VIRTUAL WORKSHOP ON:
RESEARCH ON BIOLOGICAL CONTROL OF FAW IN AFRICA USING PARASITOIDS, PREDATORS AND NEMATODES

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Abstracts

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Invisible allies in the fight against fall armyworm *Spodoptera frugiperda* in different agro-ecologies in Cameroon: the need to know and conserve beneficials

Presenter: Komi Fiaboe, International Institute of Tropical Agriculture (IITA), Yaounde, Cameroon

Fall armyworm (FAW) *Spodoptera frugiperda* (J.E. Smith) and southern armyworm (SAW) *Spodoptera eridania* (Stoll) have become major threats to crops in Africa since 2016 despite long-term presence of other spodopterans. African governments adopted emergency actions built around chemical insecticides, with limited efforts to assess the richness or roles of indigenous natural enemies. Field surveys and laboratory studies were conducted to identify and assess the performance of parasitoids associated with both pests in Cameroon. *Telenomus remus* (Nixon), *Trichogramma chilonis* (Ishi), *Charops* sp. (Szépligeti), *Coccygidium luteum* (Cameron), *Cotesia icipe* (Fernandez & Fiaboe) and *Cotesia sesamiae* (Cameron) were recorded on FAW. Distribution of spodopterans, their endoparasitoids and parasitism varied with host plant/insect and location. In the laboratory, *T. remus* showed significantly higher parasitism on FAW than SAW, and significantly shorter development time on FAW. Implications for conservative and augmentative biocontrol in Central Africa are discussed.

Conservation biocontrol of FAW in Zambia

Presenter: Léna Durocher-Granger, Wageningen University and Research, Wageningen, Netherlands

Since 2018, research on conservation biocontrol in Zambia has provided insight about local parasitoid species attacking FAW, the factors influencing their occurrence, and the effect of intercropping and planting dates on their activities.

Natural enemies of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) within Agro-ecological zones of South Kivu Province, Eastern DR Congo

Presenter: Marcellin Cuma Cokola, Functional and Evolutionary Entomology, Gembloux Agro-Bio Tech, Liege University, Gembloux, Belgium

The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) has become a global maize crop pest because of its polyphagous feeding behaviour, resistance to certain active molecules and its dispersal capacity. This pest was recorded in DR Congo since 2016, the year of its invasion on the African continent. Therefore, no information on its natural enemies categorized as predators and parasitoids is available for the development of an integrated management strategy that includes potentially indigenous biological control agents in the long term. A monitoring system based on the trapping of predatory insects and the study of parasitoid emergence in relation to the development stages of *S. frugiperda* (egg masses, larvae and pupae) was developed to characterize these natural enemies in three agro-ecological zones of South Kivu (low, medium and high altitude) in eastern DR Congo. The diversity of predatory insects was compared across three agro-ecological zones and the percentage of parasitism was determined for parasitoid species. All predatory and parasitoid species collected during this study were morphologically identified using various identification keys and insect

collections from previous studies. In addition, predatory insects and parasitoids emerging from *S. frugiperda* egg masses, larvae and pupae were analyzed molecularly using the mitochondrial DNA (mtDNA) cytochrome oxidase subunit 1 (COI) barcode gene to compare them to existing barcode data sets. This study explores the diversity of natural enemies associated with *S. frugiperda* and provides a basis for the selection of predatory and parasitoid species for the effective control of *S. frugiperda* in DR Congo.

Effect of chemical- and biopesticides on larval parasitism of fall armyworm in Ghana

Presenter: Dirk Babendreier, CABI, Delémont, Switzerland

We here report results from on-farm and on-station trials which were conducted in the Northern region and Upper West region, Ghana to assess the effect of chemical- and biopesticides on larval parasitism of the fall armyworm. Biopesticides tested were based on Bacillus thuringiensis (combined with either Monosultap or a Pieris rapae virus), Neem or Maltodextrin, all of which are commonly used for FAW control in Ghana.

First report of native parasitoids of fall armyworm *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae) in Mozambique

Presenter: Albasini Caniço, School of Agriculture-University of Lisbon, Lisbon, Portugal

The alien invasive insect pest *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae), commonly referred to as fall armyworm (FAW), is causing significant losses to maize production in Africa since its detection in 2016. As an emergency response, governments in several countries distributed and/or promoted massive use of synthetic insecticides among smallholder farmers to fight FAW. The inappropriate use of synthetic insecticides by non-trained and ill-equipped farmers raises environmental and health concerns. This study aimed to assess the occurrence of native parasitoids of FAW, their parasitism rates, and relative abundance in the central province of Manica, Mozambique. A field collection of FAW egg masses and larvae was conducted from May to August 2019 (dry season of the 2018/2019 cropping season) and in December 2019 and January 2020 (rainy season of 2019/2020 cropping season). A total of 101 egg masses and 1444 larvae of FAW were collected from infested fields. Five larval parasitoids were recorded, but no egg parasitism was observed. *Coccygidium luteum* Brullé (Hymenoptera: Braconidae) and *Drino quadrizonula* Thomson (Diptera: Tachinidae) were the primary parasitoids. Maximum parasitism of 23.68% and 8.86% and relative abundance of 100 and 96.3 were recorded for *C. luteum* and *D. quadrizonula*, respectively. Total parasitism by different parasitoid species was at 9.49%. Cultural practices favoring the action of these parasitoids should be advocated. View Full-Text Keywords: fall armyworm; invasive species; parasitoids; biological control; Mozambique

Fall armyworm induced early herbivory cues: implications for parasitoid recruitment

Presenter: Amanuel Tamiru, International Centre of Insect Physiology and Ecology (icipe), Nairobi, Kenya

Herbivore Induced Plant Volatiles (HIPVs) provide parasitoids reliable chemical signals about plants colonised by their host and hence enhance their foraging efficacy. Typically, herbivore infestation on plants leads to an increase in HIPVs emission although suppression could also occur. In this study, we investigated the effects of oviposition by fall armyworm (*Spodoptera frugiperda*) pest on maize

and multitrophic consequences thereof. Our findings revealed, oviposition by *S. frugiperda* triggers early herbivory cues involving suppression of volatile emission; however, herbivore's key parasitoid is tuned to the cues. Implication of the findings for biological control of *S. frugiperda* pest is discussed.

Parasitism of locally recruited egg parasitoids of the fall armyworm in Niger

Presenter: Malick Ba, ICRISAT, Niamey, Niger

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), is an insect native to the tropical and subtropical Americas that has recently spread to Africa, where it predominately attacks maize, sorghum and other plant species. Biological control is an environmentally friendly way of combatting the pest and contributes to an integrated pest management approach. In Africa, several trichogrammatid parasitoids and *Telenomus* remus Nixon (Hymenoptera: Platygastridae) have been found parasitizing eggs of the FAW. In Niger, the egg parasitoids encountered include, Trichogrammatoidea sp. (Hymenoptera: Trichogrammatidae) and *Telenomus remus* Nixon. Parasitism of the FAW eggs by the two egg parasitoids was assessed in the laboratory, followed by field testing on sentinel eggs. In the laboratory, *T. remus* parasitized on average 78% of FAW eggs, compared to 25% for Trichogrammatoidea sp. *Telenomus remus* was able to parasitize egg masses that were fully covered with scales, while Trichogrammatoidea sp. parasitized only uncovered egg masses. On-farm releases of *T. remus* in sorghum fields caused up to 64% of FAW egg parasitism. Parasitized eggs yielded viable progeny, which can contribute to FAW egg parasitism build-up during the cropping season. Our findings lay the groundwork for the use of *T. remus* in augmentative releases against FAW in Africa.

Assessing the potential of inoculative release of *Telenomus remus* to control the fall armyworm, *Spodoptera frugiperda* in real field condition in Ghana

Presenter: Lakpo Koku Agboyi, CABI, Accra, Ghana

The egg parasitoid, *Telenomus remus* was identified as one of the key parasitoid of the fall armyworm (FAW) in Africa, present in many countries, including Ghana. In response to the thread caused by the FAW to African maize farmers, we conducted a series of field release studies with *T. remus* in Ghana. Three releases of 15,000 individuals were conducted in maize plots of 0.5 ha each in the major and minor season 2020 respectively, and compared to no-release control plots as well as to farmer managed plots with chemical pest control. Egg mass parasitism reached 33% in the *T. remus* release plot in the major season while 72-100% of egg masses were parasitized in the minor season during which only low pest densities were found. In general, the parasitism rate increased gradually a week after each release and then decrease. No significant difference in egg mass parasitism was found among the three treatments. Similarly, no decrease in larval numbers or plant damage was found in the *T. remus* release fields compared to the no-release field while lower damage was observed in farmer-managed plots. Larval parasitism reached 18-42% in the major season but was significantly lower in the minor season, with no significant differences among treatments. We further did not observe significant differences in tassel damage, cob damage or yield among the three treatments. From the results presented here it is not clear to what extend inundative releases of *T. remus* could effectively reduce FAW populations. Reasons for this so far insufficient control are discussed and may include dispersal, release rate etc.

Four egg parasitoid species of the fall armyworm, *Spodoptera frugiperda* found in Zambia, and their biological control potential

Presenter: Lian-Sheng Zang, Institute of Biological Control, Jilin Agricultural University, Changchun, China

The fall armyworm (FAW), *Spodoptera frugiperda* (Smith), an insect native to the tropical and subtropical Americas, has recently invaded in Africa and Asia, and is seriously threatening food security as a pest of cereals. Biological control is an environmentally friendly way of combating the pest and contributes to integrated pest management. In 2017-2019, we investigated the egg parasitoids of FAW in Lusaka, Zambia, total four species were found. They were identified as *Telenomus remus* Nixon, *Chelonus bifoveolatus* Szépligeti, *Trichogramma mwanzai* Schulten & Feijen, and Trichogrammatoidea sp. based on the morphology and molecular biology. To evaluate their possibility and efficiency on controlling FAW, the parasitism suitability of both Trichogramma species on 0- to 2- day eggs were compared with three Trichogramma species in China. The results showed that both Trichogramma species could accept FAW eggs at 0-, 1- and 2-day-old age, and complete development successfully, but parasitic number of *T. mwanzai* and Trichogrammatoidea sp. on 0- and 1-day-old eggs were significantly higher than 2-day-old eggs. Trichogrammatoidea sp. supplied with FAW eggs could parasitize the largest number of eggs among five tested species. Generally, *T. remus* and *C. bifoveolatus* exhibited better biological control potential regardless of FAW egg mass covered with scales or without scales. The present study provides some basic data for applying egg parasitoids against FAW invading Africa.

Field trials in Africa demonstrate the control of the fall armyworm using formulated entomopathogenic nematodes

Presenter: Patrick Fallet, University of Neuchâtel - FARCE, Neuchâtel, Switzerland

The recent invasion of the alien fall armyworm (FAW; *Spodoptera frugiperda*, Lepidoptera: Noctuidae) into Africa and Asia has led to tremendous crop losses and to a substantial increase in insecticide influx into maize production. The combined effects are threatening food security, public health and the environment. Effective, safe and sustainable control measures against FAW are of prime importance. A collaborative effort between CABI, Rwanda Agriculture and Animal Resources Development Board and the University of Neuchatel, aims to develop a novel strategy to control FAW using formulations containing entomopathogenic nematodes (EPN). A whole series of laboratory assays, as well as first field trials conducted in Africa, lead to the conclusion that EPN formulated in water, oil or gel and applied into the whorl of maize plants can significantly reduce FAW infestation level. Although it is generally believed that EPN should be used for soil pest control or in protected crops, we here demonstrate that their usage is feasible and effective in open field crops even in smallholder farming environments. Our results clearly indicate that an optimized application of EPN represents a safe and effective alternative to pesticides in the fight against FAW. This study is financed through a PhD scholarship from the University of Neuchatel, as well as through CABI by the Department for International Development (DFID, UK) and the Directorate-General for International Cooperation (DGIS, Netherlands).

The fall armyworm can overcome biological control agents using plant defenses

Presenter: Ivan Hiltpold, University of Delaware, Newark, US

The fall armyworm (FAW, *Spodoptera frugiperda*) is an important agricultural pest native to Central America and currently spreading worldwide. In North America, this species is mostly managed with genetically modified plants, chemical insecticides or a combination of both. Whereas these techniques could be used in the invasive range of the FAW remains uncertain as most of the newly-invaded countries cannot afford the current costs of these technologies or don't have the regulation policies in place to adopt these practices. Therefore, there is a pressing need for alternative, affordable and sustainable management strategies. While exploring the use of silicon (Si) accumulation in corn to control FAW, we noticed that, despite being efficient against several insect pests, this element did not negatively affect FAW growth. Moreover, FAW gravid females were preferentially laying eggs on plants supplemented with Si. FAW larvae growing on Si-supplemented plants accumulated this element in their tissue and used it as a defense mechanism against biological control agents. Indeed, infection rates by entomopathogenic nematodes and fungi were lower when the FAW had the opportunity to accumulate Si. Whether this is true with parasitoids has yet to be tested. Mechanisms behind this increased resistance to biological control pathogens remain unclear but this defense mechanism in FAW can have implications on the success of the implementation of biological control strategies in regions where Si is highly bioavailable.

On-going work on classical biological control of fall armyworm at CABI

Presenter: Marc Kenis, CABI, Delémont, Switzerland

Literature search and field work in collaboration with research organisations in several latin American countries have allowed us to preselect two parasitoid species for classical biological control of fall armyworm (FAW), the braconid egg-larval parasitoid *Chelonus insularis*, because it is regionally the most abundant and frequent parasitoid on FAW, and the ichneumonid *Eiphosoma laphygmae*, because, among the main parasitoids of FAW, it is probably the most specific. Both parasitoids are being studied in the quarantine facilities at CABI Switzerland and *E. laphygmae* has been sent to Pakistan and Benin for further studies. Data will be presented on their biology, specificity and competition, as well as on the prospects for biocontrol and future collaboration.