Fall armyworm:
How a climate model can help

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The fall armyworm (*Spodoptera frugiperda*), which originates from South America, is an invasive alien insect known for causing devastation in many a cropland. This tropical or subtropical pest is adapted to reproduce and survive in hot conditions, and was first reported in South Africa in 2017.

Researchers initially aimed at determining whether the climatic conditions in South Africa would be suitable for the permanent establishment of this invasive pest which, if indeed possible, would mean that the fall armyworm is a permanent pest that could be an annual problem for especially grain producers. Three years after its initial arrival in the country, research conducted at North-West University has shed much light on this pest and its invasion of croplands.

Monitoring the fall armyworm

Fall armyworms feed on a staggering 353 plant species. Initially, it was feared that the pest would not only cause severe damage to maize, but also to crops such as grain sorghum, soya beans, wheat, tobacco, sunflower and various vegetables. In America grasses such as kikuyu are also affected, which could lead to losses for livestock and dairy farmers.

The fall armyworm's presence is monitored using moth traps. The most common trap used in South Africa is a bucket that contains a synthetic female fall armyworm pheromone. Male moths are attracted to the trap as a result of the pheromone and fall into the bucket, where a block of poison kills them.

Unfortunately, the pheromone not only attracts fall armyworm moths, but also false armyworm moths. When they are trapped in the bucket, moths lose most of the scales on their wings, making correct identification difficult. Consequently, farmers sometimes mistake false armyworm moths for fall armyworm moths.

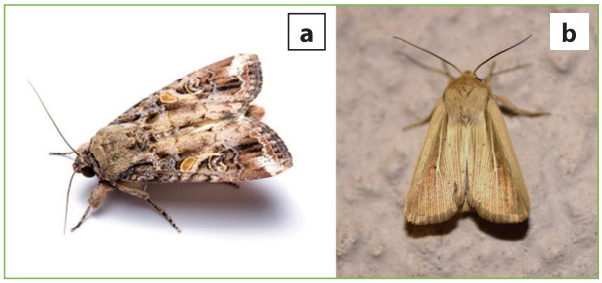
Fall armyworm larvae will always favour maize if given a choice of host plants.

Reaction to temperature

Insects are ectothermic, which means that their body temperature varies along with the ambient temperature. Cold is a limiting factor in the survival of the fall armyworm. The South African interior, which includes the main maize cultivation area, is too cold during the winter for the pest to survive. The survival of fall armyworms throughout the year is limited to the warmer northern parts of South Africa.

The research found that fall armyworm eggs only take two days to hatch at constant temperatures of between 30 and 32°C and that the larvae take ten to twelve days to develop into pupae. At a constant temperature of 18°C, the eggs take six to seven days to hatch, and the larvae develop within 28 to 37 days. The life cycle averages 71 days at 18°C and only 20 days at a temperature of 32°C.

From this it is clear how well the pest is adapted to survive and reproduce rapidly at high temperatures. Thus, more generations are completed during warmer times, which coincides with



(a) Fall armyworm moth (Photograph: Matt Bertone) and (b) false armyworm moth.

the crop-growing season. With each successive generation, moths that lay eggs emerge and populations grow.

The lower temperature limit at which they can survive determines whether these insects survive in a specific area. The temperature limit for the survival of eggs and larvae is 12°C. However, it should be considered that although night temperatures during winter frequently dip below 12°C for most areas in South Africa, day temperatures are significantly higher, and the average daily temperature may then lead to pest survival.

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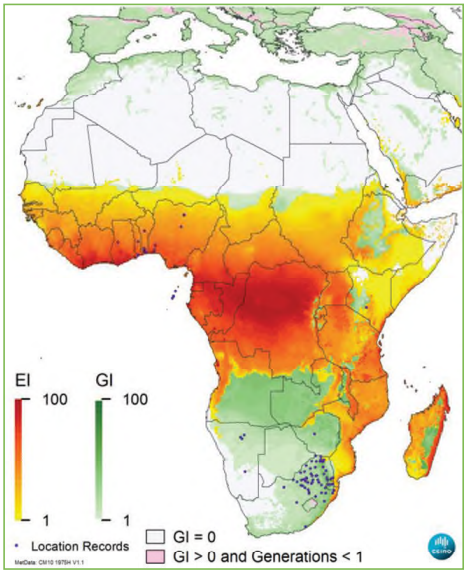
The larvae and pupae are usually sheltered, which can also contribute to the fall armyworm's ability to survive moderate winters. If temperatures fall below the lower limit of survival and persist for a while, the pest will not be able survive in such an area. Distinctions should therefore be made between areas where the environmental conditions are always favourable for the fall armyworm to survive and areas to which these insects can migrate when the environmental conditions change, thus becoming favourable for survival and reproduction.

Figure 1: Climate suitability for the fall armyworm in Africa modelled with CLIMEX software. (Source: CSIRO)



Wintering in South Africa

As part of the study, the CLIMEX software program was used to develop a model that predicts which areas the fall armyworm can survive in during the South African winter (permanent populations) and which areas the pest can spread to during favourable times (seasonal populations). The model was developed in collaboration with Prof Darren Kriticos of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia, and it is based on the fall armyworm's response to climate variables (*Figure 1*).

The darker colours in *Figure 1* indicate greater suitability. EI describes the areas that are potentially suitable for permanent populations, and GI describes the areas suitable for survival and reproduction under favourable climatic conditions. The areas in which permanent populations can be found are indicated in the yellow to red index, while the green index indicates seasonal occurrence. Areas that are unfavourable to the occurrence of the fall armyworm are indicated in white.

Figure 1 shows that permanent populations can settle in the north of Limpopo and along the KwaZulu-Natal South Coast and possibly parts of the Eastern Cape coast. The total grain cultivation area in Southern Africa's climate is suitable for the survival and reproduction of this pest during the summer months. If survival during moderate winters would occur in the grain cultivation area, a cold front with low temperatures could wipe out these populations.

In the case of the fall armyworm, the cold fronts that strike the Western Cape (with low temperatures and occasionally snow) during winter work to the benefit of winter cereal producers. These low temperatures are not conducive to the fall armyworm's survival and reproduction, as it is a tropical or subtropical pest.

However, the fall armyworm appears to be wintering in a larger area than the model predicts, for example, in the area of Malelane and Mbombela. There is also much speculation about valleys in other areas in South Africa where average temperatures may be higher during winter than in surrounding areas. Further research currently refines the model to accommodate events such as climate change and areas where cold temperatures sporadically occur for short periods.

Host plants

Because the fall armyworm feeds on such a wide range of host plants, the larvae's preference for crops and grasses was investigated. This research confirmed that the pest prefers maize, although it also feeds on other crops such as grain sorghum, soya bean, sunflower, groundnuts and cotton. Surveys and research have shown that unlike in America, fodder crops and grasses are not under threat in South Africa. Larvae cannot survive on grasses such as Brachiaria, Napier and vetiver. This is good news for livestock farmers, as Brachiaria and Napier are planted as livestock feed. If the larvae are given a choice between maize and other host plants, maize is always their first choice.

Information is constantly added to the temperature model to refine it and make the predictions as accurate as possible. The response to temperature variables that may affect pest migration and spread is still being researched and the reporting of fall armyworm infestations or survival areas contributes to a more accurate model.

Producers who are aware of overwintering larvae in their production areas or experience sudden outbreaks during the season can phone Hannalene du Plessis on 018 285 3007 or Johnnie van den Berg on 018 299 2376. Alternatively, send an email to Hannalene.DuPlessis@nwu.ac.za.