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Outbreaks of Cotton Thrips (*Thrips tabaci* L.) A Review of Causes, Impacts and Management Strategies

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is a globally significant crop, vital to the economies of many developing countries due to its multifaced uses in fiber, oil, and livestock feed production. However, its productivity is severely threatened by infestation of thrips (*Thrips tabaci* L.), a highly invasive pest that causes substantial yield and quality losses. This review synthesizes the current understanding of *T. tabaci* outbreaks in cotton, emphasizing their biology, ecology, causative factors, and management strategies. The pest exhibits rapid population growth under favorable conditions, completing multiple generations annually. Environmental factors particularly humidity, rainfall, and moderate temperature (around 30 °C)-strongly influence thrips abundance, while weak correlation are noted with higher temperatures. Outbreaks are further driven by anthropogenic activities such as excessive pesticide use, monoculture expansion, and poor crop rotation practices, which disrupt natural pest-enemy balance and foster insecticide resistance. Spinosad and spinetoram have demonstrated relatively lower resistance level among tested insecticides, while acephate and ulala remain effective chemical options. Nonetheless, reliance on chemicals alone is unsustainable; thus, integrated pest management (IPM) approaches are increasingly advocated. Cultural measures including crop rotation, timely sowing, and use of resistant varieties (e.g., CRIS-7A, AA-802) reduce thrips incidence, whereas biological control agents such as *Chrysoperla carnea*, *Coccinella septempunctata*, and predatory mites play crucial roles in natural regulation. The review concludes that sustainable thrips management depends on the integration of ecological, technical, and chemical approaches, supported by farmer education and policy-level interventions. Further research into thrips ecology, resistance mechanisms, and climate-resilient IPM practices is essential to mitigate future outbreaks and ensure stable cotton production.

Keywords: Outbreak, Thrips, Cotton, Strategies, Population.

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INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a vital crop in numerous developing countries providing a crucial source of revenue and sustenance for farmers by 2018 (Munir et al., 2020; Malinga, 2021). Arshad et al. (2022) and Zhao et al. (2023) cotton is grown in more than 64 countries worldwide with India the United States, China, Brazil and Pakistan accounting for 75% of global production notably India and China together contribute around 50% of the worlds cotton

production (Malinga, 2021). The above-mentioned research showed the high significance of cotton all over the world because of their most valuable products such as fiber, wood, oil, livestock feed etc. This is also clear from the cotton is a valuable crop with multiple uses. It provides fiber for textiles oil from seed for culinary purposes and protein rich meal for animal nutrition (Munir et al., 2020). Cotton crop enhance the economy of farmers and country's economy plays crucial role in the betterment of people and their

lifestyle.

Thrips (*Thrips tabaci* L.)

agroecosystems. They belong to order Thysanoptera. They are phytophagous, predaceous or mycophagous insect pests that inhabit a broad range of habitats. Although about 7700 species of thrips have been reported to date, hardly 1% of thrips, *Thrips tabaci* (Thysanoptera: Thripidae) in cotton is highly invasive and harmful insect pest that causes significant yield losses (Yousif et al., 2022). It has been reported thrips moves as the cotton plant grows thrips infestation tend to spread from the lower leaves to the upper part. To assess population of thrips on young plants, observe leaf damage visually rather than relying on scouting. Apply pesticide before the damage becomes severe enough to cause leaves to curl into a cup shape. Damage by thrips in combination with jassid caused 37.6% cotton seed yield losses (Atique et al., 1990).

Biology and ecology of cotton thrips

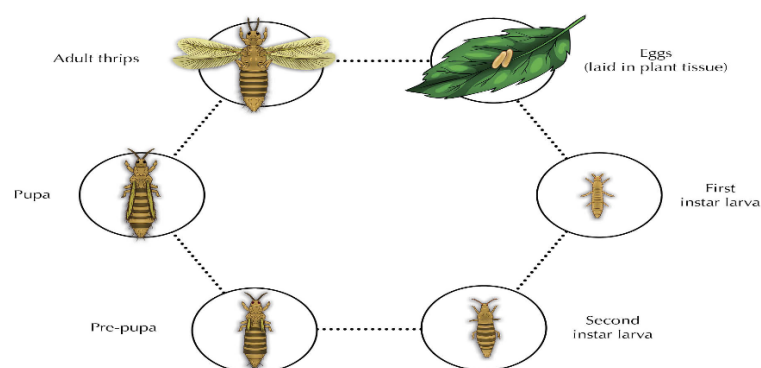
Lifecycle

Females lay eggs singly by inserting them into leaf tissue. Only one end of the egg is in proximity to the tissue surface to allow emergence of immatures. Eggs are microscopic, white or yellow, and kidney-shaped. As eggs mature, they develop an orange tinge and eventually reddish eye spots become evident. On onion, the average length and width of eggs are 0.23 mm and 0.08 mm, respectively (Patel et al. 2013). Incubation period is 4–5 d on onion (Fekrat et al. 2009). Hatching occurs in 2–3 d under laboratory conditions (Pourian et al. 2009), while it may take 5–10 d under cooler field conditions as reported in Utah (Alston and Drost

2008).

Lifecycle

The developmental cycle of thrips consists of six stages including the egg two larval instars two pronymphal phases and the adult stage (Pourian et al., 2009). The entire life cycle duration is 10 to 30 days depending on environmental factors (Eurtunc, 2020). Thrips reproduce through both sexual and asexual (Fail, 2015; Li, 2015; Shelton, 2015) unfertilized eggs can develop into males and females (Riley et al., 2018) whereas fertilized eggs give rise exclusively to females (Li et al., 2015). the eggs are tiny smooth and white measuring about 0.2mm long and 0.08mm wide (Salas, 1993 and Pale et al., 2019). And are individually inserted into leaf tissues (Li et al., 2015). A single female may lay up to 100 eggs which hatch within approximately six days (Moraiet et al., 2017). The first larval stage is whitish and translucent while the second stage turns yellowish (Gill et al., 2015). The larval period extends for nearly 10 days (Shiberu and Mohammed, 2014). During the pupal stage the insects do not feed and this phase lasts four days before adult emergence (Koschier et al., 2022; Pourian et al., 2009). Adult females are about 1.2 mm long, simultaneously males are smaller than 0.7 mm long (Gill et al., 2015). The body color differs from yellow to brown according to temperature (Diaz-montano et al., 2011). Adults with fringed pale wings are very active (Kumar and Omark, 2021). Adults may live up to 35 days (Allen et al., 2015), and complete multiple generations yearly (Fathe et al., 2011).



Behavior

Thrips severely affect young cotton plants by feeding on cotyledon leaves leading to a silvery sheen on the foliage and deformation or curling of the lower surface of true leaves (Cook et al., 2003). The consumption of *Rhadinoceraea reitteri* eggs by adult individuals has been

reported by Knechtel (1931). According to Alford (1984) it has been reported as a natural predator for thrips is two spotted spider mites (*Tetranychus urticae*) in orchard ecosystem. H. graham (2021) also noted that thrips harm cotton seedlings by piercing and sucking plant cells with their rasping mouthparts. This feeding activity gives the

leaves a silvery appearance and causes them to curl upward. Thrips feeding within leaf cracks and folds lead to distortion and curling of still-unfurling cotton leaves. As the leaf expands the injured cells fail to develop properly while the healthy ones continue growing resulting in an upward curl. Severe thrips infestation can cause tangled cotton plants by destroying the terminal bud thus eliminating apical dominance. Such infestation often delays crop maturity, increasing the likelihood of problems later in the season. If left unchecked heavy thrips attacks can seriously impair the growth of cotton seedlings.

Factors affecting *Thrips tabaci*

Climate

It was observed that the correlation between temperature humidity rainfall and sky conditions shows a positive association with the thrips population. However, the relationship between temperature and thrips population was found to be weak ($r = 0.103$) in contrast humidity rainfall and sky conditions exhibited a moderate and positive correlation with thrips population ($r = 0.515, 0.751$ and 0.577 , respectively). Among these factors all showed a significant relationship with thrips population except temperature (Bashir et al., 2022). therefore. It can be concluded that with the increase in temperature from 25 to 35°C there was notable decrease in the duration of different developmental parameters, adult life parameters, entire lifespan and per cent survival of *T. tabaci*. Ideal temperature for the growth of *T. tabaci* is 30 °C as growth rate was maximum at this temperature. (Kaur et al., 2017).

Natural enemies

Natural enemies such as predators' parasitoids and pathogens contribute significantly to controlling pest population in agricultural ecosystems (Chaitanya et al., 2024). According to Isaacs et al. (2009) pest population is also associated with aiding crop pollination. But below the ETL if the pest is above the ETL it's essential to reduce them, therefore. Natural enemies are considered one of the most eco-friendly approaches for pest management. Studies have identified several key predators in cotton fields including the green lacewing (*Chrysoperla carnea*) ladybird beetle (*Coccinella septempunctata*) big eyed bug (*Geocoris* spp.) six spotted lady beetle (*Menochilus sexmaculatus*) as well as parasitoids such as *Trichogramma* spp. and *Apanteles* spp. along with predatory spiders among these *C. carnea* has shown strong potential for the biological suppression of thrips (Khan et al., 2012; Rashid et al., 2012; Solangi et al., 2013; Sarwar, 2014). Some predatory thrips species contribute to lowering thrips population. Their natural enemies including members of families anthocoridae

lygaeidae and certain mites. However, their effectiveness in controlling thrips is relatively limited with *Chrysoperla carnea* proving to be more effective against them (Zia et al., 2008).

Host plant

Planting thrips-resistant cotton reduces insecticide reliance. This approach would holistic integrated pest management strategies by reducing chemical resistance and protecting beneficial insects. The characteristics that decrease thrips population in cotton are not well-known; however, dense leaf hairs and high gossypol content have been linked to thrips resistance. (Miyazaki et al., 2016). The study showed that CRIS-7A, a variety with dense hairs, had the lowest thrips and jassid population per leaf. The maximum per leaf population of thrips, jassid and whitefly was recorded on CRIS-105, CRIS-5A and CRIS-7A (Soomro et al., 2001).

Outbreaks of thrips

Outbreaks of cotton thrips are caused by some biotic and abiotic factors, insecticide resistance and change in agricultural practices as reported that, The seasonal outbreak of thrips individuals on two cotton varieties and effect of ecological components markedly temperature, humidity and rainfall (Hussain et al., 2020). From the agricultural point of view the sowing time also affects thrips population as reported that the thrips infestation intensified in the last week of June exceeding critical limit in July with (8 to 10 individuals per leaf) threshold level. The month of July proved to be the most favorable period for thrips showing the highest population density among all observed varieties (Asif et al., 2020).

Factors affecting the outbreak of thrips

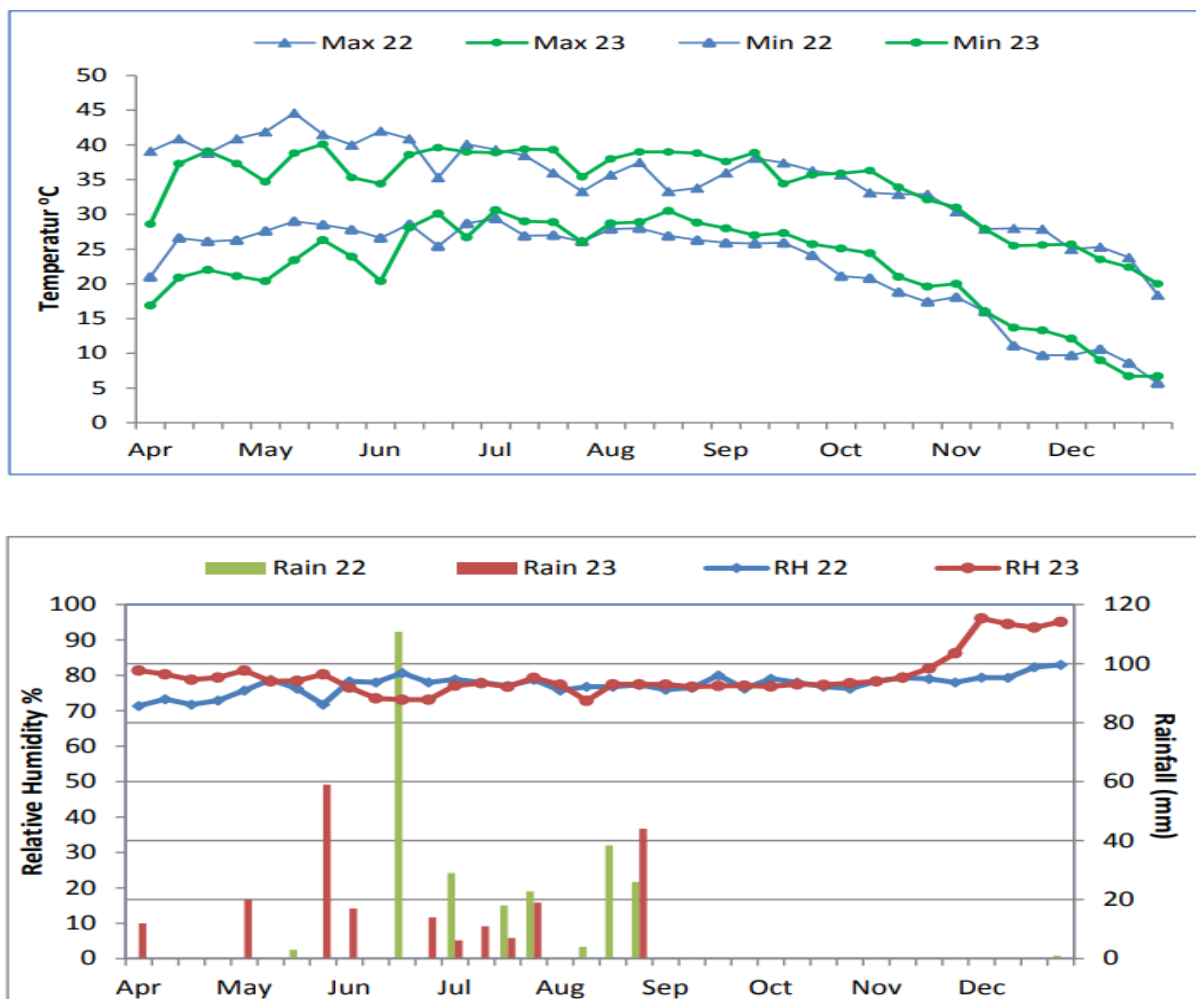
Climate changes

Generally, the weather conditions, temperature and humidity significantly influence thrips outbreak as reported in Hashem et al., (2022) A positive correlation exists between thrips population and certain environmental factors, while the relationship between thrips population and temperature is weak (0.103) humidity rainfall and sky condition show a significant and moderate association (0.515, 0.751 and 0.577, respectively). The relationship between thrips population and these factors is positive, without temperature. The findings reveal significant rises in temperature, humidity, rainfall and overall weather conditions. It is reported in (CCRI) yearly to mean peak temperature 2023-24 that it stood at 34.36°C, down from 35.0°C, in the preceding year. Likewise, the yearly mean low temperature for the current year was 22.42°C, slightly lower than the 22.5°C recorded last year relative humidity ranged from a lowest of 79.8% to a highest of 96.1% throughout the current season. The total rainfall for

the current season was 209.2mm, compared to 253.0mm in the previous year.

Therefore, the thrips population increased in 2023-24. The correlation analysis revealed a strong positive relationship

between temperature and pest population, most notably with *Bemisia tabaci* ($r = 0.715$, $P < 0.001$), followed by *Thrips tabaci* ($r = 0.5$, $P < 0.001$) and *A. bigutulla* ($r = 0.348$, $P < 0.001$) (Gorchani et al., 2025).



Insecticide resistance

Insecticide resistance is a highly variable and context-dependent phenomenon influenced by genetic biochemical and environmental factors (Brattsten et al., 1986) therefore the lack of awareness in the farmers can carry the application of same insecticide due to the insecticide resistance on same piece of land in every season. There is a suggestion for stakeholders, policy makers, extension workers, Governmental institutes agricultural organization etc. to make sure farmers and growers for the rotation of insecticides for prevention of insecticide resistance there is some insecticides have been resistant to thrips *T. tabaci*. As observed in Wakil et al. (2023) that the study evaluated resistance development in field-collected population against

eight insecticides including deltamethrin, lambda-cyhalothrin, imidacloprid, Spinosad, spinetoram, cypermethrin, and abamectin the study demonstrated differing degrees insecticide resistance the thrips population exhibited the lowest resistance when treated with Spinosad (3-8-fold) and spinetoram (3-13-fold). Moreover, resistance intensity differed among population collected distinct geographical regions and according to the Rahim et al. (2025). The effective insecticides are ulala and acephate against thrips *tabaci* in the cotton field and these are best for less crop infestation and better cotton production the acephate is better chemical for the control of this insect pest as reported that the. The highest thrips mortality was observed with acephate 75 sp, resulting in 86.91% and

75.47% mortality after 24 and 72 hours. (Babar et al., 2016).

Role of human activities in thrips outbreak

Human activities are significant for thrips outbreak such as excessive and non-judicious use of synthetic insecticides leads to killing the beneficial insects those are natural control of insect pests, they are environmental friendly to other animals as compare to use of chemicals and the monoculture is also tends the thrips outbreak some study points were observed in (Andow, 1982) that, Monoculture expansion leads to increased population of pests. In contrast cotton monoculture increased pest population, the expansion of monoculture practices has been found to increase 13 pest populations, while reducing two. In wheat crops, growth was observed in only three pest populations, whereas seven either remained stable or declined. Most insect species showing no change or a decrease are multivoltine and feed on multiple host plants (oligophagous or polyphagous) conversely all pest species that showed an increase were monophagous relying solely on a single host crop within the studied region. A greater portion of wheat-associated insect community is multivoltine and oligophagous or polyphagous compared to that of cotton which may account for differing responses of wheat and cotton pests to expanded monoculture. Other influencing factors may include the insect's mobility host location efficiency and the reactions of natural enemies such as predators and parasitoids and irrigation significantly contributes to thrips outbreaks as evidenced by the average number of nymphs and adults per five plants under different irrigation and cover crop conditions in the years 2022 and 2023. (Sapkota et al., 2024).

Impacts of outbreak

There are several impacts of thrips tabaci outbreak on the cotton crop as yield loss and fiber quality reported as, A study in Pakistan found that a combined infestation of thrips in cotton is (14.6 per leaf) and jassid (4.6 per leaf) resulted in yield losses up to 37.6% in seed cotton (Attique and Ahmad., 1990) and cotton fiber is slightly affected by the population of thrips as mentioned in (Sarwar et al., 2020). reported in cook et al., (2011) feeding by thrips leads to leaf deformation, tearing and distortion, which reduces the overall leaf area. This damage hinders plant growth, limits root development and ultimately results in excessive branching.

Management strategies

Cultural control

Implementing proper sanitation, including removing and destroying infested plant material, can help reduce thrips populations. Thrips thrive in weed hosts, so Managing

weeds in and around fields is crucial. (Roli, 2023). While the crop rotation and cover cropping is also an important practice to reduce the population of thrips. As mentioned, it is essential to understand how modification in cropping system influence pest population. According to Donald et al. (2003), thrips were collected from cotton seedlings grown in rotation with corn or following a rye winter cover crop. The study examined the ecological succession of crop pests resulting from a shift from the traditional cotton alfalfa rotation to cotton -grain rotation system. Findings revealed that the diversity growth and spread of harmful species in weeds surrounding the field and intermediate crops could be reduced by approximately 60 to 70% through lateral tillage along a 30-meter border around the cotton field. This approach also protects beneficial insects from the adverse effects of pesticides. Additionally, biological control methods can be applied to remaining 70 to 80% of the field. Properly implementing a cotton grain crop rotation system can help naturally manage (reduce or eliminate) the population harmful organisms (pests' diseases and weeds) in agrophytocenosis. (Botir and Sanjar, 2021). The use of tolerant resistance varieties against thrips is crucial as reported that. The results indicated that AA-802 and VH-259 with 3.40 and 4.45 thrips per leaf respectively exhibited tolerant and vulnerable genotypes (Saleem et al., 2013) Effect of sowing dates for cotton against thrips are significantly affected as mentioned that, the study's findings suggested that changing the planting date could be an effective strategy for reducing thrips damage and losses in upland cotton. (Kerns et al., 2019).

Biological control

Biological control is an important IPM tactic which is environmentally sound and eco-friendly for pest management and has been extensively applied. China has reported nearly 500 natural enemy species in cotton system, but most remain understudied. Seventy-six species of predators and parasitoids targeting lepidoptera pests, and 46 species of natural enemies targeting sucking pests have been described (Luo et al., 2013) therefore. Biological control for thrips is considered as significant control measure because it has been tasted that several natural enemies have been found that are good enough to control thrips (van lenteren and loomans, 1999).

Chemical control

Various effective insecticides have been suggested for controlling sucking pests, but their use has led to resistance resurgence disruption of natural enemy populations and environment contamination (Dhaliwal and Arora, 2001) therefore. It is dire need for environmentally sound and

sustainable insecticides against thrips management. Ecofriendly insecticides were tested as reported in Rahim et al., (2025) that it is suggested that ulala and acephate insecticide be applied to cotton crops to manage thrips infestations and promote healthier production. Meanwhile radiant (spinetoram) and movento energy have been observed sufficiently in controlling thrips with 62% and 56% mortality rates respectively. (Nadeem et al., 2022)

Integrated pest management (IPM)

The research concluded that colored sticky traps, and botanical extracts serve as eco-friendly components of integrated pest management (IPM), effectively minimizing pest population (Khalil and Fakhara, 2024). IPM encompasses various strategies including cultural practices biological control, chemical control and host plant resistance. Combining these approaches effectively is key to achieving optimal results. AI-powered technology plays a vital role in early pest detection facilitating timely interventions and informed decision making (Qayyum et al., 2024)

CONCLUSION

The outbreaks of cotton thrips represent a significant and recurring challenge in cotton-growing regions, affecting both crop vigor and yield quality. Thrips infestations are closely linked to favorable environmental conditions such as dry weather and high temperature, which facilitate their rapid multiplication and spread. The damage caused by these pests-especially during the seedling and early vegetative stages-results in leaf curling, stunted growth and reduced photosynthetic activity, ultimately lowering productivity. Effective management, therefore, requires an integrated approach combining regular field monitoring, timely insecticide application, and the adoption of cultural and biological strategies. The implementation of resistant cotton varieties and conservation of natural enemies can further minimize chemical dependence and enhance ecological balance. Continued research on thrips population dynamics and sustainable control measures remains essential to mitigate future outbreaks and secure the economic viability of cotton cultivation

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