Seasonal Abundance of the Whitefly *Bemisia tabaci* (Gennadius) on Some Cotton Cultivars in Diyala Governorate, Iraq

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Abstract

whitefly *Bemisia tabaci* (Gennadius) is an important pest of cotton *Gossypium hirsutum* , and cultivar-associated differences in infestation can provide a practical component of integrated pest management. A field experiment was conducted during 2025 in Al-Mujaddad village, Al-Khalis District, Diyala Governorate, Iraq, to compare the susceptibility of three Cultivars cotton cultivars, Ashur-1, Lachata, and Coker 310, to naturally occurring *B. tabaci*. The experiment was arranged in a RCBD with four replicates. Twenty leaves were collected from each replicate at weekly intervals from 15 June to 15 November 2025, providing 23 sampling dates and 5,520 examined leaves. Whitefly density was expressed as individuals (nymphs and adult) / leaf, and an area under the pest population curve (AUPPC) was calculated to integrate seasonal pest pressure. Seasonal mean density differed significantly among cultivars ($F(2, 6) = 341.37$, $P < 0.001$). Coker 310 recorded the highest density (0.486 ± 0.011 whiteflies leaf−1), followed by Ashur-1 (0.388 ± 0.014), whereas Lachata recorded the lowest density (0.304 ± 0.009). The corresponding AUPPC values were 76.24, 60.78, and 47.64 whitefly-days leaf−1 for Coker 310, Ashur-1, and Lachata, respectively ($F(2, 6) = 365.77$, $P < 0.001$). Whitefly abundance increased from early summer, peaked on 7 September, and declined thereafter. The mirid predator Campylomma unicolor Poppius, 1914 (Hemiptera: Miridae) was also documented qualitatively in the field, with adults and eggs observed on cotton leaves associated with B. tabaci. Relative to Coker 310, seasonal mean density was 20.2% lower on Ashur-1 and 37.4% lower on Lachata. These results identify Lachata as the least susceptible cultivar under the tested conditions and Coker 310 as the most susceptible. Multi-season and multi-location validation is recommended before broad agronomic recommendations are made.

Keywords: cotton; *Gossypium hirsutum*; *Bemisia tabaci*; cultivar susceptibility; seasonal abundance; host-plant resistance; Iraq

1. Introduction

Cotton is one of the most important commercial fiber crops worldwide, and upland cotton (*Gossypium hirsutum* L.) accounts for most global production. The productivity and quality of cotton are constrained by numerous biotic stresses, including sap-feeding insects. Host-plant resistance is a durable management approach in which genetic variation among cultivars is used to reduce pest establishment or damage, and it can complement chemical and biological control within integrated pest management programs [8].

Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) is a highly polyphagous whitefly complex that damages crops through phloem feeding, honeydew production and associated sooty mold, and, is a major economic pest of cotton and has been reported to cause yield losses of up to 50% (15), and transmission of plant viruses. Modern reviews of plant-whitefly interactions emphasize that resistance may involve physical traits, secondary metabolites, and defense-signaling pathways, and that the effectiveness of these mechanisms varies among host genotypes [10]. In cotton, cultivar differences in whitefly preference and performance have been associated with leaf color and trichome characteristics, although the direction and strength of these relationships are not universal [8, 7]. Molecular studies also indicate that cotton defense against *B. tabaci* involves coordinated signaling and transcriptional responses rather than a single resistance trait [11].

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Field susceptibility is therefore best evaluated directly under local production conditions. Recent field work has continued to demonstrate strong genotype-dependent differences in seasonal *B. tabaci* abundance and oviposition on cotton [1]. Seasonal abundance also changes with crop phenology, environmental conditions, plant quality, and natural enemies [16, 6], so repeated sampling across the crop cycle is necessary to distinguish a persistent cultivar effect from a short-lived population fluctuation.

Ashur, Lachata, and Coker 310 have all been used in Iraqi cotton research. A field study at the University of Baghdad compared these cultivars for growth, yield, and fiber quality [5], while Ashor 1 has been described as an Iraqi cultivar developed after the earlier introduction of Coker 310 [4]. Additional Iraqi research has included Coker 310 and Lachata among locally evaluated cotton germplasm [12]. However, comparative field evidence on their susceptibility to *B. tabaci* under Diyala conditions is limited. The present study therefore aimed to quantify weekly whitefly abundance on Ashur-1, Lachata, and Coker 310; compare season-wide cultivar susceptibility using replicate-based statistics; and describe the seasonal pattern of infestation under field conditions in Diyala Governorate.

2. Materials and Methods

2.1. Study site and field establishment

The field experiment was conducted during the 2025 growing season in Al-Mujaddad village, located southeast of Al-Khalis city, Al-Khalis District, Diyala Governorate, Iraq. The experimental field covered approximately 1,000 m² (20 × 50 m) and had a silty-clay soil. The soil was plowed and leveled before planting. Seeds of the three cotton cultivars were sown on 25 April 2025.

2.2. Experimental design

The experiment followed a randomized complete block design (RCBD) with four (replicates). Sixteen ridges were allocated to each cultivar, with four ridges forming each replicate. Thus, the experiment contained 48 ridges in total. Each ridge was 20 m long, the distance between adjacent ridges was 1.0 m, and seeds were planted on one side of each ridge at 0.40 m between planting positions. The three cultivar treatments were Ashur-1, Lachata, and Coker 310.

2.3. sampling

Sampling commenced on 15 June 2025 and continued at weekly intervals until the end of the experiment on 15 November 2025. At each sampling date, 20 leaves were randomly collected from each replicate of each cotton cultivar at approximately 07:00 h. The leaves were carefully collected and immediately placed in labeled polyethylene bags. Each bag was labeled with the sampling date, cultivar name, and replicate number to ensure accurate identification and traceability of the samples. The collected samples were transported directly to the Soil Microbiology Laboratory, Department of Soil Sciences and Water Resources, College of Agriculture, University of Diyala, where they were examined for whitefly infestation. Upon arrival at the laboratory, the sample bags were placed in a refrigerator for 1–2 h to immobilize the whiteflies and facilitate accurate counting.

For each sample, the total number of whitefly individuals present on the 20 collected leaves was recorded. The recorded population consisted of both nymphs and adults of *Bemisia tabaci*; however, the two life stages were not counted or analyzed separately. Accordingly, the dataset represented the total abundance of whiteflies (nymphs + adults) in each sample. Whitefly density was calculated by dividing the total number of individuals recorded in each sample by the number of examined leaves (20 leaves), and the resulting values were expressed as the number of whitefly individuals per leaf.

2.4. Natural enemy

During weekly field sampling, the predatory natural enemy *Campylomma unicolor* Poppius, 1914 (Hemiptera: Miridae) was identified by the author [3] in the cotton field and recorded in association with the whitefly

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B. tabaci. Adults and eggs of *C. unicolor* were observed on cotton leaves during the sampling period. The occurrence of the predator, its eggs, and adult whitefly was documented photographically under field conditions using the 50-megapixel rear camera of an Infinix Hot 50 Pro smartphone..

2.5. Statistical analysis

Weekly means of whitefly density and standard errors were calculated based on the four experimental replicates. Seasonal mean whitefly density was also calculated for each cultivar. The data were subjected to analysis of variance (ANOVA) using a randomized complete block design (RCBD), with cultivar as the treatment factor and block as the blocking factor. Seasonal mean whitefly density was calculated for each plot, while the area under the pest population curve (AUPPC) was calculated to provide an integrated measure of pest pressure over time using the trapezoidal integration method:

$AUPPC = \Sigma[(Y_i + Y_{i+1})/2](t_{i+1} - t_i)$

(AUPPC= Area Under the Pest Population Curve , Σ=Summation , Y_i= Whitefly density at time t_i , Y_{i+1} = Whitefly density at time t_{i+1} , t_i= Current sampling time , t_{i+1} = Subsequent sampling time , $(Y_i + Y_{i+1})/2$= Mean whitefly density between successive observations , $(t_{i+1} - t_i)$= Time interval between successive sampling dates , i= Observation index) by [14]. where Y_i represents the whitefly density at sampling time t_i. AUPPC values were analyzed using the same RCBD model. When treatment effects were significant ($P \leq 0.05$), Duncan's Multiple Range Test (DMRT) was used to compare cultivar means. All statistical analyses were performed using IBM SPSS Statistics version 26.0. [9]. Data presented in the tables are expressed as mean ± standard error (SE), whereas the seasonal figure presents the weekly mean whitefly density for each cultivar.

3. Results and Discussion

3.1. Seasonal population dynamics and AUPPC

The seasonal population dynamics of whitefly differed among the three cotton cultivars. Whitefly density remained relatively low during June and gradually increased throughout July and August, reaching a common peak on 7 September 2025. (Figure1) At the peak, mean whitefly densities were 0.950, 0.788, and 0.588 individuals leaf^{-1} on Coker 310, Ashur-1, and Lachata, respectively. Thereafter, the population declined progressively until the final sampling date , The present findings are in agreement with those reported by [2]. from southern Punjab, Pakistan.This variation may be attributed to the combined effects of several factors, including sowing date, crop growth stage, temperature, crop physiological condition, irrigation, and natural-enemy activity , However, because weather variables and natural-enemy abundance were not quantitatively measured in the present study, the September peak should be interpreted as an observed seasonal pattern rather than being attributed to any single environmental factor

The cumulative seasonal whitefly pressure, expressed as the area under the pest population curve (AUPPC), (Table 1) also differed among cultivars. The highest AUPPC value was recorded on Coker 310 (76.584 individuals leaf^{-1} × days), followed by Ashur-1 (61.110 individuals leaf^{-1} × days) and Lachata (47.849 individuals leaf^{-1} × days). Thus, Coker 310 experienced the greatest cumulative whitefly pressure during the growing season, whereas Lachata exhibited the lowest cumulative infestation. The AUPPC results were consistent with the observed seasonal population pattern and peak densities, indicating relatively greater susceptibility or suitability of Coker 310 to whitefly infestation compared with Ashur-1 and Lachata, These findings are consistent with those reported by [13], who observed significant variation in the density of *B. tabaci* among different cotton cultivars. Such variation may reflect

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differences in cultivar responses to whitefly infestation and in the suitability of individual cultivars for whitefly reproduction and development.

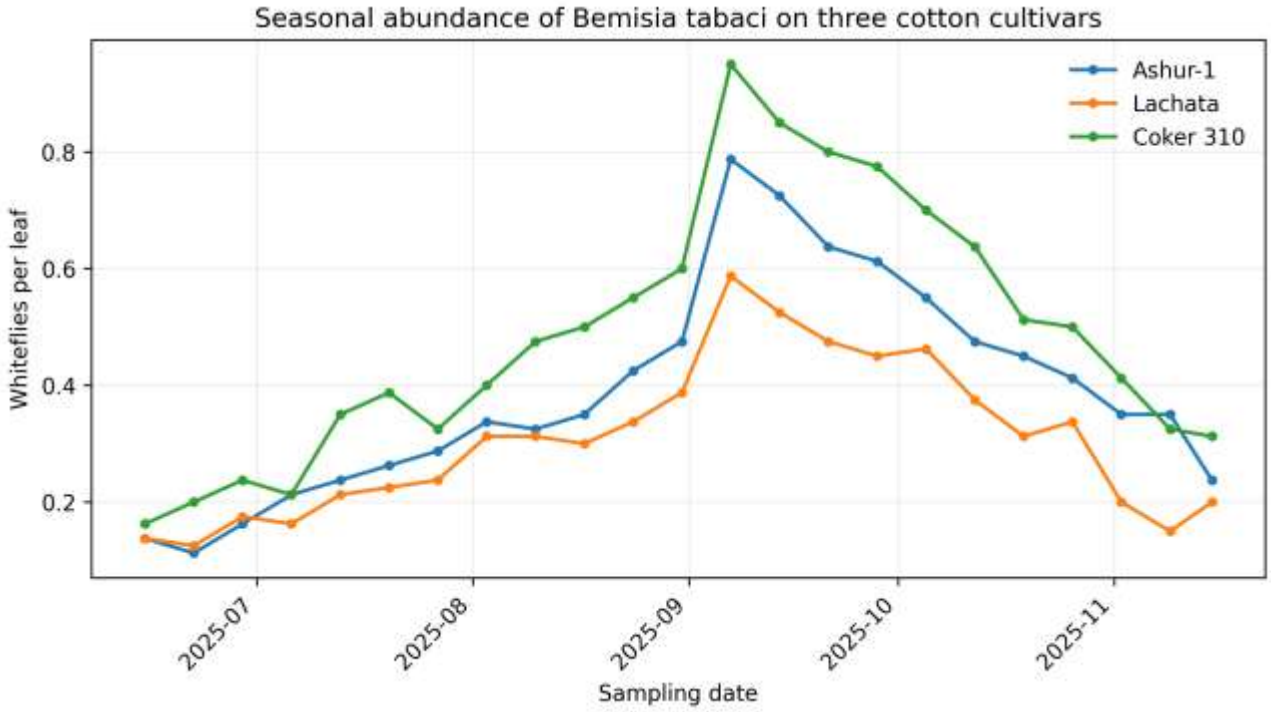


Figure 1. Seasonal mean abundance *B. tabaci* on Some Cultivars of Cotton

Table 1. (AUPPC) of mean *B. tabaci* on Some Cultivars of Cotton

Cultivars	AUPPC (individuals leaf^{-1} × days)	Rank
Coker 310	76.585	1
Ashur-1	61.110	2
Lachata	47.851	3

3.2. Overall Cultivars susceptibility of the *B. tabaci* infestation

Season-wide mean *B. tabaci* density (Table 2) differed significantly among Cultivars ($F(2, 6) = 341.37$, $P < 0.001$). Coker 310 recorded the highest mean density (0.486 ± 0.011 whiteflies leaf−1), Ashur-1 was intermediate (0.388 ± 0.014), and Lachata recorded the lowest value (0.304 ± 0.009). Duncan's Multiple Range Test placed the three means in separate groups at $P \leq 0.05$. Compared with Coker 310, seasonal mean density was 20.2% lower on Ashur-1 and 37.4% lower on Lachata. The resulting susceptibility order was Coker 310 > Ashur-1 > Lachata.

AUPPC produced the same Cultivars order. Seasonal pest pressure was highest on Coker 310 (76.24 ± 1.73 whitefly-days leaf−1), followed by Ashur-1 (60.78 ± 2.13), and was lowest on Lachata (47.64 ± 1.46). The cultivar effect was significant ($F(2, 6) = 365.77$, $P < 0.001$), and DMRT again separated the Cultivars means at $P \leq 0.05$. Because AUPPC incorporates pest density over time, its agreement with the seasonal mean shows that the ranking was not dependent on a single sampling date.

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Table 2. Season-wide *B. tabaci* infestation abundance and integrated pest pressure by cultivar.

Cultivars	Seasonal mean ± SE (whiteflies leaf^{-1})	DMRT group	AUPPC ± SE (whitefly-days leaf^{-1})	Relative susceptibility
Coker 310	0.486 ± 0.011	a	76.24 ± 1.73	Highest
Ashur-1	0.388 ± 0.014	b	60.78 ± 2.13	Intermediate
Lachata	0.304 ± 0.009	c	47.64 ± 1.46	Lowest

Means followed by different letters differ significantly according to Duncan's Multiple Range Test (DMRT) at P ≤ 0.05. AUPPC = area under the pest population curve.

Across the season, the three Cultivars maintained the same susceptibility order in both summary measures: Coker 310 > Ashur-1 > Lachata. Agreement between seasonal mean density and AUPPC strengthens this ranking because AUPPC reflects both pest density and duration rather than a single weekly count. Since infestation occurred naturally, the comparison represents Cultivars performance under the field conditions prevailing in Diyala during the 2025 season.

Differences among cotton genotypes in response to *B. tabaci* have been linked to antixenosis, antibiosis, leaf-surface features, secondary metabolites, and induced defense responses [10–11]. reported associations between leaf color, trichome density, and whitefly preference, while transcriptomic work has shown broader defense-signaling and metabolic responses in resistant cotton [11]. None of these traits was measured here. Lachata's lower whitefly density therefore should not be attributed to a specific resistance mechanism on the basis of the current data. Measurements of trichome density, leaf thickness and color, gossypol or phenolic content, oviposition, and nymphal development would help explain the field differences observed among the Cultivars.

The Cultivars used in this experiment also have direct relevance to Iraqi cotton production. Coker 310, Lachata, and Ashur have previously been evaluated in Iraq for growth, yield, and fiber traits [5], and Ashor-1 was developed locally after the earlier introduction of Coker 310 [4]. The comparison therefore concerns cultivars already linked to Iraqi production rather than unfamiliar germplasm tested only under controlled conditions. Lachata's lower whitefly density may be useful within an IPM program, but cultivar choice should also account for yield, fiber quality, maturity, and adaptation [8, 5].

Although the statistical separation among Cultivars was clear, the ranking should be interpreted within the limits of one location and one growing season. Temperature, pest pressure, crop management, and other local conditions can alter cultivar responses between years and sites. Validation across additional seasons and locations, together with stage-specific whitefly counts and yield measurements, is needed before Lachata-1 is recommended broadly as a whitefly-management component in Diyala.

3.3. Analysis of variance

The RCBD analysis detected significant cultivar and block effects for both response measures (Table 3). For seasonal mean density, the cultivar effect was large relative to the residual error ($F = 341.37$, $P < 0.001$), and the same pattern was obtained for AUPPC ($F = 365.77$, $P < 0.001$). The significant block effect indicates that spatial variation was present within the field, supporting the use of blocking in the experimental design.

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Table 3. RCBD analysis of variance for seasonal mean density and AUPPC.

Response	Source	df	SS	MS	F	P
Seasonal mean density	Cultivar	2	0.066055	0.033027	341.37	<0.001
	Block	3	0.004324	0.001441	14.90	0.0035
	Error	6	0.000580	0.000097		
AUPPC	Cultivar	2	1639.524	819.762	365.77	<0.001
	Block	3	102.411	34.137	15.23	0.0033
	Error	6	13.447	2.241		

3.4. Field occurrence of the predatory mirid *Campylomma unicolor*

Field observations also recorded the mirid predator *Campylomma unicolor* Poppius, 1914 (Hemiptera: Miridae) in association with *B. tabaci* on cotton plants. Eggs of *C. unicolor* occurred on leaves where adult whiteflies were present (Figure 2), and adults of the predator were photographed on cotton foliage (Figure 3). These records confirm the natural occurrence of the predator in the experimental field. Because predator abundance and feeding events were not quantified, the photographs are treated as qualitative evidence of occurrence rather than as a measure of predation intensity.

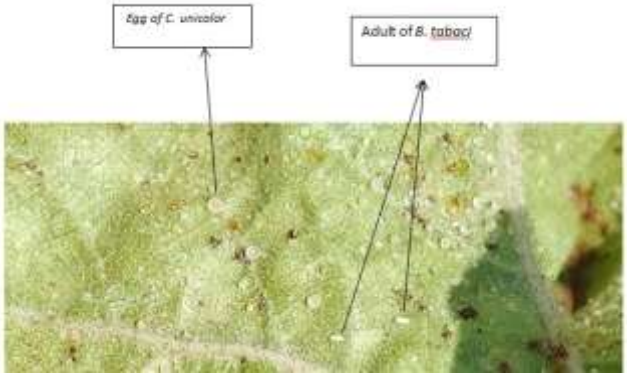


Figure 2. Field photograph of a cotton leaf showing adult *B. tabaci* and eggs of *C. unicolor*, in cotton field in Diyala Governorate, Iraq.



Figure 3. Adult *C. unicolor* on a cotton leaf

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Natural enemies can contribute to the seasonal regulation of *Bemisia tabaci* in cotton [6]. The occurrence of *C. unicolor* therefore provides useful ecological context for the whitefly population pattern recorded in this field. However, predator density, predation rate, and cultivar-specific distribution were not measured. The cultivar differences, as well as the decline after September, cannot therefore be attributed directly to predator activity from the present data alone.

The experiment was conducted at one field site during one growing season. The dataset contained total whitefly counts rather than separate egg, nymph, and adult counts. Weather variables, quantitative natural-enemy abundance, plant morphological or biochemical resistance traits, and cotton yield/fiber quality were not included in the dataset analyzed here. Although the occurrence of *C. unicolor* adults and eggs was documented photographically, predator density and predation rate were not quantified. Consequently, the study can establish relative field susceptibility and seasonal abundance, but it cannot identify the causal mechanism underlying cultivar differences, quantify the contribution of biological control, or quantify the agronomic trade-off between pest resistance and yield.

4. Conclusion

Under field conditions in Al-Mujaddad village, Diyala Governorate, the three cotton cultivars differed significantly in susceptibility to *Bemisia tabaci* during the 2025 season. Coker 310 recorded the highest seasonal mean density (0.486 whiteflies leaf−1), Ashur-1 was intermediate (0.388), and Lachata recorded the lowest density (0.304). Lachata therefore supported 37.4% fewer whiteflies, on average, than Coker 310, and AUPPC gave the same cultivar ranking. Whitefly abundance increased through summer, peaked on 7 September, and declined toward November. Within the conditions tested, Lachata was the least susceptible of the three cultivars and warrants further evaluation as part of integrated whitefly management in Diyala. Broader recommendations will require confirmation across additional seasons and locations and should include yield, fiber quality, plant resistance traits, and stage-specific entomological measurements.

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