



Biology, Morphology, and Taxonomy of the Wheat Aphid *Sitobion Avenae* (Fabricius, 1775) under Laboratory Conditions

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ABSTRACT

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The present study was conducted on the biology, morphology, and taxonomy of the Wheat aphid, *Sitobion avenae*, under laboratory conditions, Rabi season 2026. The specimens were collected from the Date Palm Research Institute, Agriculture Extension Department, Government of Sindh, Kot Diji, Khairpur, Sindh, Pakistan. Aphid populations were reared at $25 \pm 2^\circ\text{C}$, 65 RH% and 16:8h (light: dark) photoperiod. Four nymphal instars were observed during the study. The total nymphal development period ranged from 7–10 days, with a mean duration of 8.5 ± 0.75 days. The longevity of adult females ranged from 15–25 days, with a mean duration of 20.0 ± 2.50 days and reproduced parthenogenetically, producing approximately 30–70 nymphs during their lifetime. Progressive morphological development was observed throughout the successive instars with a gradual increase in body mean length from 0.60 ± 0.10 mm and 0.25 ± 0.05 mm, in the 1st nymph instar, the mean length of 2nd nymph 0.85 ± 0.15 mm, width 0.25 ± 0.05 mm, 3rd nymph mean length 1.25 ± 0.25 mm, width 0.50 ± 0.10 mm. The 4th nymph mean length 1.75 ± 0.25 mm, width 0.65 ± 0.15 mm. The mean length of adult 3.30 ± 0.70 mm, width 0.80 ± 0.20 mm. Elongate antennae, cylindrical cornicles, elongated cauda, and the presence of alate and apterous forms were important characters for accurate species identification. The biological characteristics indicate rapid population growth and high reproductive potential under favorable conditions. Our findings provide baseline information for understanding the bio-morphological and taxonomic position of *S. avenae* and developing sustainable integrated pest management strategies. Future studies should focus on the population dynamics, host interactions, and sustainable management of English grain aphid.

Introduction

Wheat (*Triticum aestivum* L.), a member of the family Poaceae, is a major agricultural and staple food crop worldwide, commonly cultivated during the Rabi season (Kalhor *et al.*, 2022). Wheat is the key source of about half of the food calories consumed worldwide and is rich in proteins (gluten), minerals (Cu, Mg, Zn, P, and Fe), vitamins (B-group and E), riboflavin, niacin, thiamine, and dietary fiber (Singh *et al.*, 2019). Over 35–40% of the world's population relies on it as their staple food, feeding more than 4.5 billion people around the world, 21% of human calorie needs and 10–12% of protein needs (Shewry, 2002). Around 21% of the land area utilized for food grains cultivation is used for wheat, and wheat does well in diverse agricultural climates and global water regimes (Hussain *et al.*, 2024). The bread quality is mostly examined by wheat seed-storage proteins, which are a significant source of food and energy (Khalid *et al.*, 2023). Although it was grown on 9.73 million hectares and yielded 31.8 million tons in Pakistan in 2023–2024, the average yield (3,268 kg/ha) was still well below

the projected output of 5,000–8,000 kg/ha (Nazar, 2026). But the variations in temperature can also influence the lifespan and growth performance of wheat cultivars and other cereal crops (Mastoi *et al.*, 2023).

Aphids are known as a regular pest of wheat crops because of a drastic increase in their population and are responsible for a low rate, as high as a 50% reduction in grain weight per year (Pathan *et al.*, 2026). As the larval stage of *Papilio demoleus* is highly destructive to lemon plants, causing significant damage to newly emerging leaves through its feeding activity (Mangrio and Sahito, 2022). Similarly, the nymphal stage of *Sitobion avenae* causes significant crop damage, with direct losses of 30–40% losses due to disease transmission (Hussain *et al.*, 2024). Four aphid species, namely; *Schizaphis graminum* (R.), *Rhopalosiphum rufiabdominalis* (S.), *Rhopalosiphum padi* (L.), and *Sitobion avenae* (F.), are pests of the wheat crop in Pakistan, and generally aphid species are known by different names, such as; greenflies, black flies, plant lice, or tiny sap-sucking insects (Schughart *et al.*, 2025). Aphids have soft bodies and are usually dark brown, pink, green, white or almost dull colored, and have three paired legs with jointed appendages, a tail-like structure called cauda over the posterior space and double eye made up of 2 sets of 3 points called ommatidia (Han *et al.*, 2019). The high temperatures can lead to an upsurge in pests like wheat aphids, which could have adverse effects on crop production (Wang *et al.*, 2021).

The various chemical control strategies are widely applied against aphid and other insect pest control but have caused problems like disturbing natural biological control (Mangrio and Sahito, 2023). Alternative management strategies are necessary and approaches such as biological control, cultural, physical, mechanical, and host plant resistance have been explored under the umbrella of Integrated Pest Management (Jasrotia *et al.*, 2022). Botanical insecticides are effective at sub-lethal concentrations, particularly those causing strong sub-lethal effects on insect pest biology (Malik *et al.*, 2017). Despite the economic importance of *S. avenae* as a major pest of wheat, detailed information on its biology and morphology, under local conditions remains limited. Accurate identification of its developmental stages is important to understand its biology and for the creation of efficient monitoring and integrated pest management programs. Thus, the biology and the morphology of *S. avenae* were studied with special reference to the morphology and measurements of various developmental stages under the laboratory conditions. This information will aid in proper species identification and sustainable management of wheat aphids.

Material and Methods

The population of the wheat aphids were collected from the research fields area of Date Palm Research Institute Agriculture Extension Department, Government of Sindh, Kot Diji, District Khairpur, Sindh, Pakistan located (27.3559° N, 68.7215° E) during, Rabi season, 2026, further justified in (Figure 1).

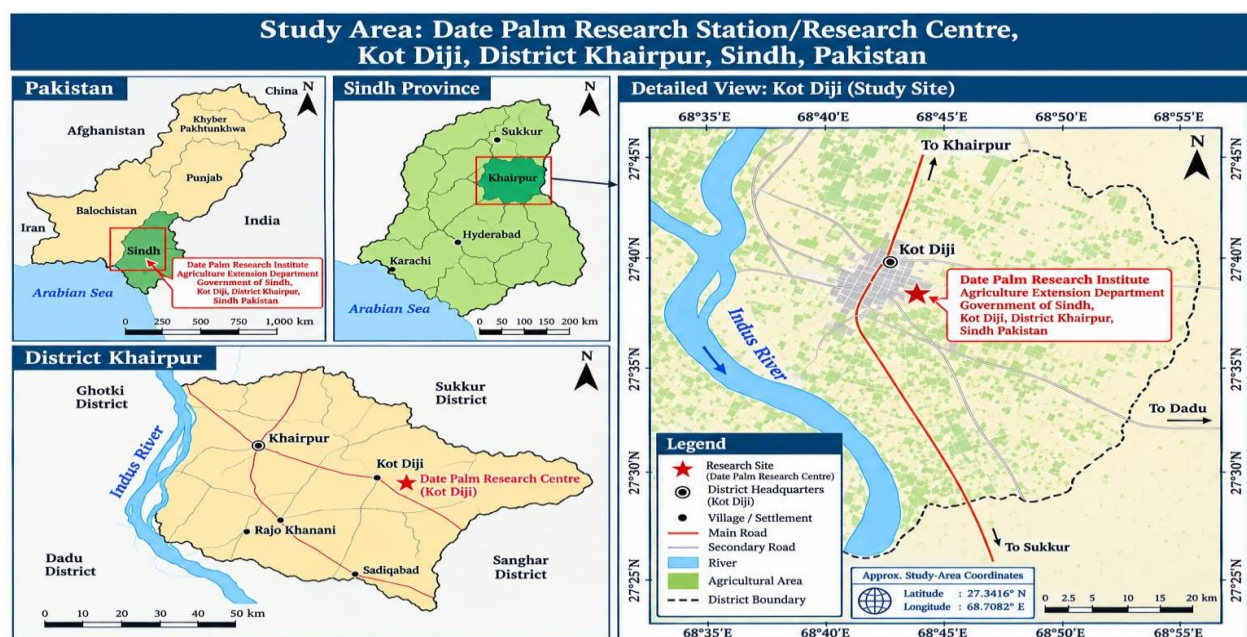


Figure 1. Map of the research study area

Collection of wheat aphid specimens

The aphid's population infesting wheat was collected from the reported fields using the hand-picking method. A total of ten wheat tillers per field were randomly selected. Aphids present on the stem, leaves, and spikes were carefully removed using a zero sized fine camel-hair brush, to avoid damage to the specimens. The collected samples were immediately transferred into labeled plastic boxes (16×16) cm. The tops of the plastic boxes were covered with muslin cloth to ensure adequate ventilation. The specimens were immediately brought to the laboratory for colony establishment and further experimentation.

Establishment and maintenance of laboratory culture

The population of the aphids was raised on host plants, healthy wheat seedlings. The stock colony was maintained under laboratory conditions at $25\pm 2^{\circ}\text{C}$, 65 RH% and a 16:8 h (light: dark) photoperiod. Every 24 h fresh wheat plant was supplied to provide a constant source of nutritious host material. Five independent replicates were maintained during the experimental period to reduce the experimental error and to ensure uniformity of observations under Entomology Laboratory, Department of Zoology, SALU, Khairpur.

Biology of the English grain aphid, (*Sitobion avenae* Fabricius, 1775)

Adult apterous females were reared individually in separate rearing boxes containing fresh wheat plants. The aphids reproduced through viviparous parthenogenesis and the life cycle of *S. avenae* was observed daily under laboratory conditions. The durations of the pre-viviposition, viviposition, and post-viviposition periods were recorded. The developmental period of each nymphal instar was determined by observing successive molts until adult emergence. Adult longevity, total lifespan, and reproductive performance were also recorded.

Identification of the specimens

The diagnostics features of the collected aphids were identified under the stereo zoom microscope. The identification was performed by using the available literature and taxonomic keys of (Blackman and Eastop, 2018).

Morphological characteristics identification

The first, second, third, fourth instar nymphs of each developmental stage and adults were studied under a stereo zoom microscope. Morphological observations involved body color, body shape, segmentation, antennae, cornicles, wing bud, and cauda. Morphometric measurements were recorded in millimeters (mm) using an ocular micrometer, calibrated against a stage micrometer. Measurements were taken from healthy individuals representing each developmental stage to determine patterns of growth during ontogeny.

Photography and documentation

Photographs of representative specimens of each developmental stage were taken with a stereo zoom microscope. The life cycle, diagnostic morphometric characters of *Sitobion avenae* illustrated with digital photographs. The photographs were then processed for figure preparation and scientific record.

Statistical analysis

The data were statistically analyzed with Statistix 8.1, SXW software. The one-way analysis of variance (ANOVA) was used to compare the means of the different developmental stages. Then significant differences were detected ($P < 0.05$), least significant differences were used to separate the means.

Results

The present study was performed on the biology and morphology of *Sitobion avenae* under laboratory conditions. The life cycle of *S. avenae* consisted of four nymphal instars followed by the adult stage. A gradual increase in body size and morphological development was observed throughout the successive developmental stages. The viviparous period of *S. avenae* is the reproductive phase during which adult females give birth to live nymphs through parthenogenesis. Under favorable conditions, a female produced 1-5 nymphs at a time and almost 30-70 nymphs over her lifetime. The number of nymphs produced depends on abiotic factors. The first-instar nymph was the smallest and most vulnerable developmental stage. Newly born nymphs were light green, soft-bodied and had short, five-segmented antennae and legs, with the siphunculi (cornicles) poorly developed. This stage was not as active as the later instars and consumed 1-2 days, and 1.5 ± 0.25 with overall mean days. The second instar nymph exhibited a noticeable increase in body size and slight darkening of body color. The nymph also possessed five-segmented antennae, and legs became more prominent. The siphunculi elongated, making the

morphological features more distinct than those of the first instar. The second instar nymph lasted 1 to 2 developmental days and 1.5 ± 0.25 in overall mean days. The third instar nymph was examined by further growth and more pronounced morphological characteristics. Their body color varied from green to yellowish-green and had antennae found with six segments. The segmentation of the abdomen became evident, and the siphunculi were fully grown. This stage lasted 1.5 to 2.5 days with an average mean 2.0 ± 0.50 days. The fourth instar nymph closely resembled the adult in general appearance, with six-segmented antennae, but lacked fully developed reproductive organs. Body size increased further, and body color became more pronounced. In individuals that later developed into winged adults (alates), wing buds became visible during this stage. The fourth instar lasted 2–3 in developmental days and 2.5 ± 0.25 with overall mean days. The adult *S. avenae* occurred in two forms, apterous (wingless) and alate (winged) females as shown in (Figure 2). Both reproduce large numbers of young ones by viviparous, parthenogenesis in a favorable condition. The apterous have high reproductive capacity than alate female when population increase the migrate to new host plants. Adult females lived for 15–25 days with a mean longevity of 20.0 ± 2.50 days. Pre-viviposition time ranged from 1 to 2 days, 1.50 ± 0.25 mean days, viviposition took 10 to 20 days, and 15.00 ± 2.50 mean days, and post-viviposition consumed 2 to 5 days, and 3.50 ± 0.75 mean days. The total lifespan of females ranged from 20 to 35 days, with an average mean value 27.5 ± 3.75 days, as depicted in (Figure 3).

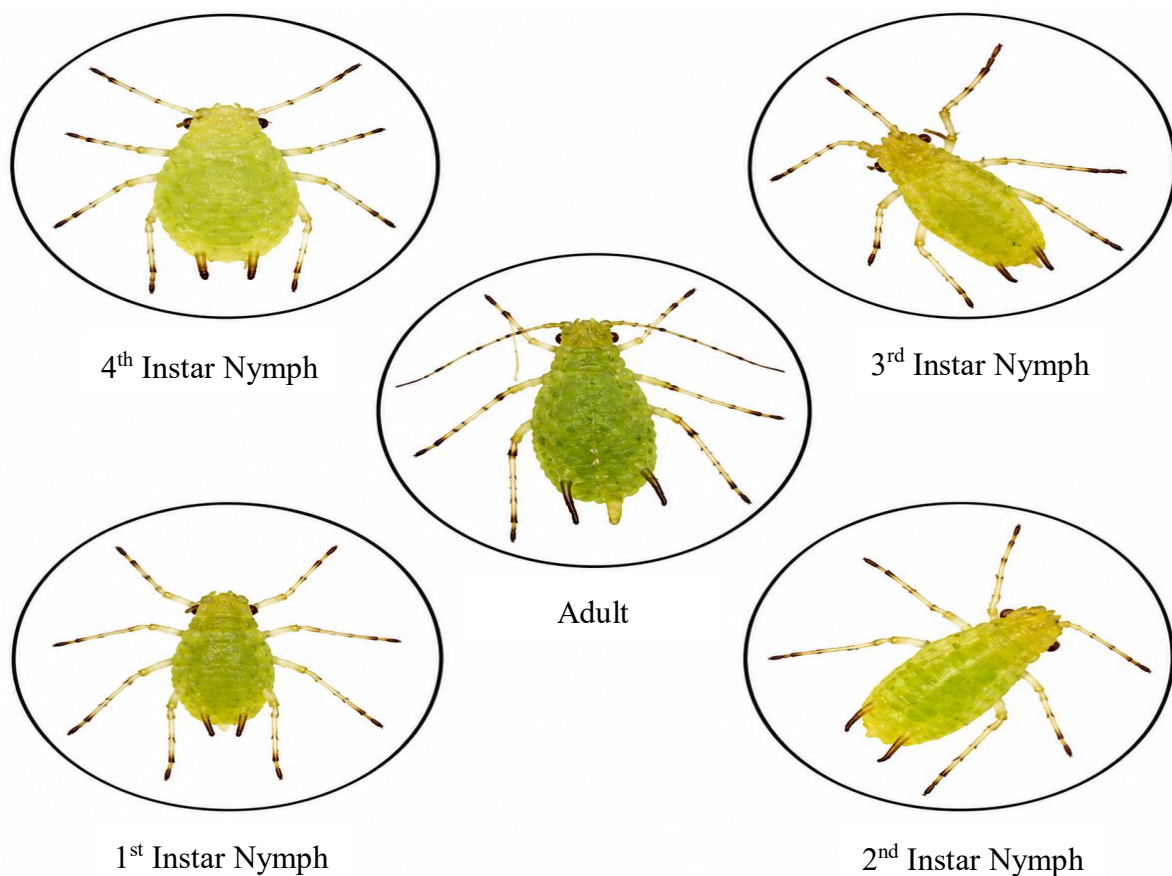


Figure 2. Nymph and adult stages of *Sitobion avenae* under the laboratory conditions

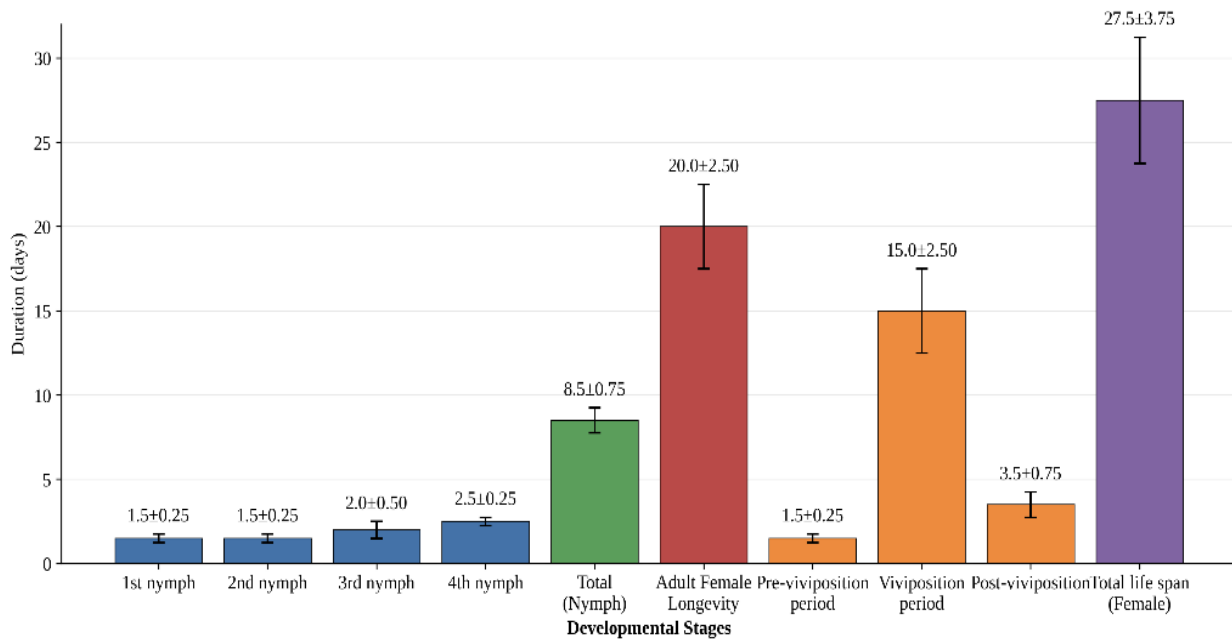


Figure 3. Developmental days of wheat aphid *Sitobion avenae* under the laboratory conditions

Morphological measurements of the developmental stages of *Sitobion avenae*

The 1st nymph instar body found small sized, with a length of 0.50-0.70 mm and width of 0.20-0.30 mm, with mean values of 0.60 ± 0.10 mm and 0.25 ± 0.05 mm. The 2nd nymph stage measured 0.70 to 1.00 mm in length and 0.30 to 0.40 mm in width, with 0.85 ± 0.15 mm and 0.35 ± 0.05 mm, mean values. 3rd stage found larger than the first and second nymphs, measured body length 1.00-1.50 mm and width 0.40-0.60 mm, with means of 1.25 ± 0.25 mm and 0.50 ± 0.10 mm and the 4th stage recorded gradually increases in size 1.50-2.00 mm in length and 0.50-0.80 mm in width, with mean values of 1.75 ± 0.25 mm and 0.65 ± 0.15 mm. The adult stage exhibited the largest body dimensions, ranging from 1.60-3.00 mm in length and 0.60-1.00 mm in width, with 2.30 ± 0.70 mm and 0.80 ± 0.20 mm mean values. Generally, these results show a gradual increase in body size during the progressive stages of *S. avenae*, which leads to the conclusion that the development of body parts is normal and the morphological differentiation from the first instar nymph to the adult stage, respectively, as justified in (Figure 4).

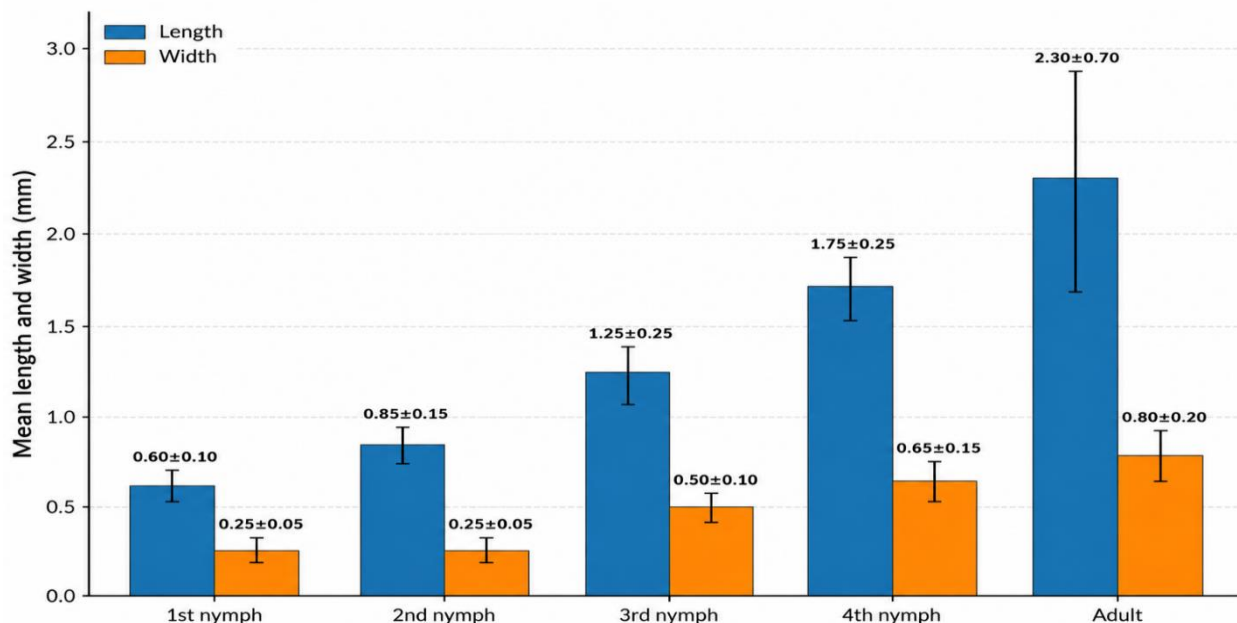


Figure 4. Nymph and adult body mean length, width, and ($\pm$ SE) of *Sitobion avenae*

Sitobion avenae morphometry of adult body organs

The hind legs were the longest appendages of the wheat aphid, measuring 1.50–2.20 mm in length 1.85 ± 0.14 mm with average mean, and played an important role in locomotion and maintaining the insect's position on the host plant. The antennae were relatively long, measuring 1.50–2.00 mm in length, and 1.75 ± 0.10 mm with overall mean. The head was the smallest body region, measuring 0.20–0.28 mm in length, and 0.24 ± 0.02 mm average mean. The thorax, which bears the legs and wings (if present), is modestly sized, 0.40–0.60 mm, mean 0.50 ± 0.04 mm. The abdomen was found the most important section for growth and reproduction, and is the largest in size, 1.00–1.60 mm, mean 1.30 ± 0.12 mm. Aphids were characterized by cornicles (siphunculi), which range from 0.40–0.50 mm and have a mean of 0.45 ± 0.02 mm, as justified in (Figure 5). The morphometric analysis showed that the hind legs and antennae of *S. avenae* are relatively long, the abdomen relatively large, and the cornicles distinct, which is important for its survival, feeding, and reproduction. The morphometric characteristics of various parts of the body of *S. avenae* are shown in (Figure 6).

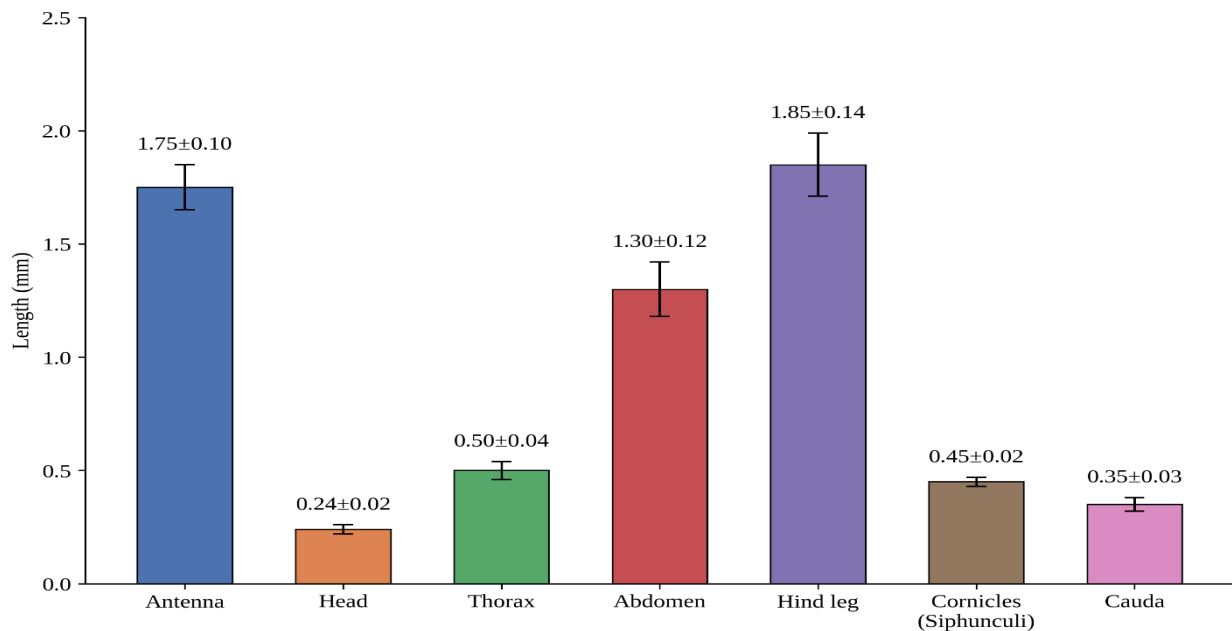


Figure 5. Morphometry of different organs of *Sitobion avenae*

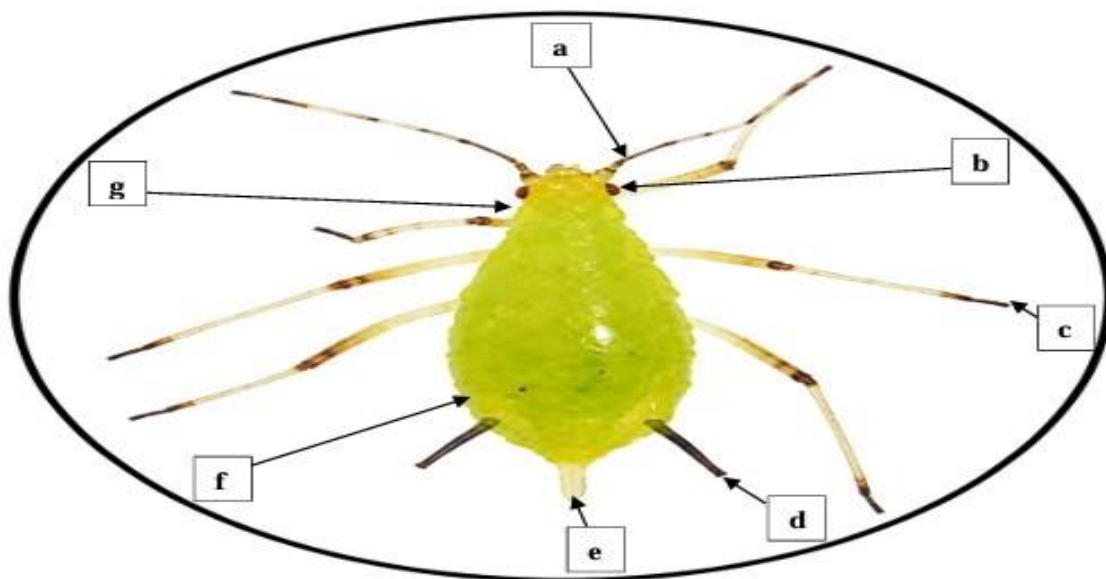


Figure 6. Dorsal view of *Sitobion avenae*, a (antenna), b (eyes), c (jointed legs), d (cornicles), e (cauda), f (abdomen), g (thorax)

Systematic position of *Sitobion avenae*

- **Kingdom:** Animalia
- **Phylum:** Arthropoda
- **Class:** Insecta
- **Order:** Hemiptera
- **Family:** Aphididae
- **Genus:** *Sitobion*
- **Species:** *Sitobion avenae* (Fabricius, 1775)
- **Common Name:** English grain aphid/ Wheat aphid

Diagnostic Features

They are spindle-shaped insect pest species, and their body color is light green to yellowish green sometimes slightly brownish. They have long and slender six segmented joints that are darkened especially at the tip antenna (filiform), often longer than body. They have long, cylindrical and black cornicles (siphunculi), which are clearly visible at the posterior end which was found slightly swollen towards the tip and this is one of the most important diagnostic features. The cauda is elongated, tongue-shaped, and pale in color, relatively longer than in many other aphid species. They have long and thin legs, joints (knee/tarsi) often dark in color well adapted for movement on wheat stem, leaves and spikes. They have two body forms winged (alate) and wingless (apterous). They possess two pairs of transparent wings, which are responsible for the dispersal and migration to new hosts, but most of the population is wingless. They produce mainly by viviparous, parthenogenesis, produce genetically identical offspring without fertilization by a male leading to rapid population growth. They suck in plant sap with the help of rostrum, secrete excess sap or honeydew. Many species of aphid have developed a symbiotic relationship, with the ants cleaning aphid honeydews from the aphids and providing protection from predators such as ladybird beetles, lacewings and other ant species.

Discussion

The present study gives detailed understanding regarding the biology, morphology and morphometric characteristics of *Sitobion avenae* under laboratory conditions. The results indicated that the aphid developed four nymphal instars to attain the adult stage and took 7-10 days to complete the developmental stage, with an average of 8.5 ± 0.75 days. This is with the work similarity of (Jatoi *et al.*, 2020), they documented adult male and female lesser date moths had longevities of 4.70 and 8.38 days, respectively, while their total life spans were 45.60 and 46.64 days. The results obtained suggested that *S. avenae* has a comparatively brief life cycle and has the opportunity of producing several generations in a single wheat season. (Wains *et al.*, 2023) reported that cereal aphids are very fast-developing insects that can multiply quickly on a short time scale if the environmental conditions are favorable. Likewise, (Jasrotia *et al.*, 2022) emphasized that the short developmental period of wheat aphids is one of the major reasons for their economic importance in cereal crops. (Mangrio and Sahito, 2025), documented that the adult longevity of *Rhynchophorus ferrugineus* lasts 43.70 ± 5.92 days in males and 49.38 ± 6.38 days in females. Therefore, the present findings support previous reports that *S. avenae* possesses high biological efficiency and a strong capacity for rapid increase in numbers. The length of each instar of the nymphs was a natural increase from the first to fourth instar, representing normal insect growth and moulting. The development of early instars took 1-2 days, while the development period of the fourth instar was relatively longer lasted 2 to 3 days for adult emergence. (Blackman and Eastop, 2018) have found similar developmental changes, the nymph stages increased in body size and developmental time with each successive moult. The morphology and length of successive instars also offer good diagnostic characters for species identification, as mentioned (Hussain *et al.*, 2024). The similarity of the present study with previously reported work substantiates the general trend of development of *S. avenae* under laboratory conditions.

Through morphological observations gradual changes were observed in the color, body shape, antennae, siphunculi, segmentation of abdomen and wing buds. The nymphs were light green, with poorly developed siphunculi present in the newly born, clearly visible abdominal segmentation and elongated cornicles in later instars. The adults were wingless (apterous) or winged (alate). (Mal *et al.*, 2024), assessed the biology, feeding potential, and seed damage of *Callosobruchus maculatus* on five pulses, with cowpea (*Vigna unguiculata*) being the most preferred host. The results are in close agreement with those of (Blackman and Eastop, 2018) they recorded elongated antennae, cylindrical cornicles and elongated cauda like main characters in the taxonomic description of *S. avenae*. (Hussain *et al.*, 2024) reported the morphological characteristics

are important for the differentiation of *S. avenae* from wheat aphids. The morphometric study also showed that the body length and width from the 1st instar to the adult stage were continuously increased. Adults exhibited the largest body dimensions, whereas early instars showed comparatively lower variation. This is a normal pattern of growth, progressive increase due to repeated moulting and tissue development. (Hussain *et al.*, 2024) reported similar morphometric trends stating that the body measurements are important taxonomic and developmental characters. The lifespan of female adults were about 20 to 35 days, with mean lifespan 27.5 ± 3.75 days. (Ghumro *et al.*, 2026), evaluated the biology of *Carica papaya* was studied at $30 \pm 2^\circ\text{C}$ and $40 \pm 2^\circ\text{C}$, with female and male lifespans of 36.58 and 25.79 days, respectively, at $30 \pm 2^\circ\text{C}$. The prolonged reproductive period recorded in this study is due to the outstanding reproductive capacity of *S. avenae*. The female aphids were parthenogenic and viviparous. (Wains *et al.*, 2023), reported similar reproductive behavior. Wheat aphids can use favorable environmental conditions quickly through parthenogenesis while survival is reduced when environmental conditions are excessively warm. Therefore, monitoring of *S. avenae* is necessary to manage their populations properly.

The high rate of population increase, often noted in wheat fields, may be attributed to a short developmental cycle, prolonged lifespan of the female and continuous reproduction. (Han *et al.*, 2019) showed that temperature at moderate levels stimulates aphid development and reproduction, but high temperature has a negative effect on aphid survival. (Wang *et al.*, 2021) similarly reported that climatic warming influences feeding behavior and host-plant interactions affect the population of wheat aphid. Although the present study was conducted under laboratory conditions, the observed biological characteristics strongly suggested that *S. avenae* has the capacity to become a destructive pest whenever suitable temperature, humidity, and host quality are available. (Wains *et al.*, 2023) reported that the climatic conditions are also very important in establishing seasonal abundance of aphids in the wheat-growing areas. Regular monitoring, aphid-tolerant varieties, and eco-friendly pesticides are recommended to minimize wheat aphid losses (Sahito *et al.*, 2017). The use of biological control, host plant resistance, cultural control and judicious pesticide management, rather than chemical control are best remedies. (Hussain *et al.*, 2024) also emphasized the importance of developmental stages for proper identification to select the most appropriate management strategy. The detailed biological and morphological information generated during the present study therefore provides valuable baseline data for pest surveillance, forecasting, and sustainable management programs. Overall, the present investigation is in close agreement with previous national and international studies describing *S. avenae* as one of the most important aphid pests of wheat.

Conclusion

The present study provides a comprehensive understanding of the biology, morphology, and taxonomy of the wheat aphid, *Sitobion avenae* under laboratory conditions that has a short developmental cycle 7–10 days, rapid parthenogenetic viviparous reproduction, and high population growth potential. Four different nymphal stages were also recognized, body size and morphological complexity increased with each instar from first nymphal instar to the adult stage. The present morphometric analysis showed the length and width of the insect increased consistently, whereas the more prominent morphological characters like elongated antennae, prominent cornicles and well-developed abdomen help to identify the insect species accurately. These bio-morphological attributes are responsible for the pest's fast infestation and economic damage to wheat crops. Hence early detection and implementation of Integrated Pest Management strategies such as; biological control, wheat resistant varieties and prudent use of biopesticides are crucial for sustainable control of *S. avenae*.

Recommendations

The results of the present study suggest the need to monitor wheat fields regularly to detect early attacks by *Sitobion avenae*. The population of natural enemies should be conserved and enhanced to support effective biological control. Further field studies under different environmental conditions for evaluating the results in the laboratory and in field conditions is needed to gain better sustainable aphid management.

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