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Agricultural menace by locust swarms

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Abstract
Desert Locusts are an International trans-boundary insects that migrate in over 30 countries. Locusts belong to predominant Acrididae family and Schistocerca genus. They are commonly known as Desert Locusts or Short Horned Grasshoppers. Locusts are harmless in solitary phase but becomes extremely harmful to crops and plants in gregarious phase. Locust Swarm (LS) also known as Tiddy Dal in Hindi fly in many countries from Africa to West Asia. LS are so densely inhabited that it may have 40 to 150 million locusts per Sq Km of area [1, 5]. Plagues of LS has devastated countries since ancient times of Pharaoh and still wreaking havoc [14].
LSs are infamous for their gregarious size and voracious appetite. LSs are severely harmful to agricultural crops, plants and green vegetation. According to United Nations Food and Agriculture Organization (FAO) a LS of average size may eat food equivalent to the diet of 35000 people per day. LS plagues are in record since 1964. Year 2019 has witnessed largest incursions of LS since 1993. In India problem from LSs escalated in 2020, especially in the state of Rajasthan. Migratory LSs from the neighboring country Pakistan; where early arrival of monsoon and moist desert land has become boom for breeding and blossoming, and lack of vegetation; compelled LS to fly to India in search of food [13]. It is alleged, Government of Pakistan (GOP) flouted all warnings and alerts issued by FAO. Insecticides were not sprayed on LSs by GOP to control breeding and spreading of Desert Locusts.
Present paper is an overview of Desert Locusts with introduction, classification, characteristics, plagues and upsurges of LSs, Economical impacts, prevention and control of LSs, advantages and role of FAO. Desert Locust plague management strategy need to be framed. Effective and proactive ways to control LSs need to be developed and preventive measures based on EWE data need to be explored to minimize agricultural devastation by Desert Locusts.

Keywords: locust swarm, plague, upsurges, desert locust, trans boundary insects migration, solitary phase, gregarious phase, agricultural menace

Introduction
As per entomological classification the insect locust (Tiddy) belongs to Acrididae family and Orthoptera order. Locusts have three stages of life cycle:- egg, hopper and adult. A female solitary locust can lay 80-90 eggs whereas gregarious locust can lay 150 eggs, twice or thrice in their life cycle. The eggs are laid in egg pods and up to 1000 egg pods are found in one Sq m. The eggs hatch in 2 weeks, hoppers develop in 4-6 weeks and adults mature in 3 weeks. The whole body of locust is divided into three major segments; head, thorax and abdomen. Moist sandy soil and availability of green vegetation are favorable conditions for breeding and spreading of LSs. Solitaria morph locusts are greenish in early instars and greyish in adult phase whereas gregaria morph locusts are pinkish in early instars and yellowish in adult phase [6, 9].
In dry season, when there is no rainfall and very less vegetation, Desert Locusts remain in solitary phase. LS is forced together to take varied appetite and release serotonin in their central nervous system which makes them more social and crowded. Arrival of rains bring green vegetation, Desert Locusts transforms to group forming gregarious phase from solitary phase. LS suddenly becomes more active for breeding and growing. In solitary phase LSs inhabits 10 % of world's total land or 30 countries while in gregarios phase LSs can inhabit 20% of world's total land or 60 countries [14].
Locusts generally live for 3 to 5 months depending upon ecological and food conditions. Locusts have ability to live in solitary or in swarm. Gregarious locusts may live for 9 months and swarm may have 40 to 150 million locusts per Sq Km of area. Locusts can affect livelihood of world's 10% population, fly over 20% of world's total land surface and eat almost 200 tonnes of crops, plants or vegetation every day. Gregarious locust can eat 2Gm of vegetation per day. Desert locusts may change form according to ecological parameters from solitary, short winged and non-migratory form to gregarious, long winged and migratory form. LSs can easily traverse 150 Km every day synchronized with wind speed. A single LS can cover 1.2K Sq Km area [10, 14].
Desert Locusts generally fly from African countries Arabia countries and west Asian countries. During recession period (when they are inactive) they stay in African countries and during plague period (when they are active) they fly in Asian countries and cause heavy damage to vegetation. In India LSs migrate from Pakistan. Migration continues from March to July months. Nowadays due to climate change (rise in temperature and early arrivals of pre monsoons) LSs have extended stay in India upto the month of November [13, 18].
It is interesting to note that Desert Locusts increase exponentially. There may be a tenfold to sixteen fold rise in locust numbers in consecutive generations. To control such a massive LSs is practically difficult task. Efforts are required to adapt preventive measures with the help of Early

Warning Equipment (EWE) to counter outbreaks of Desert Locust. Outbreaks occur when areas become favorable for breeding due to good rains, rising temperature and plenty of green vegetation. Number and density of Desert Locust increase enormously to form hopper bands and swarms [19, 20].

In 2020 situation in India has become more alarming as migratory LSs are spreading in Rajasthan, Madhya Pradesh and Uttar Pradesh, where they threatened crops and vegetation in many districts. States of Gujrat, Punjab, Haryana and Delhi were also kept on high alert as precautionary measure by Ministry of Agriculture, GOI. Farmer's in almost 30 districts of these states suffered huge monetary losses as their crops vanished due to Desert Locust incursions. Each locust can eat an amount equal to its own weight in a day. Literally LSs eat everything which comes their way.

Indian economy is agro based. Indian farmers can't bear financial losses wreaked by locust plagues. Directorate of Plant Protection, Quarantine and Storage (DPPQS) in association with Locust Warning Organization (LWO) are trying hard to find out curative measures to prevent and control LSs induced agricultural menace in India. Tran's boundary migration nature of LSs require International cooperation to cope with complex situation [23]. Following the successful mega breeding in West Africa, Pakistan and India, UN FAO may declare LS incursions (presently upsurges) in 2020 a plague if situation worsens by the end of Dec 2020.

Classification of Desert Locusts

Desert Locusts are classified as: Eukarya-Domain, Animalia-Kingdom, Arthropoda-Phylum, Uniramia-Subphylum, Insecta-Class, Orthoptera-Order, Caelifera-Suborder, Acrididae-Family, Cyrtacanthacridini-Tribe, Schistocerca-Genus, S. gregaria, S. Solitaria-Species [9].

Binomial name of Desert Locust is Schistocerca gregaria. Desert Locusts are also known as Acridium peregrina and Gryllus rufescens.

Characteristics of Desert Locust

Characteristics of solitaria and gregaria phases of Desert Locust are compared vis a vis below [9].

Solitaria Locust Gregaria Locust

1. Adults are greyish in colour Adults are yellowish in colour
2. Instars are greenish in colour Instars are pinkish in colour
3. Behave independently Behave cohesively
4. Repelled from other locusts Attracted by conspecific
5. Walk slowly Walk rapidly
6. Short winged Long winged
7. Active in night Active in night
8. Restricted diet Broad diet
9. Inhabits 10% of world's total land Inhabits 20% of world's total land
10. Migratory in form Non migratory in form

Upsurges and Plagues

Recessions, Upsurges and plagues of Desert Locusts are based upon activity, period of stay and severity of damage to vegetation. Recessions are periods without widespread swarm infestation during which species revert to transient and solitarious phase. Upsurges are periods during which a widespread LS mutates from transient to gregarious breeding phase in the contemporary and adjoining areas for two or more successive seasons. Plagues occur when widespread infestation of LSs and hopper bands affect extensive vegetated areas repeatedly for many successive years. Upsurge incursions are evaluated when gregaria locusts cause devastating damage to crops and are recorded yearly while plagues period may extend from 2-8 years [20, 25]. Desert Locust plagues doesn't occur after regular intervals instead plagues occur intermittently.

Major upsurges were in the years:

1964, 1968, 1970, 1973, 1974, 1975, 1976, 1978, 1983, 1986, 1989, 1993, 1997, 2004, 2019 and 2020.

Major plague period were recorded in twentieth century:

1926-1931, 1932-1934, 1940-1948, 1949-1956, 1957-1963, 1967-1969, 1986-1989

An upsurge of Desert Locust is declared a plague by UN FAO if, incursions of LS continue to occur, ecological parameters continue to be favorable for breeding, growing and spreading of LSs, breeding of Desert Locusts continues, LS size increases continuously, migration of LS continues and agricultural wreaking havoc continues over a certain period of time.

Economical Impacts of Lss

Desert Locusts have strong biting and chewing mandibles which enables them as perfect vegetation eater. Voracious appetite of Desert Locusts has significant ill effects on farmer's economy in particular and national economy in whole. Economy losses are mentioned below [27, 30]:

- Desert Locust upsurges and plagues can cause widespread crop losses.
- Consumption of vegetation by LSs may cause acute shortage of food supply in affected areas.
- Export earnings and food security may be threatened in LSs affected areas.
- Allergens and pheromones (in gut) of Desert Locust are injurious to human health.
- Desert Locust droppings are toxic and are poisonous for cooked, uncooked as well as stored foods.

Prevention and Control of LSs

Solitaria Desert Locusts are known to be harmless to vegetation whereas gregarious Desert locusts cause severe damages to farmer's crops, plants, trees and any vegetation. They literally eat every part; leaves, flowers, fruits, seeds, branches, bark, and stems due to their voracious appetite. Each gregarious locust consumes vegetation equal to its weight. One LS can consume 200 tonnes of vegetation per day which is significant economic loss to a developing country like India. Apart from agricultural damages LS are also believed to leave behind allergens, pheromones present in their gut. LS also shred wings and integument which causes asthma. However priority is to check agricultural menace. Thus, it becomes necessary to control and prevent menace caused by LSs. Controlling a LS becomes a herculean job due to their migratory nature and Trans boundary existence. Area covered by a LS is so vast and unpredictable that spraying of insecticides in the entire infested zone is next to impossible. Research is going on to develop techniques of breaking the herd and dividing the swarm into smaller groups. Seeking Trans boundary International cooperation is also a diplomatic concern [20, 27]. Various methods deployed for prevention and control of LS

agricultural menace are mentioned below:

- Mechanical Control: Typical noise is produced in the infested area to unsettle LS. Vibrators are used to produce vibrations inconvenient to Desert Locusts.
- Aerial Spray: Insecticides like Dichlorodiphenyltrichloroethane (DDT), Benzene Hexachloride (BHC), Malathion (C10H19O6PS3) and Lindane (C6H6Cl6) are sprayed with the help of helicopters and drones. Spraying of insecticides in bulk has its own limitations due to detrimental ecological impacts. Organophosphates are also in use.
- Ultra Low Volume (ULV) spray: Ecofriendly insecticides are sprayed with the help of ULV equipment to control smaller groups of Desert Locusts.
- Burning and Heat Blowing: Desert Locusts are either burned or exposed to heat to control their population. However scale of application again puts limitations for such methods.
- Large Interceptors: Desert Locusts are intercepted with the help of large stationary nets or mobile nets mounted on special utility vans.
- Desert Locust Cannibalism: Desert Locusts are cannibals. One way of controlling LS is to promote cannibalism by breaking LS in smaller groups. With the breakup of group, orientation of Desert Locusts changes which make them vulnerable to be preyed. Cannibalism is the ability of eating individual of the same species. Desert Locust eat anti aligned individuals in swarm to meet their requirement of protein and salt. LS is broken in smaller groups by flying airplane over infested area thus producing sharp noise to destabilize LS.
- Predator Control: Birds, wasps and reptiles eat Desert Locust. They may be used to control LS.
- Trench Burial: Trenches are dug and filled with water or kerosene to trap LS. Method is costly and labour oriented.
- Bio Repellent : Bio-repellent powder such as Neem leaves, Chile pepper and Garlic powder is sprinkled over crops to protect from LSs. Pungent smell and bitter taste keep LS away from vegetation.
- Bio Insecticides: These are obtained from plants, trees and natural resources. Generally, bacterial action of these insecticides reacts in the stomach of insects and kill them. Neem oil, Canola oil and Diatomaceous earth are examples of commonly used bio insecticides.
- Breeding Prevention: Application of all the previous methods has constraints and limited scope to control massive LSs. Scientists and researchers are thus working round the clock to invent some ecofriendly technique to prevent breeding of Desert Locusts.

Advantage of Desert Locust

Desert Locust in dried form contains 17% fats 62% edible proteins and rest inorganic components like Ca, Fe, P, S, Na, Cu, Mn, K etc. making it a nutritional diet for birds and fishes. Many countries prepare delicious recipes from Desert Locust. In Pakistan-Tidda Biryani, Tinjiya-Tswana, Torah Kosher- Israel, Choco locust, Mezcal-Mexico, Locust Kebab-Nairobi, Baked locust-Kuwait and in Sikonyane-Swazi recipes are prepared from Desert Locusts and served with honour. Desert Locust is also consumed in Australia, Barbecue and Cambodia. Heap of dead LS may be utilized in the preparation of organic manure [13, 31].

Role of FAO and LWO

United Nations FAO was established in 1945 in Rome, Italy with a Latin motto ‘Fiat Panis' meaning ‘Let there be bread'. FAO mandates to provide information about LS incursions and provide timely forecasts to endangered countries. FAO operates Desert Locust Information Service (DLIS) to collect data from various LSs affected countries and correlates it with weather data, habitat data and satellite imagery to predict LS location, migration and breeding possibilities [21].

FAO also imparts training on various aspects of LSs. The apex body carryout field surveys, situation assessment and controls operations in LS plague affected areas to issue alerts to probable vulnerable countries. UN FAO predicted in April 2020 that second incursion of LS will be 20 times larger than first and could become 400 times by June 2020 in African countries of Ethiopia, Kenya, Uganda, Sudan, Tanzania and Somaliya. FAO warned that in these African countries vegetation devouring may be to such an extent, there could be 0% harvest with 100% losses.

LWO was established in 1939 with its HQrs at Jodhpur, India after the ravages and predation of Desert Locust plague of 1926-1937 under Directorate of PPQS, GOI. Main objective of LWO is to keep surveillance of upsurge and plague areas and issue warning to the states for possible LS incursions [23].

Conclusion

Agricultural menace by LSs is extending and increasing in India every year. Year 2019 and 2020 witnessed successive invasions of Desert Locust in the states of Rajasthan, Uttar Pradesh and Madhya Pradesh. Although exact data is yet to be shared by LWO but it is estimated that LS had severe consequences in about 30 districts of these states. Better interstate coordination is required for timely transfer of infestation data. GOI also issued alert to adjoining states of Delhi, Punjab and Haryana against probable incursions of LSs migrated from neighboring country Pakistan which failed to abide International norms of spraying insecticides in LS infested areas in order to control breeding and spread of LSs.

Indian state agencies did well to curb the menace by taking timely action on FAO and LWO alerts. However, shortage of equipment, lack of trained manpower and absence of early precise information put hurdles in implementation of control operations. Preventive measures to reduce outbreaks of LSs affect need to be evolved to get rid from tiny Desert Locust threats. Conducive ecological conditions; temperature rise and early arrival of pre monsoon due to climate change; for breeding and spread of LSs are also exacerbating the situation.

International organization UN FAO is playing leading role in collecting, compiling, analyzing, summarizing and generating timely alerts for vulnerable countries against Desert Locusts probable invasions. War-footing efforts and services of DLIS are appreciable but monitoring and executive body of FAO need to be strengthen, enabling the agency to put befitting restrictions on defaulting and irresponsible countries like Pakistan and Iran, which fail to comply with guidelines issued by UN FAO, thereby posing agricultural threats caused by Desert Locusts to entire world.

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