Makerere University Journal of Agricultural and Environmental Sciences
Vol. 14. pp. 63 - 74, 2025

pISSN 1563-3721
eISSN: 2958-4795

https://doi.org/10.70060/mak-jaes-2025-169

Received: *8 July 2024; Accepted*: *7 July 2025*

Occurrence and settling behaviour of the migratory locust (*Schistocerca gregaria*) on vegetation in the north eastern dry agro-ecological zones of Uganda - A short communication

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Abstract

The desert Locust (*Schistocerca gregaria* Forskål) is a very important pest worldwide and frequently invades over 60 countries. In Uganda, the latest major desert locust invasion was in 2020, five decades after the previous plague. During the 2020 invasion, surveillances of the pest and native community responses were documented in the affected sub-regions of Karamoja, Teso and Acholi. The objective was to determine locust settling and feeding preferences; and the perceptions of the interventions used by local people to inform future surveillance, containment and control efforts. The study was implemented through a rapid rural appraisal of 200 respondents, a biological monitoring study along 1 km line transects, and a focus group discussion with 20 influential people in the invaded areas. Inventories of tree species, and cropped patches; and locust settling and feeding behavior were done along the transects. The study revealed that local people in the areas knelt down to pray, used fire and smoke, made loud noises, and sprayed chemical insecticides to prevent the locusts from settling in their areas. Praying was widely reported among the three sub-regions (ethnicities). Chemical applications had the highest efficacy in disruption of the locust activity. Tall green vegetation especially Acacia spp. and *Balanites aegyptiaca* tree species attracted swarms for settling/roosting. The most utilised field crops were *Manihot esculenta* and *Oryza sativa* crop patches. These findings can inform the future surveillance and control strategies for the pest.

Key words: Host crops, invasion areas, local interventions, roosting, swarms, trees

Introduction

The desert locust (*Schistocerca gregaria* Forskål; Acrididae: Othorptera) is one of the most devastating migratory pests of diverse crops in the world. The species often exists as solitary, gregarious or transitional forms (Showler, 2008). Solitary desert locust forms often exists in recessions areas, confined to an area of sixteen million-square-kilometers belt, extending from Mauritania through the Sahara Desert in northern Africa, across the Arabian Peninsula, and into Northwest of India (Kimathi *et al*., 2020). The transitional forms are changing forms, and the gregarious are migratory. The major focus for control interventions are on the transitional and gregarious forms (Kimathi *et al.*, 2020; Wanxi *et al*., 2020).

In the recession area in the summer season (July – October) breeding occurs around the Indo-Pakistan border, Sahel, West Africa, Eritrea, Ethiopia, Sudan; whereas winter breeding (October – January) occurs in the Red Sea and Gulf of Aden coasts, Somali Peninsula; and spring breeding (January – June) in the north west Africa, Iran, Pakistan, Interior of Saudi Arabia and Yemen (Showler, 2008; Tarai and Doumandji, 2009). Prevailing conditions of moist soils, moderate temperatures (32-35^{0}C), and greening vegetation favor increasing populations of transitional and gregarious desert locust forms. Favorable conditions trigger egg laying, and hopper (nymphs) emergence. As the locust populations begin to increase in relatively small areas, it triggers the hopper groups to start changing in color and behavior, and to become gregarious; subsequent emerging adult groups become big in sizes and start to fly downwind as swarms; towards the invasion areas at wind speeds of 20-50 km/hr (Showler, 2008)**.** According to Kimathi *et al*. (2020), the migrating swarms can contain up to 100 million locusts, and can fly at 1,000 - 1,800m from the ground for over 100 km/ day in steady wind, or at least 5km/day in cold days. In the daily swarming schedule, the new mornings start with basking, feeding and mating, then resuming the active flights after gaining warmth from the warming environment, the swarms then roost on vegetation during the unfavorable midday heat up but resume swarming with the early evening cooling; and roosting again during cold and dark nights (Showler, 2008). Roosting is associated with the behavior of vegetation feeding, mating, and release of fats and defecation. The presence of green areas induces swarms to settle and quickly feed on the existing green vegetation; taking in food equal to their body weight before take off (Showler, 2008; Tarai and Doumandji, 2009).

Under optimal ecological and climatic conditions, surveillance and control failures, several successive generations may occur, causing swarms to form and invade countries under the invasion belt including Spain, Russia, Nigeria, Kenya, Uganda, India and southwest Asia. The locust invasion areas can extend to over sixty countries. In the invasion areas swarms are normally unevenly distributed in time, so that very large swarms may be available for only a few days, followed by relatively long periods when none is present. Locust surveillance and control campaigns often fall short of expertise, funds and supplies; resulting into upsurges and plagues (Rainey *et al*., 1979; Kimathi *et al*., 2020; Wanxi *et al*., 2020;).

Desert locus invasions to eastern Africa and the horn of Africa have been documented, notably the plagues of 1986–1989 and 2004–2005, which caused heavy yield losses that affected the livelihoods over larger parts of Africa, the Near East and South West Asia, and demonstrated lack of capacities for pest surveillance and control (Lecoq, 2005). The recent 2020 invasion that escalated from poor pest surveillance and control operation failures in Somalia and northern Kenya reached and caused major loses in the north eastern dry agroecological zones of Uganda. The first invasions were noticed in Amudat district, in the month of February 2020 and then spread to Nakapiripit and Katakwi districts, all in Karamoja. However, these passed mostly un-documented. Thereafter, fresh swarms entered the country in the month of April 2020 and covered most of the districts in east, north east and northern Uganda. The swarm sizes varied as they spread to other localities (MAAIF, 2020). The April 2020 locust invasion were documented and scientists were able to study the pests' roosting/settling and feeding preferences with respect to the prevailing vegetation across different sub-regions. This paper presents the information on the locust settling and feeding preferences; and the perceptions of the interventions used by local people to inform future surveillance, containment and control efforts as a contingency plan.

Methods and materials

Study site description

The study was carried out in twenty districts of north eastern and northern Uganda, comprised of Amuria, Kumi, Kapelbyong, Bukedea, Soroti, Katakwi, Nakapiripirit, Amudat, Moroto, Karenga, Kaabong, Abim, Nabilatuk, Agago, and Pader, Kitgum, Gulu, Nwoya, Serere, and Ngora (Fig. 1). These districts are in the Karamoja, Teso and Acholi subregions, with very diverse ethnicities. Figure 1 also shows the distribution and magnitude of the invasion in Uganda. The north east dry ecological zone has a total land area of about 37,456.9 km^2, with human population of about

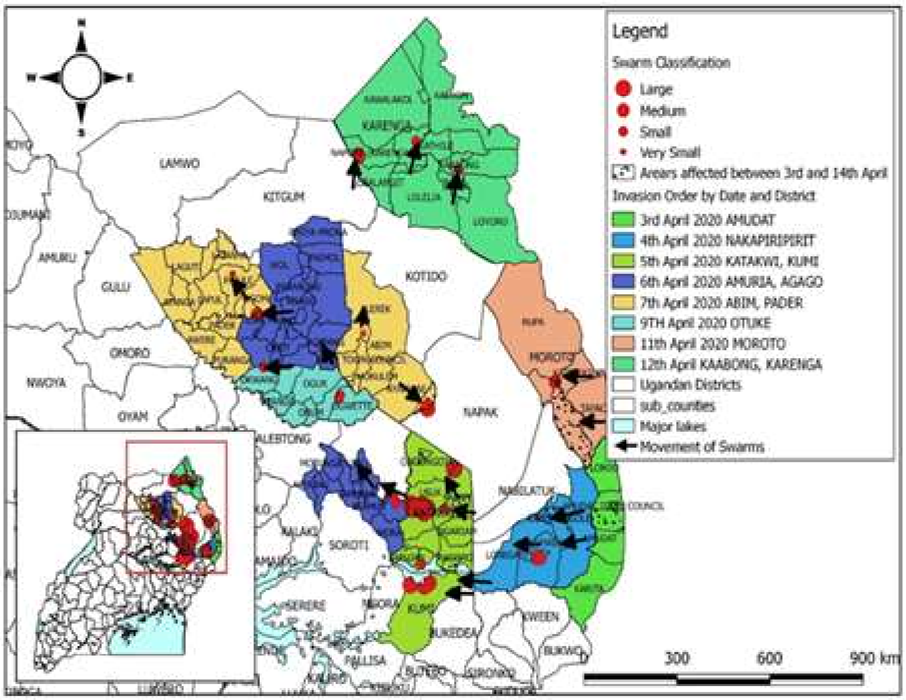

Figure 1. Areas invaded by the desert locusts in north eastern Uganda in 2020 (Karamoja: Amudat, Nakapiripirit, Moroto, Kaabong, Karenga; Acholi: Pader, Abim, Agago; Teso: Amuria, Katakwi, Kumi)- in collaboration with the MAAIF team (2020).

3.9 million people. The zone experiences semi-arid conditions with a uni-modal rainfall pattern (about 300 -1500mm annually) stretching from April to November with a dry period from December to March. Temperature for the zone ranges between 16 - 26.9 °C and wind speed of ranges of 4.9-17.9 kph. The soils are Ferralsols and Leptosols with a sandy loam texture; and altitude ranges from 1000-1200 masl. The vegetation is savanna bush lands, semi-arid shrubs, and trees. Farming is the main economic activity with the major crops being maize, millet, cassava, sweet potatoes, beans, peas, sunflower, groundnuts, cotton and tobacco; and major livestock being cattle of dual-purpose indigenous cattle breeds, goats, pigs and sheep. The area is endowed with a variety of natural resources such as wetlands, papyrus swamps, palm trees, dry woody savanna forests, rivers (Nile), Mountains (Moroto), lakes (Kyoga and Kwania), and a national game park (Murchison Falls and Kidepo), which provide enormous ecosystem services and livelihoods (UBOS, 2021).

Study design

The study was conducted within the desert locust invasion and post invasion periods (April – June 2020) in the invasion areas. A rapid rural appraisal (RRA) was implemented using a semi-structured questionnaire. Two hundred (200) respondents were selected for the study. The first tier of selection was purposive, for communities that dealt with swarms as highlighted in figure 1 above; the second tier was by approaching households falling within 1 km transects that were utilized by the teams collecting biological data. Observations and inventories of the occurrence of the locusts in patches of tree vegetation and field crops were made following 1 km line transects set up through the pest invaded areas with observations made up to 200m either side of the transect, adapted from Buckland *et al.* (2001). Inventory was done with tally counters by trained loggers who documented vegetation (tree and crop) species with and without roosting locusts (6am – 7pm). The tallies were later processed into species and proportional locust occurrence within the transects. Information from the RRA and biological monitoring was validated through focus group discussions (FDG) with extension personnel, church leaders and key farmers in the invasion areas (N=20).

Data analysis

The data on crop species and locust occurrence was entered into Excel version 2019, and descriptive statistics were generated using R (2022). RRA data was used to calculate the proportional community perception of the control strategies.

Results

Perceptions of locust control strategies (interventions) and their efficacies in the invaded areas of Uganda

There are four strategies reported for distortion of the desert locust activity as applied by the locals, and the government initiatives. The control strategies can be categorized into spiritual, physical, and insecticide applications (Table 1). The strategy with the widest application was the 'kneel down and pray', with moderate perceived efficacy, and was mostly demonstrated by the Akarimojong speaking people of Karamoja. Making loud/sharp noises was commonly practiced in Karamoja and to a lesser extent in Acholi, but perceived ineffective in Karamoja and only 14% effective in Acholi. Application of chemical insecticides was also popular and had moderate perceived efficacy levels in the regions (Table 1).

Occurrence of the locusts on tree vegetation and field crops in the North eastern dry Ecological zone of Uganda during the 2020 locust invasion

The results revealed that the commonly encountered tree vegetation in the area included: *Acacia* spp. (Fabaceae), *Balanites aegyptiaca* (Balanitaceae); Ficus spp. (Moraceae), *Tamarindus indica* (Fabaceae), *Tectona grandis* (Lamiaceae) and *Mangifera indica* (Anacardiaceae). The tree vegetation with the highest occurrence was *Acacia* spp. followed by *B. aegyptiaca* (Fig. 2) while the tree vegetation with the lowest occurrence was *Ficus* spp. The rest of the tree species had intermediate

Table 1. Proportions of people using and percentage efficacies of interventions for Desert locust activity distortions in Uganda (n = Acholi = 40, Teso =80; Karamoja = 80)

Sub-region	Fire and Smoke		Kneel down and pray		Sharp/loud noise (instruments)		Insecticide spraying	
	Proportional application	% efficacy	Proportional application	% efficacy	Proportional application	% efficacy	Proportional application	% efficacy
Acholi	0.40	6.00	0.44	34.00	0.22	14	0.08	32.00
Teso	0.23	0.00	0.65	31.25	0.19	0	0.5	40.00
Karamoja	0.74	8.57	0.92	27.14	0.82	0	0.77	57.14

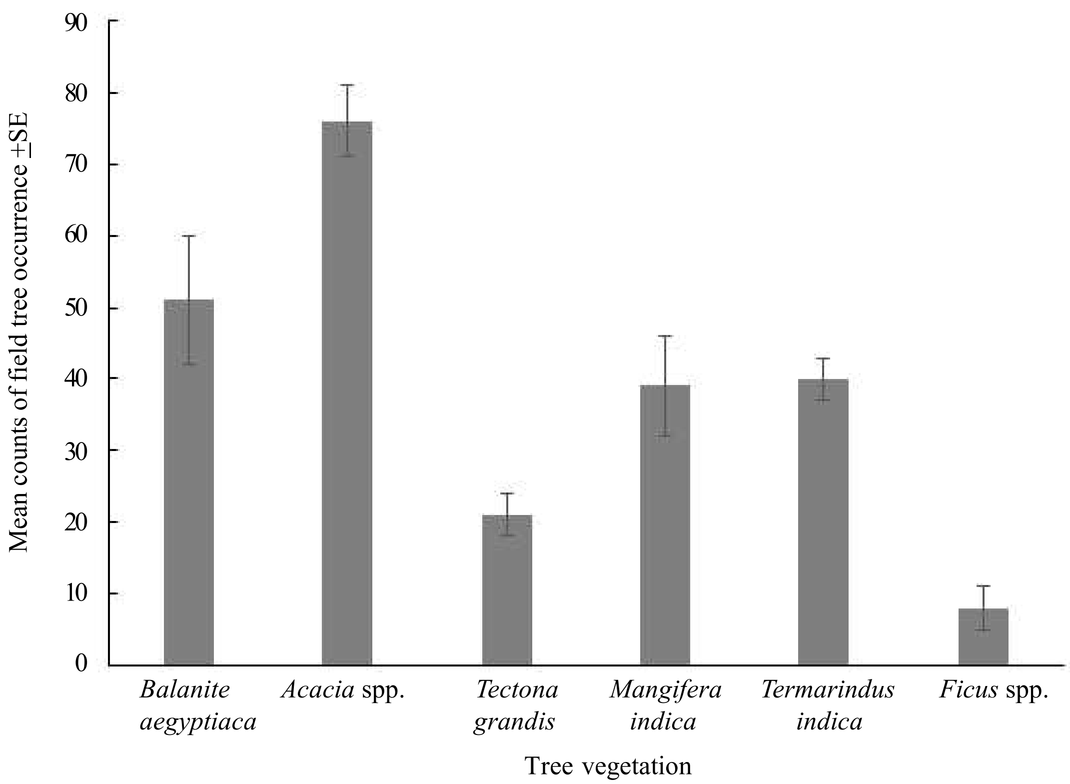

Figure 2. Mean tree species field occurrence (patch counts/1 km transect) in the north eastern dry ecological zone of Uganda, during the desert locust invasion 2020.

occurrence levels (Fig. 2). With regards to field crops, the commonly encountered ones at the time of the invasion were patches of *Manihot esculenta* (Euphorbiaceae), *Oryza sativa* (Poaceae), *Zea mays* (Poaceae), *Sorghum bicolor* (Poaceae) and *Gossypium hirsutum* (Malvaceae), with the highest occurrence being of *M. esculenta*; even as *G. hirsutum* was the least encountered (Fig. 3).

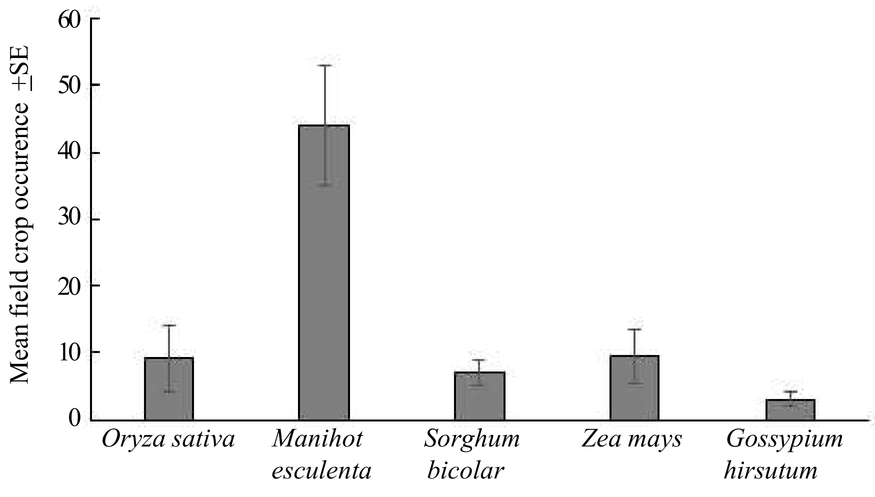

Figure 3. Mean field crop occurrence (patch counts/1 km transect) in the north eastern dry Ecological Zone of Uganda year; February-May 2020.

Settling and feeding preference of S. gregaria on field tree and crop vegetation in the north eastern dry ecological zone of Uganda

With regard to *S. gregaria* settling/roosting and feeding preference for the tree vegetation, results showed that the highest levels were on *B. aegyptiaca* and *Acacia* tree species followed by *T. indica;* and *Ficus* spp. had the lowest occurrence of the locusts (Fig. 4). *Schistocerca gregaria* proportional field crop settling/roosting and feeding preference was highest on *M. esculenta* followed by *O. sativa* whereas *G. hirsutum* had the lowest during the 2020 desert locust invasion in north eastern Uganda (Fig. 5).

Discussion

Schistocerca gregaria invaded the northern dry agroecological zones of Uganda through the north eastern route (Western Pokot area of Kenya) and spread inwards. Northern Kenya and Southern Sudan are known winter breeding areas (October – January) and potential sources of invasion to Uganda (Showler, 2008; Tarai and Doumandji, 2009). The FAO (2020) alert reported breeding in Northern Kenya,

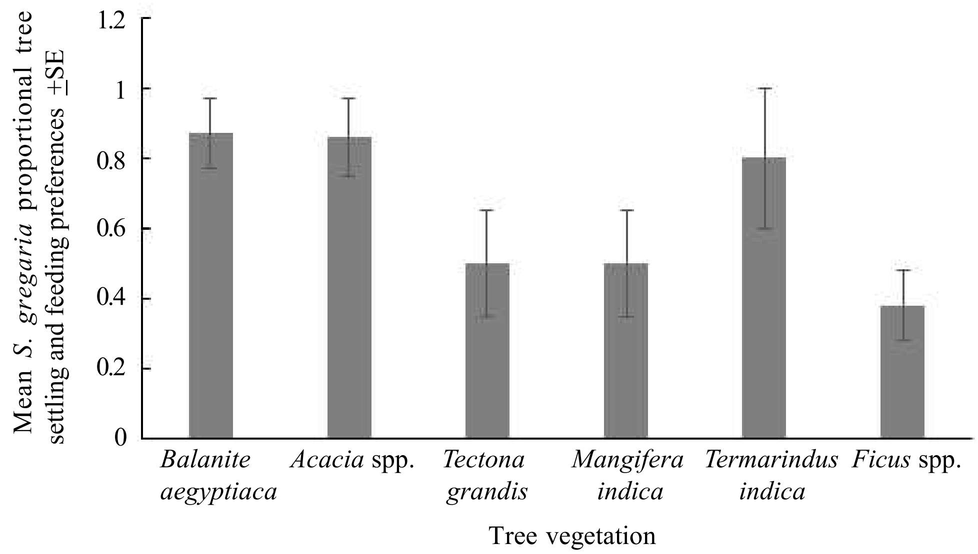

Figure 4. Mean *S. gregaria* proportional tree settling preferences (per 1 km transect) for roosting and feeding during the invasions in the north eastern dry ecological zone of Uganda.

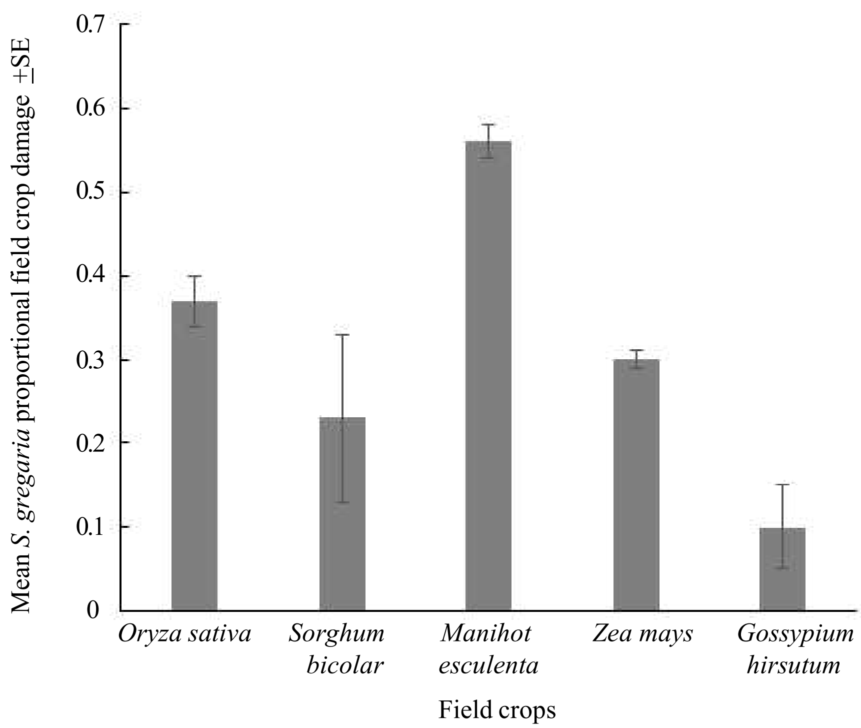

Figure 5. Mean field crop settling and crop feeding preference (per 1 km transect) in the north eastern dry ecological zone of Uganda during the Desert locust invasion of 2020

close to the Somali Republic and Arabian Peninsula; and the failures in the control operations in Southern Somalia and Northern Kenya could have resulted into the relatively large locust swarms that invaded Uganda. Therefore, most the international efforts should be geared towards preventing of swarming from these breeding sites. Larger locust swarms invaded the country via Amudat and Nakapiripirt in Karamoja and later downgraded into smaller swarms that spread inwards to Teso, other parts of Karamoja, and Acholi areas. The downgrading of large to smaller swarms inside Uganda on encountering tall green tree vegetation could be explained by the favorable conditions for roosting and feeding provided by the trees. The work of Showler (2008) reported the preferred roosting areas as being the greening vegetation used for feeding. The results also align with the reports of NRU (2022).

In this invasion period in Uganda, the desert locust preferred settling and feeding on *Balanite aegyptiaca* and *Acacia* species. This could be due to the attractiveness of larger and visible tree canopies to the pest. Tarai and Doumandji (2009) documented desert locust tree species preferences and attributed them to a desire for noticeable greening vegetation. Maeno *et al.* (2018) reported that the larger locust groups formed at the larger plants within the local plant community and asserted that plant height was the primary cue used by migratory bands to choose night-roosting plants. This fact about *S. gregaria*'s preference should inform surveillance and interception efforts. The high field crop settling and feeding occurrence that was observed on *M. esculenta* could be explained by its abundance and visibility of its patch in the invasion area. Tarai and Doumandji (2009) in Algeria also reported locust feeding to be highest on water melon, which was most prevalent there. Wilps and Diop (1997) and later Van Der Werf *et al*. (2005) reported that in agricultural areas, *S. gregaria* tends to be more prevalent in cultivated areas, relative to grazing sites, or opted for trees and shrubs in grazing areas. This pattern might be explained by a preference for high nitrogen plants for *S. gregaria* in contrast to other locusts (Van Huis *et al*., 2008).

The perceptions on interventions show that though communities use different strategies that are considered preventative, they also accept that these do not prevent damage in case of big swarms. Pesticide application offers a modicum of effectiveness but since the locusts preferred tall tree vegetation and bushes, aerial methods are necessary and these can only be implemented by government efforts; cognizant of safety and environmental concerns.

The findings of this study are not only important in adding on information on *S. gregaria* feeding preferences but also for availing knowledge to designated control troops for targeted surveillance and control decisions in future locust invasions; for instance, teams applying chemical insecticides could target the preferred roosting and feeding patches. Noting that the locusts invaded the country from one direction could also inform the surveillance teams to prioritize the areas near Western Pokot for monitoring in case of any further invasions.

Conclusion

Schistocerca gregaria invaded Uganda from Western Pokot area of Kenya through Amudat and Nakapiripirit in Karamoja as big swarms, which later downgraded into smaller swarms, which spread in to Teso, other areas of Karamoja, and Acholi. The local community initiatives used fire and smoke, sharp/loud noises, kneeling down to pray, and insecticide applications to disrupt the locusts' settling and compel them to move on. Insecticide application was perceived to be moderately efficacious, as was prayer. *Acacia* spp. and *B. aegyptiaca* were the preferred trees whereas *M. esculenta* was the crop with highest *S. gregaria* occurrence. This information on *S. gregaria* behavior on settling and feeding preferences could inform strategies for future desert locust surveillance and control interventions.

Acknowledgment

This research was funded by government of Uganda through Ministry of Agriculture Animal Industry and Fisheries, National Agricultural Research Organisation, and Makerere University, and additional support was from FAO desert locust control Project, Uganda.

Conflict of interest

Authors declare no conflict of interest.

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