



## Desert Locust (*Schistocerca gregaria*): Biology, Behavior, Phases, and Integrated Management Strategies

\*Amit Kumar<sup>1</sup> and Heenashree Mansion<sup>2</sup>

<sup>1</sup>Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)

<sup>2</sup>Department of Entomology, College of Agriculture, Agriculture University, Mandore, Jodhpur (Rajasthan)

\*Corresponding Author's email: [amitento1998@gmail.com](mailto:amitento1998@gmail.com)

Desert locust is the world's most deadly and destructive migratory pest. It is a ravenous eater; an adult desert locust weighs about 2 grams and can consume roughly its weight daily. The locusts steal food from people's mouths and livestock that they depend on for survival. The pest epidemic, according to the FAO, poses an "unprecedented danger" to food security and livelihoods in areas already vulnerable to climate change. Swarms of desert locusts are a major economic problem in more than 65 countries, covering more than 20% of the world's total land area. It causes substantial agricultural damage. Desert locust is a direct threat to food security because it destroys crops, reducing the amount of food available to human populations. They also eat grasses and other wild plants, which has an effect on livestock and wildlife.

It is estimated that one-tenth of the world's population livelihoods are affected by desert locusts. Grasshoppers and locusts are structurally different, despite their similar appearance. Both have distinct characteristics. The front wings of grasshoppers are thin and tough, while the outer wings are broad and flexible. For long-distance flight, the locusts' wings grow longer and stronger. Locusts have a smaller body size than grasshoppers. Locusts are also capable of living in the solitary or gregarious phase, while grasshoppers can only be solitary. Female locusts are larger than their male counterparts in their solitary states, although their sizes decrease in the swarming phase. In comparison to grasshoppers, locusts can fly over long distances and they also have smaller bodies. They are voracious, as a single adult locust will eat enough vegetation to equal its weight (roughly 2 grams) in a single day.

Locust swarms are extremely mobile, capable of flying across continents and destroying entire livelihoods in less than six hours, with adult swarms covering around 150 kilometers a day. Desert locusts wreak havoc on food security by destroying crops, reducing food availability to humans. They also eat grasses and other wild plants, affecting livestock and wildlife. Desert locusts are difficult to control, but with proactive monitoring, early action, and targeted application of appropriate control measures as required. Improved knowledge of pest biology and ecology, as well as more efficient monitoring and control methods, are now essential components of an effective preventive management strategy. Locust control programs still rely heavily on chemical pesticides.

### Life Cycle of Desert Locust

Desert locusts have six stages, the first five of which are non-flying. They begin flying, mating, and laying eggs once they reach adulthood, and the cycle continues. With an average lifespan of 3-5 months, desert locusts go through three stages: egg, nymph, and adult. The female lays eggs in bare sandy soil having moisture about 5-10 cm below the surface using the valves of the abdomen. The female checks the moisture content of the soil by inserting

the tip of the abdomen. The eggs are present in batches called egg pods, which are arranged similar to a miniature hand of bananas and are similar to rice grains, being 3-4 cm long with the top about 5-10 cm below the surface. An egg pod can store up to 80 eggs in the gregarious phase and 90-160 eggs in the solitary stage.

The eggs hatch into wingless larvae or nymphs called hoppers. After a few hours of hatching, the eggs turn black in color. The hopper sheds its skin 5-6 times. When adults become winged, weight increases although they are sexually immature; after some time, they become mature and can populate and lay eggs. Generally, a female can produce 16-20 variable locusts in a single generation. The development of an egg is directly proportional to soil temperature at pod depth and moisture absorbed during embryonic development. The life span of the desert locust is about 3-5 months, in which the development of the hopper takes 30-40 days, and adults mature over 2-4 months depending on environmental conditions such as temperature. Similarly, an adult can feed up to 2-5 g every day according to its body weight.

The locusts move to green vegetation when the vegetation starts to dry out, come into physical contact with each other, and begin to behave as a single cohesive mass.

### Phases of Locust

Locusts go through phase polymorphism, which means they may transition from being solitary to being gregarious, congregating in large groups. Solitarious locusts are cryptically colored nymphs that tend to live alone and are relatively inactive. Gregarious locusts have bright colors, form bands (as larvae) or swarms (as adults), and are usually very mobile. Individuals are solitarious when locusts are found in low densities. If the locust population grows, they form dense groups and become more dangerous. According to scientists, the brain chemical serotonin has been discovered to transform the solitary phase into a gregarious phase. Contact is the catalyst for this transformation. Physical contact becomes inevitable when the locust population grows, and locusts begin to emit serotonin.

Due to an increase in serotonin in their nervous system, desert locusts may become gregarious and swarm. When the rains are particularly heavy, the population will rapidly grow, resulting in massive swarms. Desert locusts then scatter in swarms searching for food and ideal breeding conditions. Due to a lack of food, desert locusts are forced to congregate. The swarming of solitary locusts causes a shift, and the insects go through a process known as gregarious behavior. The gregarious traits are due to a small, hydrophilic labile "gregarizing" factor that is created during egg deposition and predisposes neonate nymphs to gregarious behavior. Pests can spread across continents, and locusts can migrate hundreds of miles in a single night. In a favorable environment, the desert locust can infest 60 countries; locusts congregate and become more polyphagous. The phases have distinct morphology (e.g., brain size, body size, and color), physiology (neuroendocrinological status), and behavior (tendency to move with their crowd and reaction timing to moving objects).

### Behavior of Locust

The desert locust is migratory in habitat depending upon population densities and rainfall occurrence between spring, summer, winter, and breeding areas. The hopper spends little time on the ground, moving over bare ground, alternating resting with moving up and down in large, dense, low-plant vegetations and east and west where there are tall plants in open spaces.

**Adults:** For adult wings to harden sufficiently, it takes about ten days after fledging. Rainfall provides favorable maturation conditions where males mature faster than females.

**Solitary adults:** Mainly, solitary adults fly during the night at temperatures of 20-22°C. After forming groups, they become concentrated when the vegetation dries up. They mainly rest on the ground and fly when disturbed. During dusk, they are more active and move short distances for 20-30 minutes after sunset, covering 60-250 km in a single night. Wind with high velocity mainly disperses their population, and the hotter the wind, the greater the distance traveled by the locust. According to the FAO, "A swarm of 1 km<sup>2</sup> eats the same

amount of food in one day as 35,000 people". After 30 minutes of social contact, the grouping behavior of desert locusts increases, and they become more gregarious when crowded together. A swarm of locusts can cover a distance of 100 km in the prevailing direction per day, and bands can move up to 5-130 km per day, but individual flight speed is 3-6 m/s. Usually, if wind speed is low (less than 2 m/s), flight tracks are observed visually, while at high-speed wind (2-4 m/s), tracks are downwind.

Desert locusts are polyphagous insects which feed on various parts of plants such as leaves, shoots, flowers, fruit, seeds, stems, and even bark. The damage and loss to crops are severe when desert locusts occur in a plague (gregarious phase). In this condition, management of locusts should be carried out to prevent losses.

Sizes	Swarm	Band
Very small	Less than 1 km <sup>2</sup>	1-25 m <sup>2</sup>
Small	1-10 km <sup>2</sup>	25-2500 m <sup>2</sup>
Medium	10-100 km <sup>2</sup>	2500 m <sup>2</sup> -10 ha
Large	100-500 km <sup>2</sup>	10-50 ha
Very Large	>500 km <sup>2</sup>	>50 ha

### Management of Desert Locust

Since the beginning of civilization, the locust has been one of the most devastating threats to agriculture, and different control campaigns have been carried out costing millions of dollars. However, no satisfactory outcome has been observed, and the use of various chemical insecticides causes severe problems for the environment. The FAO runs the Desert Locust Information Service (DLIS); it collects information via video and social media. National, regional, and international components are coordinated by the FAO to help achieve global meta-population management. To prevent lengthy and expensive operations, it is important to detect desert locust populations early, before they enter the plague level. The cost of controlling desert locust plagues can be very high. Population monitoring and forecasting are two aspects of locust management. However, since most breeding sites are remote and inaccessible, and adult locusts are highly mobile insects that occupy vast swaths of land, predicting locust populations is difficult. Cultural control (digging, burning), baiting (spreading locust food impregnated with insecticides), dusting with insecticide, and spraying liquid insecticides (chemical or biological) using ultra-low volume (ULV) application are all methods for controlling locust swarms.

#### Cultural Practices

Cultural methods of pest control consist of regular farm operations carried out in such a way that they either destroy the pests or prevent them from causing economic loss. Locusts contain high protein sources, so they can be used as feed for people, livestock, ducks, and fish. Two grams of locust contains an energy source of 0.5 gram protein and an energy value of 2 Kcal. Hand-picking of locusts for food and feed purposes can minimize the population of desert locusts. Killing or trampling bands, plowing or burning egg-infested fields, trapping hoppers in pits, and making loud noises with acoustic and electronic equipment are among the other cultural practices. To prevent locusts from sinking into the ground, locals use fire, clouds of smoke, and loud noises.

#### Mechanical Method

Traditional mechanical control methods are effective when there is low locust infestation and labor is cheap. Making noise increases the randomness of a swarm, which helps to decrease its population and break it apart. During the day, desert locusts are active, but they congregate on trees and open land without dense vegetation at night. They are dormant until the sun shines, so a mosquito net can catch desert locusts. Baiting and dusting are the most powerful

methods for handling hoppers. The destruction of bands and swarms may be used to control locust plagues. Mechanical control methods are promising alternatives to control the pest.

### **Botanical Method**

Botanicals are mostly plant-based products. Plant oils come in two forms: edible oils and essential oils, which are protective against locusts. They are broad-spectrum pesticides that are less toxic, less costly, and more easily available while still being safe for the environment and non-target organisms. On crop vegetation, botanical pesticides can have only mild adverse effects. Pests' resistance to them develops slowly and is uncommon. Pyrethrum, rotenone, neem, and essential oils are among the most commonly used botanical items for managing desert locusts. The combined toxic effect of botanical pesticide prepared from caraway, wintergreen, and orange oils at low concentration was found effective as it causes mortality, affects mobility and ventilation of the locusts, and also acts as an antifeedant. When offered as a diet, *Nerium oleander* has been shown to inhibit the ovarian development of desert locusts. Other essential plant oils against locusts include garlic extracts/oil, cumin, and jatropha oil. Botanical insecticides are highly effective against locusts and are non-toxic. Therefore, the use of botanicals is safer than chemical insecticides.

### **Chemical Method**

Insecticides and baits were used in the 1880s, but after the 1940s-1950s, they were replaced by less expensive dusts and sprays due to their high toxicity and negative impact on human health. Chemical insecticides such as carbamates, pyrethroids, phenyl pyrazole, and benzoylurea can be used to combat desert locusts. Because of their effectiveness, low cost, and extended durability, these insecticides have been the most common for locust control. The most commonly used materials for swarm control against the desert locust are fenitrothion and malathion. They are highly successful, with area dosages of around 400g per hectare estimated to kill half to one million adults per liter. In *S. gregaria*, the use of phenyl acetonitrile (PAN) suppresses the cellular immune response, resulting in a high mortality rate. The primary chemical and microbial pesticides are applied via vehicle-mounted or aerial ultra-low volume (ULV) spraying. ULV spraying involves spraying overlapping swaths of tiny droplets of a concentrated pesticide formulation onto locusts at very low dose rates. If infestations are small, handheld sprayers can be used to spray the pesticide directly on the bands. Vehicle-mounted sprayers are used to treat larger infestations. Spraying of bands should be carried out on the immobile young hoppers before wing development.

Spraying pesticides on infested cropland remains the most effective and widespread treatment method, but this comes with considerable drawbacks. The best time to spray is late at night or early in the morning. Locusts congregate in large numbers on bushes at this time to rest. Insecticides sprayed at this time provide good control. However, non-judicial application of synthetic insecticides could lead to pest resistance and increased environmental risks. Locusts did not become gregarious when given drugs that blocked serotonin's action or a compound that inhibited serotonin output. Controlling locusts with a drug that targets the serotonin receptor may be a viable alternative to using chemical pesticides.

### **Integrated Pest Management**

Chemical pesticides are widely used to control locust infestations, which is a significant concern, and alternatives are becoming increasingly important. Integrated Pest Management (IPM) is a broad ecological pest control solution. Natural enemies, such as ducks, help in locust control and are susceptible to locust invasion. Similarly, electronic devices that produce ultrasound help to reduce swarms of desert locusts. Likewise, nets sprayed with garlic or neem can help repel different locusts and grasshoppers in small nurseries and kitchen gardens. The pathogenic fungus *Metarhizium anisopliae* var. *acridum* has been prepared for ULV spraying of field-infested locusts. It is also called Green Muscle. Likewise, many other *Metarhizium* spp. conidia can help mitigate locusts by penetrating and invading the body tissue of insects. Both biological controls and the use of pesticides can be costly; pests become increasingly resistant to insecticides, and plant breeders must renew the genetic resistance of plants to insect pests on a regular basis. The conservation of established natural

enemies, crop rotation, intercropping, and the use of pest-resistant varieties are all part of integrated pest management.

### **Conclusion**

Swarms of desert locusts pose a significant threat to crops. They are migratory and devastating pests that attack crops in different countries of Africa and Asia, causing food insecurity worldwide. Local crop protection is not feasible, and different countries carry out different control strategies. Various insecticides and baits have been used to control locusts, but they have adverse effects on human health and the environment. As a result, the best control methods are now integrated pest management (IPM), along with survey and surveillance reporting. The proper advancement and adaptation of modern technologies can assist in the management of desert locusts. For effective management of desert locusts, monitoring, mechanical, biological, botanical, and chemical pesticides should be integrated.