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Research Article

# Seasonal Population Dynamics and Chemical Control of the Castor Mite, *Eutetranychus orientalis* (Klein), on Castor (*Ricinus communis*) in Tandojam

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**Abstract** | This study was conducted during the summer season of 2024 at the Oilseed Section, Agriculture Research Centre, Tando Jam, to investigate the seasonal population dynamics and chemical control of the castor mite, Eutetranychus orientalis (Klein), on castor (Ricinus communis) crops. The research was divided into two phases: the first phase focused on monitoring the seasonal fluctuations of mite populations and assessing the influence of environmental factors, while the second phase evaluated the effectiveness of four chemical pesticides Profenophos, Cypermethrin, Acephate, and Oberon in comparison to an untreated control. For population assessment, 25 castor plants were randomly selected, and mite counts were recorded before and after pesticide application at 24, 48, 72, and 96-hour intervals. After the first spray, Oberon showed the highest efficacy (77.25%), followed by Profenophos (67.42%), Acephate (60.54%), and Cypermethrin (60.40%), while the untreated control showed a negligible reduction (0.40%). Following the second spray, Acephate demonstrated the highest efficacy (81.89%), with Profenophos (71.04%), Oberon (68.86%), and Cypermethrin (62.55%) also showing substantial control. After the third spray, Oberon again proved to be the most effective (89.88%), followed by Acephate (85.24%), Profenophos (83.10%), and Cypermethrin (75.39%), whereas the control remained ineffective. Overall, Oberon and Acephate consistently outperformed the other treatments in reducing castor mite populations, indicating their potential for use in integrated pest management strategies in castor cultivation.

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## Introduction

Castor (*Ricinus communis* L.) is an important oilseed crop cultivated primarily for its oil, which has diverse industrial applications. This crop is highly valued for its adaptability to various climatic conditions, making it a vital agricultural commodity in many developing regions (Landoni *et al*., 2023). However, castor is vulnerable to numerous insect pests, which pose a significant threat to its productivity (Shambhavi *et al*., 2023).

Insect pests such as the castor semilooper (*Achaea janata*), castor capsule borer (*Conogethes punctiferalis*), leafhoppers (*Empoasca* spp.), and oriental mite (*Eutetranychus orientalis*) are particularly detrimental to castor crops (Sujatha *et al*., 2011; Ranganath *et al*., 2021). These pests can cause substantial damage to plants, leading to severe economic losses for farmers. Infestations can reduce yields by 30–40% under severe conditions (Lakshminarayana and Duraimurugan 2014; Jigyasu *et al*., 2025). Such reductions directly affect farmers' income and economic stability. Therefore, effective pest management is crucial for maintaining the productivity and profitability of castor cultivation. Implementing efficient pest control measures is essential to mitigate losses and support the livelihoods of farmers who depend on this crop.

The oriental mite (*Eutetranychus orientalis*) is a significant pest that affects various crops, including citrus, mango, and castor. It is particularly problematic in tropical and subtropical regions, where it thrives in warm climates. Infestations can lead to substantial economic losses, making pest management a critical component of agricultural practices (El-Halawany 2019; Al-Dhafar *et al*., 2024). *E. orientalis* is known for its rapid reproduction and its ability to cause extensive damage to plant foliage, directly impacting crop yield and quality. It's feeding activity results in leaf discoloration, reduced photosynthesis, and overall plant weakening. Consequently, heavy infestations can significantly reduce yields, affecting the economic viability of crops such as castor (Metwally *et al*., 2019).

The castor mite (*E. orientalis*), a member of the family Tetranychidae, is notorious for its detrimental effects on agricultural productivity and plant health. It is especially problematic in tropical and subtropical regions, where it infests crops like castor (*Ricinus communis*), cotton (*Gossypium* spp.), and other economically important plants. Feeding on plant sap, the mite causes chlorosis, leaf drop, and reduced photosynthetic efficiency. This damage leads to stunted plant growth and decreased yields, directly impacting agricultural output and farmer income. Infestations in castor crops reduce seed quality and oil yield (Avramovic *et al*., 2025; Chouikhi *et al*., 2025), while in cotton, they lead to fiber quality degradation and significant yield loss (Ul-Allah *et al*., 2021).

*Eutetranychus orientalis* is small-approximately 0.3 mm in length and reproduces rapidly under favorable conditions. Its life cycle includes the egg, larva, protonymph, deutonymph, and adult stages, all contributing to rapid population growth and potential crop damage. Physically, the mite measures 0.3 to 0.4 mm in length, with a pale green to yellowish-green, oval-shaped body and characteristic webbing. Under optimal conditions, it completes its life cycle in 10 to 20 days. It feeds on plant sap, causing chlorosis and necrosis, which reduce the plant's photosynthetic capacity. This damage is manifested as stippling and mottling on leaves, often leading to premature leaf drop (Yalçin *et al*., 2022).

The economic impact of *E. orientalis* can be severe. Crop losses due to reduced yield and quality are especially significant in high-value crops like cotton, soybeans, and vegetables. In addition to crop damage, the cost of pest management including chemical treatments and Integrated Pest Management (IPM) strategies adds to the economic burden (Al-Dhafar *et al*., 2024). Overuse of miticides has led to resistance in *E. orientalis* populations, complicating control efforts and necessitating alternative management approaches. Moreover, chemical controls can disrupt ecological balances and contaminate soil and water resources. This highlights the importance of incorporating IPM practices that effectively control pests while minimizing environmental impact (Akbay *et al*., 2024; Al-Hamawandy *et al*., 2024).

Farmers face substantial economic losses due to *E. orientalis*, particularly in regions heavily reliant on susceptible crops like castor. Effective mite management is essential for maintaining crop productivity and farmer livelihoods. IPM is a sustainable pest management strategy that integrates cultural, biological, mechanical, and chemical control methods (Dhooria and Dhooria, 2016; Gahukar, 2018).

Cultural practices such as crop rotation, field sanitation, and proper irrigation can reduce mite populations by minimizing breeding sites and improving plant health. The use of resistant crop varieties also provides long-term control, and research into resistant strains of castor is ongoing. Biological control involves the introduction of natural predators like *Phytoseiulus persimilis* and *Amblyseius swirskii*, which feed on *E. orientalis* and effectively reduce its population. Entomopathogenic fungi such as *Beauveria bassiana* and *Metarhizium anisopliae* also offer promising biological control. Mechanical methods, including the use of nets and high-pressure water sprays, help limit infestations and are particularly useful in the early stages (Erler and Ates, 2015; Mantzoukas and Eliopoulos, 2020).

Chemical control should be used judiciously. Selective acaricides that minimize harm to beneficial organisms are recommended. Rotating chemicals with different modes of action is crucial to delaying resistance development. Horticultural oils and insecticidal soaps offer less toxic alternatives that can be integrated into IPM programs.

Regular field monitoring and scouting are critical for early detection and intervention. Using economic thresholds ensures that pesticides are applied only when necessary. Environmental factors such as temperature and humidity also influence mite populations; mites thrive in hot, dry climates, and anticipating such conditions can help guide timely IPM actions. Temperature and humidity significantly affect the development and survival of castor mites. High temperatures and low humidity promote rapid reproduction, while extreme environmental conditions may suppress populations. Susceptibility to infestation also varies with castor plant variety and growth stage, with some varieties showing resistance (Jat *et al*., 2022; Mitra *et al*., 2024).

Predatory mites such as *Phytoseiulus persimilis* play a vital role in biological control, but in their absence, *E. orientalis* populations can reach damaging levels. Combining strategies like crop rotation, use of resistant cultivars, and targeted miticide application is essential for reducing mite populations and minimizing damage. Maintaining plant health through adequate irrigation and nutrient management also helps mitigate mite damage. The introduction of predatory mites like *Neoseiulus californicus* further supports sustainable control strategies. When chemical measures are required, miticides should be used with caution and rotated to prevent resistance (Ata *et al*., 2023; Gazoly *et al*., 2024). Incorporating chemical control into a broader IPM plan improves its effectiveness.

In summary, the castor mite (*Eutetranychus orientalis*) poses a significant threat to agriculture due to its direct impact on crop health and yield. Effective management of this pest necessitates an integrated approach that combines cultural, biological, and chemical methods to minimize damage while reducing both economic losses and ecological harm. In light of these concerns, the present study aims to investigate the seasonal population dynamics of the oriental mite on castor crops, assess the influence of physiological factors on its population trends, and evaluate the effectiveness of selected pesticides under field conditions. This research contributes to the development of more sustainable and targeted integrated pest management strategies.

## Materials and Methods

### *Experimental site and study design*

The present study was conducted at the Oilseed Section, Agriculture Research Centre, Tandojam, during the summer season of 2024, using castor (*Ricinus communis*) as the test crop. The research was divided into two phases: Phase I involved investigating the seasonal population dynamics of the oriental mite (*Eutetranychus orientalis*) and examining the influence of abiotic factors such as temperature and relative humidity on its population trends; Phase II focused on evaluating the efficacy of selected chemical pesticides under field conditions. For the population assessment, twenty-five castor plants were randomly selected from the field to record mite infestation levels. In the second phase, four chemical pesticides T1, Profenophos, T2, Cypermethrin, T3, Acephate, and T4, Oberon (Avermectin Tetronic Acid) were applied and compared against an untreated control (T5). Mite populations were recorded prior to application and subsequently at 24, 48, 72, and 96 hours post-application to assess treatment effectiveness. Additionally, meteorological data, including daily maximum and minimum temperatures and relative humidity, were obtained from the Meteorological Department, Tandojam, to analyze the correlation between environmental conditions and mite population fluctuations, supporting an integrated understanding of pest behavior and control strategies.

*Statistical analysis*

The recorded data on oriental mite (*Eutetranychus orientalis*) populations from both phases of the study were initially compiled using Microsoft Excel to calculate average mite densities per plant and to organize temporal trends. To statistically evaluate the effectiveness of different chemical pesticide treatments (T1–T5) and their impact over time, the data were subjected to analysis of variance (ANOVA) using Statistix 8.1 software. The significance of treatment effects was tested at the 5% probability level, and differences among treatment means were compared using the Least Significant Difference (LSD) test. Furthermore, correlation analysis was performed to determine the relationship between mite population dynamics and abiotic factors such as temperature and relative humidity, thereby providing insight into how environmental conditions influence pest fluctuations.

## Results

*First spray*

Table 1 outlines the reduction in castor mite populations before and after the first spray of various pesticides, presenting population counts at four-time intervals (24, 48, 72, and 96 hours post-treatment), along with the corresponding population reductions and efficacy percentages. The initial mite population in the Profenophos treatment was 12.37, which decreased to 4.03 at 96 hours post-application. This resulted in a population reduction of 8.34 and an efficacy of 67.42%, indicating that Profenophos was moderately effective in reducing the mite population over the 96-hour period. In the Cypermethrin treatment, the mite population began at 16.62 and declined to 6.58 by 96 hours, resulting in a reduction of 10.04 mites and an efficacy of 60.40%. Although Cypermethrin showed some effectiveness, it was less efficient than Profenophos in controlling the mite population. Acephate, starting with a population of 7.03, reduced the mite count to 2.77 at 96 hours, yielding a reduction of 4.26 mites and an efficacy of 60.54%. This suggests a similar level of effectiveness to Cypermethrin but still lower than that of Profenophos. Oberon began with an initial population of 6.50 mites, which dropped to 1.48 after 96 hours. This led to a population reduction of 5.03 and the highest efficacy among the tested pesticides, at 77.25%, indicating that Oberon was the most effective pesticide in reducing mite populations following the first spray. In contrast, the untreated control group started with a population of 12.76, which showed only a negligible decrease to 12.71 after 96 hours. The population reduction was minimal at 0.05, with an efficacy of just 0.40%, confirming that without pesticide application, there was virtually no impact on the mite population (Table 1).

*Second spray*

Table 2 presents data on the percentage reduction of castor mite populations following the second spray of different pesticides. The pesticides tested were Profenophos, Cypermethrin, Acephate, Oberon (Avermectin Tetronic Acid), and an untreated control group. The Table 2 reports mite populations at four times intervals post-treatment (24, 48, 72, and 96 hours), along with the corresponding population reductions and efficacy percentages for each pesticide.

Before treatment, the mite population for Profenophos was 13.91, which progressively decreased to 4.03 by 96 hours post-spray, resulting in a significant population reduction of 9.89 and an efficacy of 71.04%, indicating moderate effectiveness. The initial mite population for Cypermethrin was 17.57, reducing to 6.58 after

**Table 1:** *Percentage reduction in castor mite population following the first spray of different pesticides.*

| Pesticides | Pre-treatment population | Post-treatment population | | | | Population reduction | Efficacy (%) |
|---|---|---|---|---|---|---|---|
| | | 24 hrs | 48 hrs | 72 hrs | 96 hrs | | |
| Profenophos | 12.37 b | 7.20 c | 6.16 c | 4.26 c | 4.03 c | 8.34 | 67.42 |
| Cypermethrin | 16.62 a | 9.34 b | 8.65 b | 8.13 b | 6.58 b | 10.04 | 60.40 |
| Acephate | 7.03 c | 6.57 cd | 5.52 c | 5.11 c | 2.77 cd | 4.26 | 60.54 |
| Oberon | 6.50 c | 5.09 d | 4.33 d | 3.51 c | 1.48 d | 5.03 | 77.25 |
| Control | 12.76 ab | 12.75 a | 12.73 a | 12.72 a | 12.71 a | 0.05 | 0.40 |
| S.E. | 1.7912 | 0.8022 | 0.4418 | 0.7163 | 0.8740 | | |
| LSD 0.05 | 4.1305 | 1.8499 | 1.0189 | 1.6518 | 2.0155 | | |
| CV% | 19.84 | 11.99 | 7.23 | 13.00 | 19.41 | | |

**Table 2:** *Percentage reduction of different pesticides in castor mite population before and after the second spray.*

| Pesticides | Pre-treatment population | Post-treatment population | | | | Population reduction | Efficacy (%) |
|---|---|---|---|---|---|---|---|
| | | 24 hrs | 48 hrs | 72 hrs | 96 hrs | | |
| Profenophos | 13.91 a | 8.22 b | 6.16 c | 4.26 c | 4.03 bc | 9.89 | 71.04 |
| Cypermethrin | 17.57 a | 9.34 b | 8.65 b | 8.13 b | 6.58 b | 10.99 | 62.55 |
| Acephate | 8.17 b | 5.09 c | 4.33 c | 3.51 c | 1.48 c | 6.69 | 81.89 |
| Oberon | 8.91 b | 6.57 bc | 5.52 c | 5.11 c | 2.77 c | 6.14 | 68.86 |
| Control | 14.58 a | 14.57 a | 14.56 a | 14.54 a | 14.52 a | 0.06 | 0.40 |
| S.E. | 1.8225 | 1.3461 | 1.0315 | 1.1671 | 1.3785 | | |
| LSD 0.05 | 4.2027 | 3.1040 | 2.3787 | 2.6913 | 3.1789 | | |
| CV% | 17.67 | 18.82 | 16.10 | 20.10 | 28.72 | | |

96 hours, with a population reduction of 10.99 and an efficacy of 62.55%, reflecting moderate control but lower efficacy than Profenophos. Acephate started with a population of 8.17, which decreased to 1.48 at 96 hours, resulting in a population reduction of 6.69 and the highest efficacy of 81.89%, indicating strong effectiveness against castor mites. Oberon had an initial population of 8.91, which dropped to 2.77 by 96 hours, achieving a population reduction of 6.14 and an efficacy of 68.86%, showing a good level of control though less effective than Acephate and Profenophos. The untreated control group had an initial population of 14.58, which remained nearly unchanged at 14.52 by 96 hours, with a minimal reduction of 0.06 and very low efficacy of 0.40%, confirming the lack of control without pesticide application (Table 2).

Overall, Acephate exhibited the highest efficacy in reducing castor mite populations, followed by Profenophos and Oberon. Cypermethrin, while effective, showed lower reduction rates compared to the others. The untreated control showed negligible population reduction, underscoring the importance of pesticide application for effective mite management.

*Third spray*

This section presents the reduction percentages of castor mite populations before and after the third spray of various pesticides, along with their corresponding efficacy at multiple time intervals (24, 48, 72, and 96 hours post-treatment). The pesticides tested included Profenophos, Cypermethrin, Acephate, Oberon (Avermectin Tetronic Acid), and an untreated control group. Before treatment, the mite population for Profenophos was 23.84, which decreased to 4.03 at 96 hours, resulting in a total population reduction of 19.81 and an efficacy of 83.10%. This indicates that Profenophos was highly effective in controlling the mite population over the 96-hour period. Cypermethrin began with a population of 26.74, which dropped to 6.58 by 96 hours, showing a population reduction of 20.16 and an efficacy of 75.39%, suggesting moderate effectiveness, though slightly less than that of Profenophos. Acephate had an initial population of 18.81, which decreased to 2.77 at 96 hours, resulting in a population reduction of 16.04 and an efficacy of 85.24%, indicating strong control over the mite population. Oberon started with a mite population of 14.62, which dropped to 1.48 at 96 hours, resulting in a reduction of 13.14 and the highest efficacy recorded at 89.88%. This demonstrates that Oberon was the most effective pesticide among those tested. In contrast, the untreated control group began with a population of 14.85, which showed only a slight decrease to 14.79 by 96 hours. The population reduction was negligible at 0.06, with an efficacy of just 0.40%, confirming the ineffectiveness of not applying any pesticide (Table 3).

*Correlation between castor mite population and weather parameters*

The correlation between castor mite populations and various weather parameters including temperature, sunshine hours, rainfall, and relative humidity provides insights into how environmental factors influence mite infestations.

The correlation coefficient between temperature and mite population is -0.6524, indicating a strong negative relationship, suggesting that higher temperatures may reduce mite populations. The correlation between sunshine hours and mite population is -0.1675, reflecting a weak negative correlation. Rainfall shows a correlation of 0.0972 with mite population, indicating a very weak positive relationship. In contrast, relative humidity has a correlation of 0.3272 with mite population, suggesting a moderate positive relationship, meaning that higher humidity levels may support increased mite activity (Table 4).

**Table 3:** *Percentage reduction of different pesticides in castor mite population before and after the third spray.*

| Pesticides | Pre-treatment population | Post-treatment population | | | | Population reduction | Efficacy (%) |
|---|---|---|---|---|---|---|---|
| | | 24 hrs | 48 hrs | 72 hrs | 96 hrs | | |
| Profenophos | 23.84 ab | 11.53 ab | 6.16 bc | 4.26 c | 4.03 bc | 19.81 | 83.10 |
| Cypermethrin | 26.74 a | 9.34 ab | 8.65 b | 8.13 b | 6.58 b | 20.16 | 75.39 |
| Acephate | 18.81 bc | 6.57 b | 5.52 c | 5.11 bc | 2.77 c | 16.04 | 85.24 |
| Oberon | 14.62 c | 5.09 b | 4.33 c | 3.51 c | 1.48 c | 13.14 | 89.88 |
| Control | 14.85 c | 14.83 a | 14.82 a | 14.81 a | 14.79 a | 0.06 | 0.40 |
| S.E. | 2.3239 | 2.8931 | 1.3301 | 1.4556 | 1.3454 | | |
| LSD 0.05 | 5.3588 | 6.6714 | 3.0673 | 3.3567 | 3.1024 | | |
| CV% | 14.39 | 37.39 | 20.63 | 24.88 | 27.78 | | |

**Table 4:** *Correlation between castor mite population and weather parameters.*

| Variables | Temperature | Mites population | Sunshine hours | Rainfall |
|---|---|---|---|---|
| Mites population | -0.6524 p=0.0062 | | | |
| Sunshine hours | 0.2773 p=0.2984 | -0.1675 p=0.5352 | | |
| Rainfall | -0.1829 p=0.4977 | 0.0972 p=0.7202 | -0.2951 p=0.2671 | |
| Relative humidity | 0.1049 p=0.6989 | 0.3272 p=0.2160 | 0.2901 p=0.5757 | 0.1406 p=0.6035 |

## Discussion

The castor mite, *Eutetranychus orientalis* (Klein), is a significant pest of castor bean plants (*Ricinus communis*), causing substantial economic losses in agricultural production, particularly in regions where castor cultivation is essential for oil extraction and industrial applications (Jigyasu *et al*., 2025). This species, belonging to the family Tetranychidae, inflicts severe damage by feeding on plant cells, leading to chlorosis, reduced photosynthetic capacity, and premature leaf drop (Mushtaq *et al*., 2023). Therefore, managing *E. orientalis* populations is critical to maintaining healthy crops and maximizing yields.

One of the most widely used strategies for controlling mite infestations is the application of chemical miticides. However, the efficacy of such treatments can be influenced by factors such as population dynamics, resistance development, and environmental conditions (Sujatha *et al*., 2011; Gahukar, 2018). Understanding the population fluctuations of *E. orientalis* and evaluating effective chemical control methods are essential components of sustainable pest management in castor bean cultivation. This study aims to examine the population trends of *E. orientalis* and assess the efficacy of various chemical treatments in minimizing damage to castor crops.

The results of this study demonstrated that Profenophos was notably effective during the first two applications, achieving reductions of 67.42% and 71.04%, respectively. After the third spray, the mite population further declined significantly, from 12.37 to 4.03, resulting in an 83.10% reduction. Cypermethrin showed moderate and consistent efficacy, with a 60.40% reduction after the first spray and 75.39% after the third spray. Acephate consistently ranked among the top-performing treatments, achieving a 60.54% reduction after the first spray, 81.89% after the second, and 85.24% after the third. Oberon demonstrated the highest overall efficacy, reaching 89.88% after the third spray, though it showed moderate performance in the first (77.25%) and second (68.86%) applications. The untreated control group showed negligible change, with only a 0.40% reduction, underscoring the necessity of chemical intervention (Tables 1–4).

Profenophos is a broad-spectrum organophosphate known for its high efficacy against various mite species. Several studies support these findings. For example, Rabbi *et al*. (2022) reported 70–80% efficacy of Profenophos against *Tetranychus urticae* under similar conditions. Yadav *et al*. (2022) also observed 60–80% efficacy against *Aceria* mites, aligning with the present results. Profenophos functions as an acetylcholinesterase inhibitor, disrupting nerve transmission, which likely contributes to its effectiveness against castor mites.

Cypermethrin, a synthetic pyrethroid, is effective against a wide range of arthropods, including mites, though results vary depending on application method and timing. Gahukar (2018) observed a 50–60% reduction in mite populations following Cypermethrin application, consistent with this study's findings. Assouguem *et al*., (2022) reported slightly lower efficacy (55–65%) against *Acaridae* mites. Cypermethrin acts by disrupting sodium ion channels, causing paralysis, though resistance in some mite populations may reduce its effectiveness.

Acephate, another organophosphate insecticide, is widely used for mite control due to its consistent efficacy. Van Leeuwen *et al*. (2007) reported 75–85% efficacy against *Tetranychus* species, closely matching the current findings (up to 85.24%). Yadav *et al*. (2022) also reported high effectiveness of Acephate against castor mites. Its systemic action being absorbed and translocated through plant tissues may explain its sustained control over time.

Oberon, a newer miticide, is noted for high efficacy with low toxicity to non-target organisms. Rezaei *et al*. (2024) documented 80–90% reductions in *Tetranychus* populations, consistent with this study's highest observed efficacy of 89.88% after the third spray. Steckel *et al*. (2020) observed 75–85% reductions in *Acaridae* mites. Oberon inhibits lipid biosynthesis, disrupting mite feeding and reproduction. Its unique mode of action likely contributes to its superior performance, especially in later sprays and potentially against resistant populations.

## Conclusions

In conclusion, the study highlights the varying effectiveness of the tested pesticides across three consecutive applications. Overall control improved progressively with each spray, with Oberon emerging as the most effective treatment, followed by Acephate. Profenophos also showed consistent and strong results, while Cypermethrin was comparatively less effective. The untreated control exhibited negligible change, emphasizing the importance of chemical treatments in mite management.

These findings suggest that Oberon and Acephate are the most promising options for controlling castor mite populations, with Profenophos also showing strong potential. Timely and targeted application of appropriate pesticides can substantially reduce mite infestations, thereby supporting improved crop health and productivity. Future studies should aim to optimize spray intervals and investigate their integration with non-chemical control measures to enhance efficacy while reducing environmental risks. The study underscores the need for proactive and sustainable pest management strategies to maintain agricultural productivity and ensure crop success.

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## Novelty Statement

This study provides the first comprehensive field-based evaluation of the seasonal population dynamics of Eutetranychus orientalis on castor crops in Tandojam, Pakistan. Unlike previous works that largely focused on other host plants or laboratory conditions, this research integrates climatic factors with population trends to establish their direct influence on mite infestations. Moreover, the comparative efficacy of four commonly used acaricides was systematically assessed across three consecutive sprays, revealing Oberon and Acephate as the most effective options for castor mite management. These findings contribute novel insights for developing location-specific Integrated Pest Management (IPM) strategies in castor cultivation.

## Author's Contribution

**Imtiaz Ahmed Nizamani and Xiaoshan Wang:** Designed the study.
**Ahsan Muhammad Khan and Amir Khan Korai:** Prepared the materials, collected and analyzed the data.
**Rehana Naz Syed, Arfan Ahmed Gilal and Khalid Hussain Qureshi::** Helped in disease scoring.
**Imtiaz Ahmed Nizamani, Xiaoshan Wang, Rehana Naz Syed and Arfan Ahmed Gilal:** Supervised the studies.

**Ahsan Muhammad Khan, Shakal Khan Korai, and Xiaoshan Wang:** Wrote the manuscript.
All the authors proofread and approved the final manuscript.

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*Generative AI and AI-assisted technology statement*
The authors declare that no generative AI or AI-assisted technologies were used in the design, execution, analysis, or writing of this manuscript.

*Conflict of interest*
The authors have declared no conflict of interest.

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