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Biological attributes of niger aphid, *Uroleucon compositae* (Theobald) (Hemiptera: Aphididae) under laboratory condition

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Abstract
The investigation into the biology of the Niger aphid, *Uroleucon compositae*, has revealed important insights into the developmental stages and morphological characteristics of this insect. The study found that the nymph of *U. compositae* goes through four distinct instars before reaching the adult stage. In the first nymphal instar, the aphid is wingless, elongated, delicate, and pale brownish in colour. It possesses small compound eyes located just behind the base of the antennae, which appear reddish to black. The first-instar nymph's measurements indicate a length of approximately 0.85±0.04 mm and a breadth of 0.36±0.03 mm. The antennae are relatively long, with five segments measuring about 0.88±0.05 mm. The three pairs of well-developed, light brown thoracic legs are uniformly covered with hairs, and their lengths are 0.688±0.005 mm (front), 0.824±0.007 mm (middle), and 0.950±0.020 mm (hind). The first instar nymphal period lasts for 2.43±0.67 days. In the second nymphal instar, the aphid darkens in colour, becoming dark brown, oval, and slightly bulged in shape. The compound eyes have three dot-like ommatidia at the posterior end. The nymph measures 1.22±0.06 mm in length and 0.56±0.03 mm in breadth. The antennae are shorter than the body, with five segments, and their length is 1.08±0.03 mm. The leg lengths are 0.885±0.014 mm (front), 0.972±0.024 mm (middle), and 1.196±0.023 mm (hind). Hairs are observed on all three pairs of legs, and the cornicles are distinct and cylindrical in shape. The second instar nymphal period lasts for 2.6±0.55 days. In the third nymphal instar, the aphid darkens further to a dark brown color. The compound eyes become larger, rounder, and reddish-black, and the antennae consist of six segments. The nymph's length is 1.55±0.12 mm, and its breadth is 0.77±0.06 mm. The antennal length measures 1.43±0.06 mm. The leg lengths are 0.983±0.030 mm (front), 1.165±0.010 mm (middle), and 1.912±0.028 mm (hind). The cornicles and cauda are dark brown. The duration of the third nymphal instar is 2.10±0.70 days. In the fourth nymphal instar, the aphid appears blackish in colour and elongated in shape. The compound eyes are expanded and remain black to reddish, and the antennae are six-segmented. The length and breadth of the fourth nymphal instar are 2.65±0.05 mm and 0.94±0.03 mm, respectively. The antennae measure 2.41±0.05 mm in length. The legs are stout, with the coxa, trochanter, distal area of the femur, and tibia being dark brown, while the remaining portions are light in color. The leg lengths are 1.524±0.043 mm (front), 1.815±0.063 mm (middle), and 2.353±0.106 mm (hind). The duration of the fourth instar is 2.30±0.64 days. The total nymphal period for *U. compositae* is 9.43±1.08 days. The adult aphid is shiny and dark black in colour, with a spindle-like to elongated pyriform body. The compound eyes are bulged and reddish-black. Alate adults are similar to apterous adults. The morphometrics of the adult reveal a length of 2.86±0.04 mm and a breadth of 1.25±0.03 mm. The antennae measure 2.68±0.02 mm in length, and the leg measurements are 2.222±0.076 mm (front), 2.328±0.032 mm (middle), and 2.897±0.099 mm (hind). The hind legs are particularly long and stout. The adult lifespan is 9.90±0.98 days. The adult life cycle consists of pre-reproduction, reproduction, and post-reproduction periods, which last for 1.13±0.76, 7.76±1.23, and 1.00±0.63 days, respectively. During the reproduction period, *U. compositae* exhibits a fecundity of 52.70±8.41 nymphs, and the total lifespan is 19.33±1.32 days.

Keywords: *U. compositae*, niger aphid, biology, attributes, niger crop, etc.

Introduction
An oilseed crop called Niger (*Guizotia abyssinica* (L. f.) Cass.) is grown in Ethiopia, Germany, Brazil, Mexico, and India. It makes up roughly 3% of oilseed production in India and 50% of Ethiopian oilseed production. There are other names for it, including noog in Ethiopia and ramtil or kalatil in India. It is grown over 2.5 lakh hectares, with a yield of roughly 3 q/ha.

However, by 2015-16, India was producing 0.76 lakh metric tonnes of niger. In terms of average production and average show area, Andhra Pradesh ranked top. As of the 2019 fiscal year, 45 thousand metric tonnes of niger seed were produced in India; during 2020-2021, production is expected to reach 63 thousand tonnes by Anonymous [1]. The seed has approximately 40% oil, of which 75-80% is linoleic acid, 7-8% is palmitic and stearic acid, and 5-8% is oleic acid. The Indian varieties have 25% oleic and 55% linoleic acid by Nasirullah *et al.* [8]. When the oil is extracted, the leftover meal has more crude fibre than most oilseed meals but is free of any harmful substances. Two significant niger producing nations worldwide are Ethiopia and India. With almost 50% of the world's land and production, India is one of the fastest-growing nations. With an average yield of 290 kg/ha, Niger is grown on an area of 156.46 lakh per hectare, producing 45.42 lakh tonnes by Anonymous [1]. A total of 24 insects are recorded on niger in both Ethiopia and India. Of these the aphid [*Uroleucon compositae* (Theobald)] is most important to Indian context while nigerfly (*Dioxyna sororcula* and *Eutretosoma spp.*) and black pollen beetles (*Meligethes spp.*) are the most important in Ethopia. In recent, Trivedi *et al.* [14] that have observed the diversity of aphid in south Gujarat and revealed that *U. compositae* had 7.16% relative abundance with 468 population index in Navsari district of south Gujarat. Niger aphid, *U. compositae* is a most destructive pest and also known as safflower aphid or artichoke aphid by Kadam *et al.* [6], Kanturski *et al.* [7].

In order to secrete a substance resembling honey dew on the leaves and other plant parts during the pre-flowering stage, both nymphs and adults suck the cell sap from shoot apices, peduncles, leaves, and stems. Afterwards, the leaves developed a black sooty mould that inhibits photosynthetic activity, causing stunted growth. Consequently, the development of the necessary cure against *U. compositae* is urgently needed. All of our efforts are required to combat these significant insect pests by biological characteristics in order to prevent yield losses brought on by these destructive pests, promote the cultivation of niger crop on a broad scale, and enhance production and productivity of oilseeds in India and Gujarat.

Materials and Methods

The biology of the niger aphid was studied during *Rabi* 2020-21, under laboratory condition in P.G. Research Laboratory, Department of Entomology N.M.C.A., N.A.U., Navsari. The apterous parthenogenetic viviparous female aphids were initially collected from niger plant grown in field at Crop Museum, College farm, N.M.C.A., N.A.U., Navsari. The collection of aphids was made in corrugated perforated boxes and released on niger plant grown in micro-plot (3 m × 4 m = 12 m2) on same day. In order to keep the plant stand in the micro-plot, all agronomical procedures were performed. Under lab conditions, the current study on the biological characteristics of the niger aphid was initiated as soon as the released female settled on the plant and developed the new culture. Aphids were raised in petridishes measuring 2 centimetres in height and 15 centimetres in circumference. Aphids found nourishment in the tender leaves of niger. with order to keep the leaf turgid for an extended period of time, the basal stalk of the leaf was wrapped with cotton wool that had been moistened. Each day in the morning, fresh food was added. Its lid was placed on top of the petridish. Each day in the morning, fresh food was added. Its lid was placed on top of the petridish. During the current experiment, the plants of the Niger variety "Gujarat Niger-2" cultivated in a micro-plot close to the Department of Entomology's Biocontrol laboratory served as the food source. For the purpose of studying fecundity, longevity, and the length of various instars, the culture was kept in a pertidish state.

From the lab culture, ten apterous parthenogenetic viviparous females were removed and placed in the petridish. Nigella soft leaves were fed to nymphs at their birth. The females were taken out of the petridish after being exposed for 24 hours. With the use of a wet camel hair brush, the female's nymphs were moved, and they were raised separately in different Petri Dishes.

Method of recording observations

Nymph

To investigate nymphal longevity, newly born nymphs were transplanted individually into each petridish with fresh niger leaves and examined on a regular basis. The nymph's skin cast off was taken into consideration while determining the instar change. It was noted what colour and form each nymphal instar had. Under a trinocular microscope (Make: Olympus-SZ 61) equipped with a Catcam-130 camera and software power Scope picture (Version 3.1), the size of each nymphal instar was also measured. Additionally, the length of each instar and longevity were noted.

Adult

The fourth moult caused the adults to emerge from the nymph, and their size, colour, and shape were closely examined under a microscope. Using fresh niger leaves, the newly emerged adults of *U. compositae* were raised independently in petridish in order to explore the pre-reproductive, reproductive, post-reproductive, fecundity, and adult longevity. The date of the aphid's emergence and the date of the young's birth were used to compute the pre-reproductive phase. The date of giving birth to their children and the end of their childbearing were used to determine the reproductive period. The post-reproductive period was determined by counting backwards from the date of the last birth to the adult aphid's death. The number of nymphs that each female generated throughout the course of her life was counted in order to examine fecundity. Adults were watched till their demise. From the date of emergence to the date of adult death, the lifespan of each adult was computed independently.

Result and Discussion

The biology and morphometrical study of niger aphid were conducted under laboratory condition at 29.46±2.59 °C temperature and 38.66±6.52% relative humidity during February 2021. The data regarding the biology of various life stages of niger aphid are represented in Table 1 to 4 and Photograph (a) to (f). The visual observation related to colour, appearance and behaviour of different stages of the niger aphid are described in this chapter. Moreover, parthenogenetically reproduction was observed during experimental period whilst there was no oviparous reproduction were noticed.

Nymph

The nymph was passed through four difference instars before reaching to the adult stage (Photograph (a) to (b)) and they were determined from the exuvia casted off at each moulting stage.

First instar

The newly born nymph was wingless, elongated, delicate and pale brownish in colour. The compound eyes were small, placed just behind the base of antennae and it was reddish to black (Photograph a.). The length of body was varied from 0.79 to 0.98 mm with an average 0.85±0.04 mm and the breadth was varied from 0.32 to 0.42 mm with an average 0.36±0.03 mm. The present investigation is in tally with the observations of Bade and Kadam [2] who reported that the length of first instar of *U. comositae* was varied from 1.03 to 1.09 mm, on the other hand, the width ranged from 0.52 to 0.58 mm on the sunflower crop, respectively on gaillardia. Furthermore, Pawar *et al.* [11] who reported that the length of first instar (*U. compositae*) was 0.91±0.17 mm but the breadth was 0.47±0.08 mm; likewise, the length of the first instar nymph was 1.08±0.10 mm, moreover, breadth was 0.41±0.12 mm observed by Bhatt [3]. The present investigations are corroborated with past workers. A pair of antennae was longer (0.88±0.05 mm) than the body width and shorter to the body length and it was five segmented with setaceous type. Similar findings are observed by Pawar *et al.* [11] who have reported that the average length of antennae was 0.87±0.13 mm. The findings of above workers are more or less in conformity with the present investigation.

The three pair of thoracic legs, which were well developed, thickly, were covered uniformly with hairs and light brown in colour. Coxa was triangular in shape. Although coxa, trochanter and tibia were observed in brown yet remaining light brown and semi-transparent. Tarsus was two segmented. The second tarsal segment longer than the first one; it was triangular in shape. At the summit of the tarsus. A pair of tarsal claws was noticed. The average length of front, middle and hind legs were 0.688±0.005, 0.824±0.007 and 0.950±0.020 mm, consecutively. Cornicles was dark in colour and cauda was round. Similar findings were observed by Pawar *et al.* [11] who have reported that the average length of fore, middle and hind legs was 0.70±0.15, 0.82±0.17 and 0.95±0.16 mm when investigation on safflower. Thus, the results of present investigation are in close with past reports. The first instar nymphal period varied from 1 to 3 days with an average 2.43±0.67 days. The present findings are in close agreement with Patel [9] who claimed that the duration of first nymph was 2.50±0.61 days when reared on gaillardia whereas, Ipper [5] noted that the average duration of the first nymph was merely 2.17 days. However, the present study is deviated from the investigations of Rani and Kharbade [12] who found that duration of first instar *U. compositae* was 3.22 days in average; the duration of first instar *U. compositae* was recorded as 1.91±0.31 days by Bhatt [3]. Singh and Singh [13] who opined that the duration was varied between 2 and 3 days. The variation in duration of first nymphal instar of *U. compositae* might due to prevailing weather conditions in a particular locality. Moulting is a biological process wherein aphid goes through in order to make the provision for next instar. A moulted cast of first nymph of *U. compositae* was transparent white.

Second instar

Freshy moulted second instar nymphs differed from first instar nymph by its appearance and competitive size. The second instar was dark brown in colour, oval and slightly bulged. Compound eyes had three dots like ommatidia at posterior end and it were almost similar to first instar, both in colour and size (Photograph-b). The length of nymph varied from 1.09 to 1.33 mm with an average 1.22±0.06 mm and the breadth of nymph varied from 0.52 to 0.65 mm with an average 0.56±0.03 mm. A more and similar tread was recorded pertaining to length (1.22±0.22 mm) and breath (0.650±0.12 mm) of second instar on *U. compositae* by Pawar *et al.*, [11]. Similarly, Bhatt [3] has revealed that the length of the 2nd nymph was 1.49±0.14 mm, while breadth was 0.55±0.10 mm when fed on safflower; Bade and Kadam [2] noticed that the length was measured about 1.40 mm and the width was measured 0.72 mm when investigation of *U. compositae* on safflower; Pawar *et al.* [11] have observed that the length of 2nd instar nymph was 1.22±0.22 mm, whereas the breadth was 0.650±0.12 mm. The present investigations are in tally with above findings. The present investigations are corroborated with past workers.

The antennae were shorter than the body length with five segments, it was 1.08±0.03 mm in total length. The measurement of 1 to 5 segments were 0.07±0.01, 0.07±0.01, 0.27±0.01, 0.15±0.01 and 0.53±0.02 mm, respectively. The present finding is more or less similar with the findings of Pawar *et al.* [11] who reported that the antennal length of *U. compositae* was 1.27±0.16 mm. All three pair of legs varied from the first instar in term of size. Also, uniform hairs were observed on legs. The average length of the front, middle and hind legs were 0.885±0.014, 0.972±0.024 and 1.196±0.023 mm. Similarly, Pawar *et al.* [11] who worked on safflower aphid, *U. compositae* and found that the average length of the front, middle and hind legs were 0.88±0.18, 0.97±0.22 and 1.122±0.23, respectively. Thus, the results of present investigation are in close with past reports.

The cornicles were distinct, prominent and cylindrical in shape. The duration of second instar nymph varied from 1 to 3 days with an average of 2.6±0.55 days. The above findings are supported with Patel [9] who reported that the period of *U. compositae* of second instar was 2.55±0.61 days; the average duration of the 2nd nymphal stage was 2.00 days when investigated on safflower by Bade and Kadam [2]. Whereas, the present findings pertaining to second instar of *U. compositae* was deviated from the report of Ipper [5] who found that the duration of second instar was barely 1.37 days; Bhatt [3] who conducted a study on biology of *U. compositae* and found that the second nymphal period was noted as 1.78±0.49 days. The variation in duration of second nymphal instar of *U. compositae* might due to prevailing weather conditions in a particular locality. A moulted cast of second nymph of *U. compositae* was white in colour and transparent.

Third instar

The dark brown colour was noticed during the investigation on third nymphal instar and it distinguished from second instar with regard to size, antennal segments and appearance (Photograph-c). The compound eyes were bigger, round and reddish black.

The measurement on third instar nymphs recorded that the length of each nymph varied from 1.36 to 1.78 mm with an average of 1.55±0.12 mm and 0.68 to 0.89 mm with an

average of 0.77±0.06 mm in breadth. A more or less similar measurements were reported by Pawar *et al.* [11] who observed that the length and breadth of third nymph of *U. compositae* were 1.57±0.28 mm and 0.86±0.16 mm, respectively on safflower; Bhatt [3] reported that the length of the 3rd nymph was 2.11±0.20 mm, while breadth was 0.89±0.11 mm when studied the biology of *U. compositae* on gaillardia; The third nymphal instar of *U. compositae* was measured from 1.97 mm in length and 0.94 mm in width when reared on safflower by Bade and Kadam [2]. The present investigations are corroborated with past workers. Antennae were six segmented and average length was measured as 1.43±0.06 mm. The measurement of 1 to 6 segments were 0.10±0.01, 0.08±0.01, 0.25±0.03, 0.19±0.01, 0.21±0.01 and 0.61±0.03 mm, respectively. The rostrum extended just behind the third pair of coxae. The present results support with the results of Pawar *et al.* [11] who reported that the length of antenna was 1.47±0.27 mm. The findings of above workers are more or less in conformity with the present investigation. Thus, the results of present investigation are in close with past reports.All three pair of legs were long and stout and hind legs had more hairs as compared to other front and middle legs. The average length of the front, middle and hind legs were 0.983±0.030, 1.165±0.010 and 1.912±0.028 mm, respectively. Cornicles and cauda were dark brown. The present investigation results are more and less in concurrence with the findings of Pawar *et al.* [11] who revealed that the length of third instar nymph front, middle and hind legs were 0.88±0.17, 1.18±0.21, 1.55±0.28 mm, consecutively when *U. compositae* reared on safflower. Therefore, the results of present investigation are agreed with past reports.

The duration of third nymph was 1 to 3 days with an average of 2.10±0.70 days. The present results are corroborated with the findings of Patel [9] who revealed that the average developmental period of the third instar of *U. compositae* was 1.94±0.72 days; the average duration of the 3rd nymphal stage was 2.00 days when reared on safflower by Bade and Kadam [2]. Moreover, the third of the 3rd nymphal period were 1.86±0.59 days on gaillardia by Bhatt [3]. Singh and Singh [13] who evaluated that the 3rd nymphal stage of *U. compositae* was completed within 1 to 3 days, which are in agreement with present investigation. A moulted cast of third nymph of *U. compositae* was more or less similar with previous instars.

Fourth instar

The fourth nymphal instar was blackish in colour and elongated in shape. The size of compound eyes was still expended and were black to reddish in colour. The nymph was mobile and seemed adult expect that it did not have a deep black and fully developed wings (Photograph-d). The length of nymph ranged from 2.58 to 2.73 mm with an average 2.65±0.05 mm and breadth was a 0.89 to 0.99 mm with an average of 0.94±0.03 mm. The above findings are supported by Bhatt [3] who found that the length of the 4th nymph of *U. compositae* was 2.63±0.37 mm, whereas breadth was 1.04±0.12 mm when studied the biology of *U. compositae*; Pawar *et al.* [11] who noted that the length of the 4th instar of *U. compositae* nymph was 2.78±0.51 mm, breadth was 0.93±0.17 mm. The present investigations are corroborated with past workers.

The antennae were six segmented, the length of antennal segments was accounted 0.14±0.01, 0.09±0.01, 0.75±0.03, 0.37±0.02, 0.36±0.01 and 0.70±0.02 mm for first to sixth segment consecutively. The total length was varied between 2.35 mm to 2.52 mm with an average of 2.41±0.05 mm. The rostrum extended beyond the third pair of coxae. The present findings are disagreed with the results of Pawar *et al.* [11] who revealed that the length of antenna was 1.47±0.27 mm. The findings of above workers are more or less in conformity with the present investigation. The legs were stout, long as opposed to others instar. Moreover, the coxa, trochanter, distal area of femur and tibia were dark brown while remaining portion was light in colour. The length of first and middle legs were 1.524±0.043 mm and 1.815±0.063 mm, respectively. The third pair of legs were quite small (2.353±0.106 mm) as compared to the length of antennae. In addition, the tibia and femur of third legs was measured with an average 1.289±0.084 and 0.693±0.015 mm, respectively. cornicle was dark brown in colour with cylindrical in shape while cauda was elongated. The present data are corroborated with the findings of Pawar *et al.* [11] who noticed that the length of front, middle and hind legs of *U. compositae* was 1.52±0.28, 1.80±0.33 and 2.28±0.40 mm, respectively when fed on safflower. Thus, the results of present investigation are in close with past reports.

The duration of fourth instars duration was recorded as 1 to 3 days with an average 2.30±0.64 days. The present finding is in conformity with the finding of Patel [9] who revealed that the average developmental period of fourth instar nymph of *U. compositae* was 2.50±0.61 days; Singh and Singh [13] who noticed that the 4th nymphal stage of *U. compositae* were completed within 1 to 3 days. The present data slightly derived from Bhatt [3] who observed that the duration of the fourth instar nymph of *U. compositae* nymph was 1.98±0.46 days when reared on sunflower; Bade and Kadam [2] who noticed that the average duration of 4th nymph instar of *U. compositae* was 2.90 days. The variation in duration of fourth nymphal instar of *U. compositae* might due to prevailing weather conditions in a particular locality. A moulted cast of fourth nymph of *U. compositae* was white in colour and transparent. Due to unavailability of literature, this aspect is not compared.

Total nymphal period

The total nymphal period was constituted from birth of first instar to the last fourth nymphal instar. It varied between 7 and 11 days with an average 9.43±1.08 days. The present investigations are supported by Patel [9] who studied that the total nymphal period of safflower aphid, *U. compositae* was 9.39±1.33 days; the total nymphal period varied from 7 to 13 days with an average of 9.72±1.77 days as recorded by Pawar *et al.* [11] when fed on safflower. The present investigations are deviated from the result of Patel *et al.* [10] who revealed that the total nymphal period of *L. erysimi* was 4 to 8 days with an average of 6.03±0.89 days on cauliflower. Thus, the results of present investigation are in close with past reports.

Adult

It was dark black in coloured, spindle to elongated pyriform body and with shiny appearance. The compound eyes were reddish black in colour and it was bulged (Photograph-e). Alate adult was similar to the apterous adult, except presence of wings (Photograph-f). The measurement of adults was recorded that each nymph varied from 2.80 to 2.96 mm with an average 2.86±0.04 mm in length and 1.20

to 1.32 mm with an average 1.25±0.03 mm in breadth. The present investigations on adult measurement are more or less similar to the result of Pawar *et al.* [11] who reported that the apterous adult were measured about 2.86±0.52 mm in length and 1.30±0.24 mm in breadth, on safflower; Bhatt [3] who revealed that the adult of *U. compositae* measured about 3.02±0.29 mm in length and 1.34±0.12 mm in breadth. The present investigations are corroborated with past workers.

The antennae were six segmented and it was shorter (2.68±0.02 mm) than the length of body. The length of one to sixth segments were 0.15±0.01, 0.10±0.01, 0.77±0.01, 0.40±0.01, 0.38±0.02 and 0.89±0.01 mm, respectively. The legs were long and stout and the hind legs were the longest as opposed to front and middle legs. The measurement of front, middle and hind legs were 2.222±0.076, 2.328±0.032 and 2.897±0.099 mm, respectively. The tibia was the biggest part in each of legs with hairs. It was 1.193±0.044, 1.248±0.015 and 1.725±0.072 mm in front, middle and third legs, respectively. The femur was dark in colour and it was the second longest part in each leg. Cornicles were black in colour and very long and cauda was elongated.

The longevity of adult was recorded from 8 to 11 days with an average of 9.90±0.98 days. The studies on adult longevity are more or less in accordance with the report of Patel [9] who reported that the adult longevity of *U. compositae* was 9.33±1.94 days when investigating on gaillardia; the longevity of the adult of *U. compositae* was 10.16±2.32 days by Bhatt [3]. However, in the present data disagreement with the result of Ipper [5] who revealed that the longevity of safflower aphid, *U. compositae* was 16.37 days. The findings of above workers are more or less in conformity with the present investigation.

Pre-reproduction

It can be vividly seen from the data presented in Table 1 on pre-reproduction period presented and the result indicated revealed that the pre-reproduction period recorded up to 2 days with an average of 1.13±0.76 days. The present findings are more or less similar to result of Patel [9] who revealed that the pre-reproductive period of *U. compositae* was 0.94±0.72 days on gaillardia; Bhatt [3] who also noticed that the pre-reproductive period of *U. compositae* was 1.45±0.54 days; 1.50±0.27 days were reported by Pawar *et al.* [11] when *U. compositae* fed on safflower; Singh and Singh [13] who recorded that the pre-reproductive period of *U. compositae* was 2 days when reared on safflower. The results have been contradicted with the report of Bade and Kadam [2] and Rani and Kharbade [12] who reported that the pre-reproduction period of aphid, *U. compositae* with pre-reproductive time span was 2.25 days and 2.28 days, respectively when fed on safflower. The discrepancy in pre-reproduction period of *U. compositae* might due to prevailing weather conditions in a particular locality.

Reproduction period

Looking to data presented in Table-1 indicated that the reproduction period varied from 6 to 10 days with an average of 7.76±1.23 days. A more or less identical results are observed by Bhatt [3] who revealed that the reproduction period of *U. compositae* was 7.99±2.16 days; Likewise, Patel [9] who noticed that the reproduction period of *U. compositae* was 7.44±1.97 days when reared on gaillardia. The results are disagreed with the result of Singh and Singh [13] who observed that the reproduction period of *U. compositae* was varied between 3 and 5 days; The reproductive period of *U. compositae* was 3-5 days on safflower (Ipper) [5]; Rani and Kharbade [12] who noticed that the reproduction period of *U. compositae* was 14 days. The findings of above workers are more or less in conformity with the present investigation.

Post-reproduction

The data presented in Table-1 revealed that the post reproduction period lasted for 2 days with an average of 1.00±0.63 days. In the past, more or less similar result is obtained by Bhatt [3] who noticed that the post reproduction period of *U. compositae* was 0.88±0.16 days when reared on gaillardia; 0.94±0.72 days were on gaillardia by Patel [9]. The present investigations are disagreed with the result of Ipper [5] who reported that the post-reproductive period varied between 12 and 21 days for *U. compositae*; Pawar *et al.* [11] who noticed that the reproduction period of *U. compositae* was 0.47±0.086 days when fed on safflower. Thus, the results of present investigation are in close with past reports.

Fecundity

The result obtained on the fecundity of niger aphid is presented in Table-1 and indicated that the fecundity of gravid female laid 30 and 69 nymphs with an average of 52.70±8.41 nymphs. The result pertaining to fecundity of *U. compositae* is more or less similar to Patel [9] who revealed that the average fecundity of *U. compositae* gravid female was 55.38±13.53 nymphs. In contrary, the dissimilar result found as compared to the findings of Ipper [5] who revealed that the progeny produced by each female of *U. compositae* was varied from 20 to 39 nymphs; Bade and Kadam [2] who also studied that the fecundity of *U. compositae* and found that it was 35 nymphs on safflower; the reproductive potential of safflower aphid, *U. compositae* was 38.90±7.10 nymphs per female by Pawar *et al.*, [11]. The findings of above workers are more or less in conformity with the present investigation.

Total life span

The total life span was studied and the results are presented in the Table-1 and it varied from 16 to 22 days with an average of 19.33±1.32 days. The studies on total life span are more or less in accordance with the report of Bade and Kadam [2] who noticed that the total life span of safflower aphid, *U. compositae* was 19.44±2.33 days; total life span of *U. compositae* was 20.30±3.70 days on safflower recorded by Pawar *et al.* [11]; total life span of *U. compositae* was recorded as 18.72±1.94 days by Patel [9] when fed on gaillardia; Bhatt [3] who reported the total life span was 17.69±1.98 days when investigation of *U. compositae* on gaillardia. While, the present findings data are deviated from the result of Ipper [5] who claimed that the total life cycle was completed within 19 to 26 days with an average of 22.52 days for *U. compositae;* Singh and Singh [13] who studied the total life span of *U. compositae* and found that life cycle was shorter (15 days) in susceptible host CO-1. However, it took more time (22 days) to complete one life cycle on the hosts A-1 and BlP-2 when fed on safflower; Rani and Kharbade [12] who observed that the total life cycle of *U. compositae* was completed between 11 and 16 days on safflower. Thus, the results of present investigation are in close with past reports.

Table 1: Details of life cycle of niger aphid, *U. compositae*

Sr. No.	Particular	Period (Days)		
		Min.	Max.	Average
1	Nymphal period			
	First instar	1	3	2.43±0.67
	Second instar	1	3	2.60±0.55
	Third instar	1	3	2.10±0.70
	Fourth instar	1	3	2.30±0.64
	Total	7	11	9.43±1.08
2	Adult longevity	8	11	9.90±0.98
3	Pre-reproductive	0	2	1.13±0.76
4	Reproductive	6	10	7.76±1.23
5	Post-reproductive	0	2	1.00±0.63
6	Fecundity (Nymphs/female)	30	69	52.70±8.41
7	Total life period	16	22	19.33±1.32
8	Temperature (°C)	25.80	35.65	29.46±2.59
9	Relative humidity (%)	26.00	50.50	38.66±6.52

Table 2: Morphometrical studies of niger aphid, *U. compositae* under laboratory condition

	Measurement of different instars and adults (mm)									
	1st instar		2nd instar		3rd instar		4th instar		Adult	
	L	B	L	B	L	B	L	B	L	B
Min.	0.79	0.32	1.09	0.52	1.36	0.68	2.58	0.89	2.80	1.20
Max.	0.98	0.42	1.33	0.65	1.78	0.89	2.73	0.99	2.96	1.32
Av. ± S.D.	0.85±0.04	0.36±0.03	1.22±0.06	0.56±0.03	1.55±0.12	0.77±0.06	2.65±0.05	0.94±0.03	2.86±0.04	1.25±0.03

L = Length; B = Breadth

Table 3: Morphometrical studies of different antennal segments of niger aphid, *U. compositae*

Length (mm)		Development stages of *U. compositae*				
		1st instar	2nd instar	3rd instar	4th instar	Adult
Total length	Range	0.77-0.96	1.02-1.15	1.34-1.52	2.35-2.52	2.65-2.73
	Mean ± SD	0.88±0.05	1.08±0.03	1.43±0.06	2.41±0.05	2.68±0.02
1st segment	Range	0.05-0.06	0.06-0.07	0.09-0.12	0.12-0.16	0.13-0.16
	Mean ± SD	0.06±0.01	0.07±0.01	0.10±0.01	0.14±0.01	0.15±0.01
2nd segment	Range	0.06-0.07	0.05-0.08	0.07-0.08	0.08-0.10	0.09-0.10
	Mean ± SD	0.07±0.01	0.07±0.01	0.08±0.01	0.09±0.01	0.10±0.01
3rd segment	Range	0.14-0.21	0.25-0.29	0.21-0.29	0.69-0.79	0.76-0.79
	Mean ± SD	0.18±0.02	0.27±0.01	0.25±0.03	0.75±0.03	0.77±0.01
4th segment	Range	0.09-0.16	0.13-0.16	0.17-0.22	0.34-0.39	0.39-0.40
	Mean ± SD	0.12±0.02	0.15±0.01	0.19±0.01	0.37±0.02	0.40±0.01
5th segment	Range	0.40-0.51	0.50-0.57	0.19-0.24	0.35-0.38	0.35-0.40
	Mean ± SD	0.47±0.03	0.53±0.02	0.21±0.01	0.36±0.01	0.38±0.02
6th segment	Range	-	-	0.57-0.67	0.66-0.73	0.87-0.92
	Mean ± SD	-	-	0.61±0.03	0.70±0.02	0.89±0.01

Table 4: Morphometrical studies of different leg segments of niger aphid, *U. compositae*

Leg's part		1st instar		2nd instar		3rd instar		4th instar		Adult	
		Range (mm)	Mean ± SD (mm)	Range (mm)	Mean ± SD (mm)	Range (mm)	Mean ± SD (mm)	Range (mm)	Mean ± SD (mm)	Range (mm)	Mean ± SD (mm)
Front leg	Total	0.682-0.700	0.688±0.005	0.857-0.901	0.885±0.014	0.939-1.028	0.983±0.030	1.436-1.584	1.524±0.043	2.092-2.351	2.222±0.076
	Coxa	0.067-0.08	0.070±0.003	0.067-0.079	0.074±0.004	0.088-0.098	0.092±0.003	0.049-0.109	0.095±0.016	0.106-0.125	0.114±0.006
	Trochanter	0.028-0.036	0.031±0.002	0.029-0.034	0.032±0.002	0.043-0.051	0.048±0.002	0.049-0.057	0.053±0.003	0.075-0.099	0.084±0.007
	Femur	0.192-0.199	0.195±0.003	0.261-0.284	0.272±0.006	0.298-0.329	0.310±0.011	0.413-0.488	0.450±0.026	0.679-0.744	0.703±0.022
	Tibia	0.303-0.308	0.306±0.002	0.397-0.442	0.419±0.016	0.411-0.483	0.443±0.023	0.793-0.831	0.807±0.013	1.120-1.260	1.193±0.044
	Tarsi	0.082-0.089	0.085±0.002	0.084-0.090	0.088±0.002	0.087-0.093	0.090±0.002	0.116-0.122	0.118±0.002	0.110-0.181	0.141±0.024
Middle leg	Total	0.807-0.834	0.824±0.007	0.942-1.013	0.972±0.024	1.146-1.180	1.165±0.010	1.720-1.925	1.815±0.063	2.271-2.392	2.328±0.032
	Coxa	0.056-0.065	0.060±0.002	0.074-0.080	0.077±0.002	0.085-0.098	0.091±0.004	0.101-0.119	0.112±0.005	0.118-0.128	0.123±0.004
	Trochanter	0.028-0.033	0.030±0.002	0.039-0.049	0.042±0.003	0.043-0.051	0.048±0.002	0.055-0.066	0.061±0.004	0.078-0.095	0.087±0.006
	Femur	0.215-0.228	0.220±0.004	0.265-0.320	0.299±0.018	0.352-0.363	0.357±0.004	0.485-0.520	0.503±0.013	0.731-0.767	0.749±0.013
	Tibia	0.421-0.433	0.428±0.003	0.426-0.482	0.464±0.017	0.550-0.592	0.568±0.011	0.978-1.098	1.025±0.043	1.225-1.278	1.248±0.015
	Tarsi	0.082-0.090	0.086±0.002	0.089-0.098	0.093±0.002	0.093-0.109	0.101±0.005	0.013-0.130	0.114±0.034	0.118-0.124	0.121±0.002
Hind leg	Total	0.935-0.989	0.950±0.020	1.153-1.235	1.196±0.023	1.870-1.964	1.912±0.028	2.159-2.485	2.353±0.106	2.687-3.014	2.897±0.099
	Coxa	0.078-0.081	0.079±0.001	0.080-0.092	0.089±0.003	0.085-0.095	0.089±0.003	0.108-0.194	0.149±0.031	0.122-0.128	0.126±0.002
	Trochanter	0.035-0.040	0.037±0.002	0.042-0.049	0.045±0.002	0.468-0.535	0.496±0.024	0.068-0.085	0.077±0.005	0.092-0.098	0.095±0.002
	Femur	0.241-0.251	0.248±0.003	0.314-0.353	0.336±0.013	0.423-0.487	0.454±0.020	0.670-0.712	0.693±0.015	0.825-0.848	0.837±0.007
	Tibia	0.498-0.548	0.510±0.019	0.600-0.642	0.624±0.012	0.735-0.813	0.768±0.025	1.168-1.420	1.289±0.084	1.593-1.810	1.725±0.072
	Tarsi	0.071-0.080	0.077±0.004	0.098-0.110	0.102±0.004	0.098-0.112	0.104±0.004	0.140-0.150	0.145±0.003	0.119-0.142	0.127±0.007

Photograph-a: First instar nymph of *U. compositae*

Photograph-b: Second instar nymph of *U. compositae*

Photograph-c : Third instar nymph of *U. compositae*

Photograph-d: Fourth instar nymph of *U. compositae*

Photograph-e: Apterous adult of *U. compositae*

Photograph-f: Alate adult of *U. compositae*

Conclusion

Investigation on biology of niger aphid, *U. compositae* revealed that aphid completed its life cycle with four nymphal stages. The first nymph was wingless, brownish or reddish in colour and elongated. As the nymph grew, body colour was changed from brown to dark brown. Antennae of first and second nymphal instar were five segmented. The colour of adult was shining black with spindle to elongated pyriform body with hairs. The first, second, third and fourth nymphal instar lasted for 2.43±0.67, 2.60±0.55, 2.10±0.7 and 2.30±0.64 days, respectively. The total nymphal period was 9.43±1.08 days. The pre-reproductive, reproductive and post-reproductive period of *U. compositae* was 1.13±0.76, 7.76±1.23 and 1.00±0.63 days, respectively. The longevity of adult was recorded as 9.90±0.98 days. The total life span was 19.33±1.32 days. The reproductive potential of aphid was 52.70±8.41 nymphs per female during entire life period. The length of first, second, third and fourth instar nymph was 0.85±0.04, 1.22±0.06, 1.55±0.12 and 2.65±0.05 mm, whereas breadth was 0.36±0.03, 0.56±0.03, 0.77±0.06 and 0.94±0.03 mm, respectively. The antennal length of first, second, third and fourth nymph was 0.88±0.05, 1.08±0.03, 1.43±0.06 and 2.41±0.05 mm, respectively. Adult was measured about 2.86±0.04 mm in length and 1.25±0.03 in breadth. The total length of adult antennae was 2.68±0.02 mm.

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