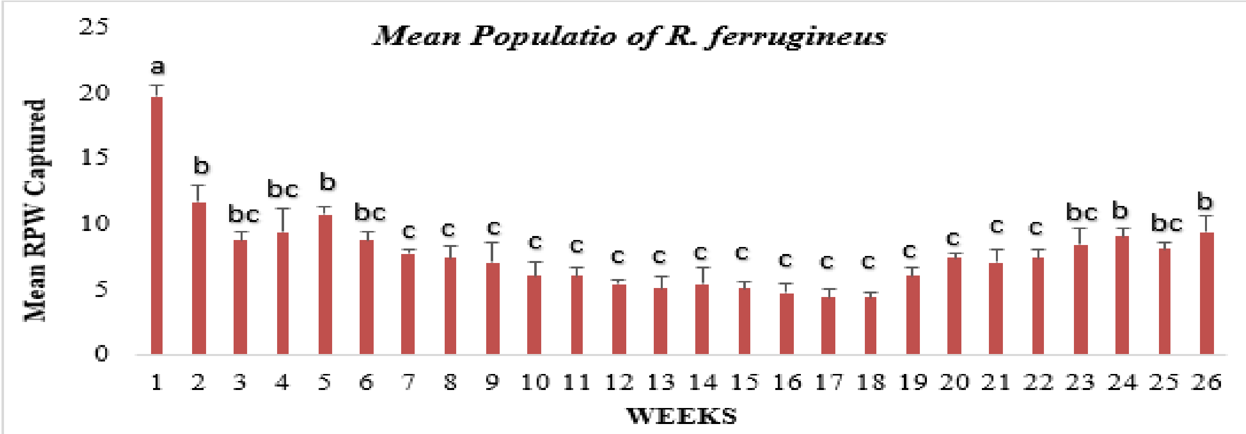

Figure 3: Bar chart showing the mean number of total RPW per week in District Panjgur. The same letter in the bars indicates that there is no significant difference between the populations of RPWs at a significance level of P<0.05.

Annexure(B)

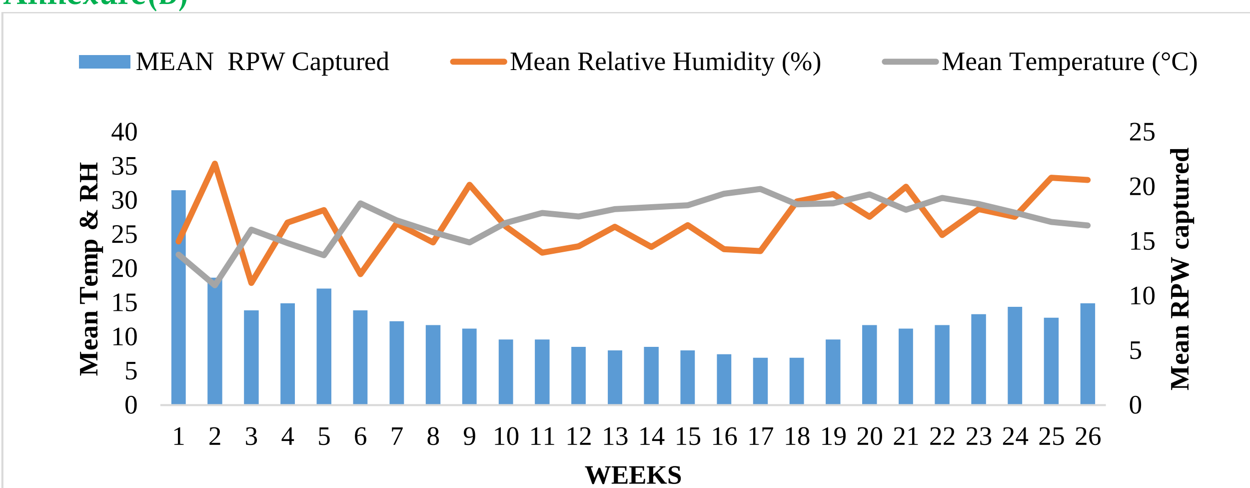

Figure 4: Scatter plot shows the weekly mean RPW vs. temperature and humidity in district Panjgur.

Annexure(C)

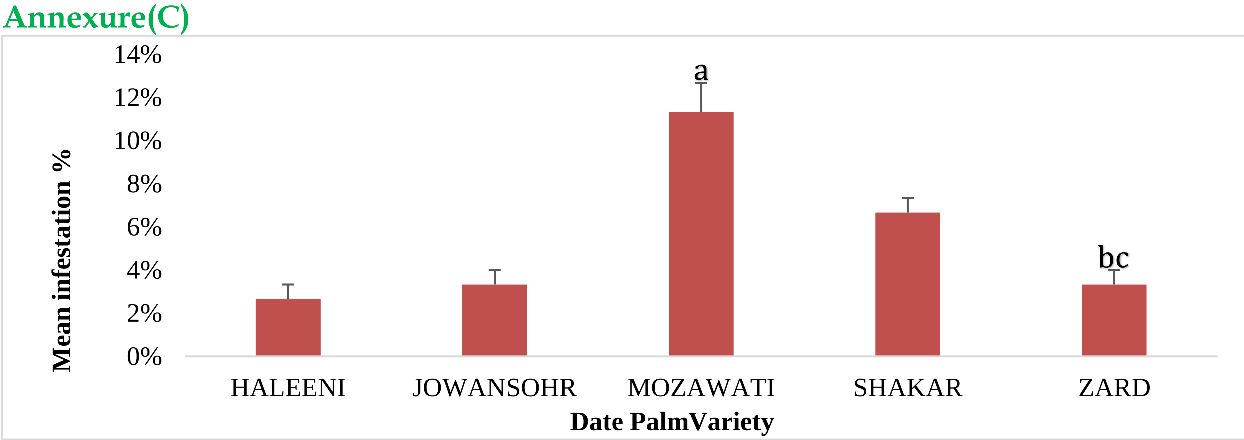

Figure 5: Bar graph showing the average RPW infestation for various susceptible date palm varieties in the Panjgur district. The same letter in brackets indicates that there is no significant difference between RPV infestations at a significance level of <0.05.