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'Desert Locust': A Menace to Indian Agriculture and Economy

Aryadeep Roychoudhury[1]

[1]*Post Graduate, Department of Biotechnology, St. Xavier's College (Autonomous), 30, Mother Teresa Sarani, Kolkata-700016, West Bengal, India.*

Correspondence E-mail Id: *aryadeep.rc@gmail.com*

Abstract

Indian agriculture and economy is currently at risk due to the upsurge in infestation of farmlands and fields with 'desert locus' which has assumed a severe shape in several states of India. The locusts have migrated from East African countries like Somalia, Ethiopia, etc. via Iran, Afghanistan and Pakistan, to reach the Thar deserts of Rajasthan, where they could find shelter and breed to a large extent, favored by high temperature and sufficient rainfall, thereby encountering a population explosion. Although the locusts prefer solitary behavior, food scarcity and extreme conditions turn them gregarious and coherent by nature. It is believed that one square kilometer of a locust swarm contains 80, 000 adults that can daily consume food equivalent to 35,000 people. This statistics is really alarming, since it speaks of the magnitude of the problem of acute food crises that a nation like India would encounter if the movement of these locusts is not monitored and restricted. Understanding the biology and social behavior of the insects, and implementing sound pest management programs will help us to address and mitigate the problem, and safeguard the crops and harvestable species against economic loss.

Keywords: Desert Locust, Crop Damages, Economic Loss, Integrated Pest Management, Social Behavior of Insect.

Introduction

In the midst of global pandemic and coronavirus plight in India, which is gradually occurring leading position in the world in terms of number of viral-affected individuals, the country in 2020 is facing a new challenge of battling for food security due to infestation of agricultural fields and grasslands by the voracious 'desert locust' which is feared to jeopardize plant protection, threaten food security and agricultural economy of the country, and is assumed to take a deadlier shape. According to Food and Agricultural Organization (FAO), a mass danger is forecasted in India due to intrusion of the locusts from East Africa through Arabian Sea on Gujarat coasts of India. The locust attacks are also suspected almost at the same time from Iran and Baluchistan. India is predicted to face successive waves of multiple attacks by locusts, much bigger in numbers, than being faced in recent times.

It is not that such a situation is unprecedented in India. According to the reports of FAO, the incidence of such locust onslaughts in British India dates back to 1926 or even earlier, especially between the periods 1926 to 1932. This brought about mass destruction of fodder crops, leading to death and starvation of several herbivorous animal species. This compelled the then British Government to set up the 'Locust Warning Organization' in 1939 with headquarters at New Delhi under the major initiative of the renowned entomologist, Hem Singh Pruthi, who was a plant protection advisor to the then Government of India, and more importantly was the founder pillar of the 'Entomological Society of India' in 1938 [1]. The main responsibility of this Organization was to trace the path and movement of these 'desert locusts' in the Scheduled Desert Area (SDA). Since then, this Organization keeps track of locust infestation all over India, and makes the states, particularly Rajasthan and Gujarat, alert regarding any possible danger.

The year 1993 was marked for locust infestation which documented that about 172 swarms ravaged the Indian agricultural fields in one single year. According to government records, 190 locust swarms attacked an area of about 3,10,000 hectares in Jaisalmer, Barmer, Bhuj, and Jalore districts of Rajasthan that single year. These locusts have also invaded India frequently in smaller scales and localized pockets in several consecutive years like 1998, 2002, 2005, 2010, 2015 and 2019 [2]. In fact, parts of Western India like Gujarat, Rajasthan, etc. are affected at non-alarming rate by these insects almost every year between the months of June to November. They normally fly from Iran, Afghanistan or Pakistan to Rajasthan or Gujarat states of India during summer. However, this attack in 2020 has assumed such a massive and worst upsurge after 27 years, with already more than 20 swarms marauding North-western parts of India, encompassing the states like Rajasthan, Gujarat, Punjab, Madhya Pradesh, Chhattisgarh, Maharashtra and Uttar Pradesh. According to FAO, recent movements are also linked with strong westerly winds from the recently originated cyclone Amphan in the Bay of Bengal.

Reason for Recent Locust Migration in India

The 'desert locus' prefers arid/semi-arid environment of East Africa in the Arabian peninsula to live, but lay eggs on bare ground in warm humid atmosphere. Most of the regions where the locusts reside, viz., the Horn of Africa, Yemen, Oman, Southern Iran and Baluchistan and Khyber Pakhtunkhwa provinces of Pakistan have faced adequate rainfall in recent times, thereby becoming favorable breeding ground for the locusts. The migration area of desert locust covers about 30 million square km in nearly 64 countries, including parts of the Indian subcontinent [3]. The locusts are thought to have migrated this time from East African countries like Somalia, Ethiopia, etc via Iran, Afghanistan and Pakistan, to reach the Thar deserts of Rajasthan, where they could find shelter and breed to a large extent, being favored by frequent rain in these areas during the months of September and October in 2019. Because of this huge population burst, they are suffering from acute food scarcity and are therefore dispersing throughout the agricultural fields of several states of India, without being restricted. In this regard, we are witnessing 'desert locus' 'hotspots' in the current scenario, in addition to coronavirus 'hotspots', both of which are gradually widening in India. It is suspected that current breeding of insects will

gradually generate new swarms in course of time, which might worsen the situation. According to FAO, the locust swarm currently affecting parts of India, was responsible for crop infestation in 2,80,000 hectares across 13 countries, prior to arrival in India. According to the Ministry of Agriculture, around 3.75 lakh hectares of crops were devoured by locust attacks in India with a loss of over Rs 100 crores in the 2019-20 cropping season. Locusts have already destroyed over two lakh hectares of crops in India, since the beginning of May 2020, and threatened another six lakh hectares of crop. This really shows how devastating the impact may be upon the agriculture and economy of the country.

Habit, Habitat and Social Behavior of 'Desert Locus'

The 'desert locus' (*Schistocera gregaria*) is a type of grasshopper which usually remains confined to the dry and arid regions of Africa, West and Southwest Asia, receiving less than 200 millimeters of annual rainfall [3]. With the increasing problem of global warming and greenhouse effect, gradual temperature rise since the past few years has led to an unprecedented warming of the planet Earth. Moreover, last few years have also witnessed some erratic and abnormal rainfall patterns with frequent cyclones due to difference in ocean temperature, the global climate change being the root of the problem. These factors synergistically might have caused the locust population to thrive and proliferate, being adaptive in such hostile situations. We never know whether these locusts are rapidly mutating as well to survive in extreme heat and frequent heavy rains, as we see for the coronaviruses. These locusts are normally quiet and solitary organisms with mutual aversions and do not prefer to survive in groups. However, when hunger-driven because of drought or food scarcity, they change their asocial or solitarious habit and forage together in coherent groups [4]. When there is a population explosion, as in the present situation, they exhibit extreme phenotypic plasticity by turning aggressive and gregarious in their food habit, accompanied by constant mutual touching of their hind legs, which means that they co-ordinate and align their movements and feed together in swarms. On approaching near each other, two distinct sensory pathways are triggered: (i) tactile mechanosensory stimulation specifically in the hind limb femora brought about by locusts jostling each other, that affects a couple of nerves, and (ii) phase-related differences in the visual and olfactory systems. The brains of gregarious locusts are 30% larger in proportion than solitarious locusts along with differences in relative development of brain regions [5]. This change in habit is phenotypically expressed through their transformation from tiny to robust bodied structure with strengthened muscles, as well as body color change from green to yellowish-brown. There can be as many as 40-80 million locusts in a 1 square kilometre swarm, flying at the rate of 150 kilometer per day and staying in the air for a long time. The chemical signal that induces and drives this behavioral transformation from solitary to congregated habit of gregarization is the serotonin, which is released in bulk amounts due to rubbing and tingling of hind legs of each other [6]. Serotonin in humans is a vital neurotransmitter chemical, regulating mood and social behavior, memory, proper appetite, sexual desires and an overall 'feel happy and calm' attitude [7]**.** In terms of the environmental implications, locusts impact native grazing species feeding on grasslands for

survival. These locusts devour almost all standing crops and plant parts like tree barks, leaves, flowers, fruits, grains and all growing points, leaving behind ruined cropland and barren pastures. While they are not known to impact forests or natural tree cover, their voracious consumption of most species of crop creates food scarcity for native fauna and other insects. In Kenya, for example, locust plagues detrimentally affected the habitat of the Grevy's zebra, a threatened endemic species. Each locust consume fresh food equivalent to its own body weight of about 2 g before mating, so that loss in food and agriculture due to 40 million locusts in a swarm is easily understandable. They become hoppers after a month and can start laying eggs when they are 60-70 days old. A single gregarious female locust can lay 60-80 eggs, three times during its average life cycle of 90 days [5]. If their growth is coterminus with that of the kharif crop, we can well presume what devastation it is going to cast in the coming months. The situation will be similar to what maize, sorghum and wheat farmers of Kenya, Ethiopia and Somalia have already experienced in March-April this year. Fortunately, since the rabi crops have already been harvested, not much loss has been registered yet. If the monsoon comes in time, it is probably after July that there would be westward movements of the swarms, as they will return to Rajasthan to re-initiate breeding, on the retreat back of the changing winds associated with the southwest monsoon. Once they start breeding, the swarm movement will cease or slow down. If, however, left uncontrolled, the sub adults will come back to their summer breeding area in the Thar deserts. If there are good rains, they will again lay eggs and lead to a new generation of 'desert locusts' migrating to India back in a few months to repeat the same cycle.

Effective Control Measures Against Locusts

Integrated pest management (IPM) combines the use of chemical, biological and cultural practices to subdue pest incursion. It involves (i) proper knowledge regarding the pest with respect to life cycle and growing areas, (ii) escaping the pest attack by properly selecting the plant varieties, site of plantations, understanding the mechanism of host-pest interactions with proper farm management; (iii) crop monitoring and establishing pest prediction models; (iv) applying control measures; and (v) proper evaluation and planning [8]. Application of insecticides and pesticides in the form of spray, dust, etc. has been followed by the farmers for quite a long time to deal with insect pests. Organophosphate chemical and/or Malathion 96, Chlorpyrifos, Endosulfan, Methyl Parathion, etc. treatment to vast stretches of agricultural land is till date the chief practice followed by the Indian farmers. However, the huge volume of insecticides that would be required to eradicate locust swarm will turn this into a futile effort. Moreover, these pesticides and insecticides are in most cases non-specific, meaning that they can target any unwanted insect species, causing loss to insect diversity. Unlike Bt (*Bacillus thuringiensis*) dusts or sprays, which are more specific to Lepidopteran and Dipteran insects, these insecticides are broad-spectrum in nature and hence unsafe. Moreover, residual effects due to continued treatment of such chemicals on crops and vegetables might lead to biomagnification in the food chain, causing human health hazards upon food consumption. Many insecticides and pesticides are also known to cause genotoxicity and carcinogenicity. The importance of

pheromone-based strategies is emphasized by the continuously increasing problems associated with the use of conventional pesticides. Pheromones are chemicals (mostly long chain unsaturated esters like acetates, alcohols, and aldehydes) produced by insects to induce a certain behavioral response on conspecific individuals. 'Mating disruption' method for pest control makes use of releasing large amount of pheromones to a crop species in order to prevent or delay insect mating. However, high-density insect populations, as in the case of 'desert locus' swarms are difficult to be controlled through this approach. Interfering or antagonizing the chemical communication channels of insect pests through certain semiochemical compounds (also called parapheromones) of anthropogenic origin and structurally related to natural pheromones also proves to be an effective measure. The attracticide (''attract-and-kill'') concept-based method consists of using pheromone or other attractant semiochemicals to lure insects to a specific point source or area containing a conventional insecticide. This method is similar to mass trapping, but many more insects are affected because the attracticide is spread over a larger area and the killing effect is not limited to individual traps [9]. Another crude practice followed by the poor farmers in rural areas of India is beat utensils in afternoon or create wood fires at night to drive out the locust swarms from agricultural fields. In addition, research groups have identified certain drugs that inhibit serotonin transporters, thereby preventing serotonin uptake and action [10]. This throws light regarding the prospect of blocking locust metamorphosis and gregarization by spraying serotonin-inhibitory drugs (mostly serotonin antagonist and reuptake inhibitors) to the locust swarms and combat locust menace. However, this might have deleterious side effects on other animals and humans, where serotonin is a normal chemical component. Even the plants do contain endogenous serotonin which plays diverse roles like modulating growth and development, photosynthesis and reproduction, in addition to antioxidative role against environmental stress and pathogen infection [11]. Application of serotonin inhibitor therefore implicates damage to the plants as well. Biological control of insects is also a common procedure adopted in plant pathology where natural predators of insects like native species of wasps, birds or reptiles and entomopathogenic fungi may ward off the locust swarms. Sometimes, a new predator against the insect pest might need to be introduced, in case of non-availability of natural predator in the infected area; however, it carries the risk of biological invasion of that exotic predator in the alien territory. Overall, none of the above mentioned approaches seem to be full proof, having their own limitations. Probably, destroying the insects during egg-laying stages, when they are sluggish, is a much better solution. Alternately, trapping these locusts via large nets and supplying them as food items to fish, poultry and farm animals due to their high nutritional value is gradually coming up as a sound control measure. Newer ecofriendly approaches like utilization of microbial biopesticides or nanopesticides can show new directions and add new dimensions to face such agricultural challenges [12]. The high insecticidal efficacy of nanostructured alumina, for example, is a result of its intrinsic electric charge, small particle size and high sorptive potential because of its large specific surface area. The policies for locust management also need to be strengthened through proper co-operations between vulnerable nations. Although the Locust Control and Research Program of Government of India mostly emphasizes on the traditional methods of controlling pests through extensive field monitoring

and spraying insecticides using ultra low volume (ULV) sprayers mounted on aircrafts, there should be updated warning systems in the form of sophisticated technologies that can properly monitor locust movement and migration to eradicate them completely. Species Distribution Modelling (SDM) will also play a major role in establishing the relationship between environmental variables and dispersal pattern or range expansion of locusts, as well as predicting regions which are more susceptible to locust swarms in future, thereby adopting adequate measures beforehand to lower the potential agricultural losses [13]. There should be national schemes to provide monetary compensations to the distressed farmers to deal with such economic losses. The Locust Environmental Booklet from FAO provides updated information on the situation and methods of handling locust swarms. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at Hyderabad in India has recently published an online update containing the guidelines for locust swarm management.

Conclusion

Since time immemorial, human population has inflicted paramount atrocity to the planet Earth and immeasurable torment to the Mother Nature, exploiting ruthlessly and unscrupulously all the abundant resources to satisfy their selfish ends, as well as polluting the resources. Our Mother Nature has been silently 'weeping and crying' for quite a long time because of our reckless behavior; in spite of that, she has liberally given us food, water and air in plenty to support our survival. Now that the situation has surpassed all tolerance limits, Nature is probably revolting back to teach us lessons and rectify ourselves from mistakes for future. The current locust swarm is thought to have originated in southern Iran due to the Indian Ocean Dipole, which caused warmer waters to its west and cooler waters to its east. Rising sea temperatures due to increased greenhouse gas emissions are expected to create more favorable conditions for locust swarms in the coming years. In the face of global climate change and warming effect with abnormal seasonal distributions, these kinds of pathogen infections or pest incursions are therefore going to recur more frequently in the coming future. Crop species are already subjected to a plethora of multiple stresses arising from environmental factors or biotic agents like pathogens and insects. Time has come when we should be extremely cautious to save our planet from warming and pollution, protect the interests of our poor farmers who are the main foundations of agricultural economy of India, as well as keep ourselves adequately ready to face such critical situations and handle them efficiently. In the rural areas, such infestation also invites social problems by crippling the livelihood and income of the poor farmers, and even affecting their children who temporarily drop out from schools to support their parents for recovery from agricultural losses. The milk quality from cattle gets deteriorated due to loss in fodder, which in turn affects the nutrition of new-born infants, feeding solely on milk. It is thus utmost need of the hour to promote adequate research in agriculture, plant protection and crop improvement schemes through sustainable, cost-effective and eco-friendly technologies, as well as adopt conservation strategies to protect our fertile agricultural lands. Otherwise, time is not too far when even the affluent sections of the society who possess enough wealth, will find no safe food grains or

vegetables and clean potable water, available in the market, to mitigate their hunger and thirst respectively.

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