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First Record of the Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on Sorghum Plants, A new invasive pest in Upper Egypt

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ABSTRACT

Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is a new invasive destructive insect pest; causing a huge threat to the food security and livelihoods of millions' smallholder farmers worldwide. Recently, it was first recorded on maize fields in 2019 at Aswan Governorate, Upper Egypt and spread to the north so fast to Luxor, Qena, and Sohag Governorates. Later, it was recorded invading the maize crop at Assiut Governorate in 2021. Afterwards, the first appearance of FAW damage on sorghum crops was recorded on the 6th of August. Identification was done by the morphological characteristics as well as laboratory rearing of the pest for confirmation. Besides, the damage symptoms were observed by naked eyes as transparent elongated patches, irregular holes-like windows on the leaves, holes in stems and sawdust-like larval feces. Moreover, larvae have distinctive morphological marks of inverted "white Y-shape" on the head, 4 large black spots arranged in a square on the 8-segment and 4 small dots on the dorsal surface of all other segments. This is the first record of FAW infestation on sorghum plants in Assiut Governorate, Upper Egypt. This information and prediction could be helpful to restrict its further spread to different cultivated crops with proper management.

INTRODUCTION

The invasion of new pests into any agroecosystem is a potential threat to pest management. Among them, fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is one of the most destructive pests also known as "Quarantine Pest"; causing a severe threat to food security worldwide (CABI, 2018; FAO, 2018). The economic importance of FAW was related to its high reproductive rate, intensive migratory behavior, high dispersal ability, strong flier up to 500 km before oviposition (Prasanna *et al.*, 2018). In addition, their caterpillars have a wide host range; damaging more than 350 cultivated economically crops such as maize, rice, sorghum, sugarcane, wheat, cotton, peanut, soybean, cabbage, beet, alfalfa, onion, pasture grasses, millet, tomato and potato (Montezano *et al.*, 2018; Chormule *et al.*, 2019). In 2016, it invaded the African continent

and its first appearance was in Nigeria, then spread rapidly to more than 28 countries of southern and eastern Africa (Goergen *et al.*, 2016; Day *et al.*, 2017; Cock *et al.*, 2017; FAO, 2018); causing considerable damage to more than 70% of maize yield losses and to a less extent to sorghum and other crops (Baudron, 2019; FAO, 2019). Recently, in May 2019, FAW was firstly recorded on maize fields only in a village of Kom-Ombo city, Aswan Governorate, Upper Egypt as reported by the Agricultural Pesticide Committee (APC), Ministry of Agriculture (Dahi *et al.*, 2020), then spread to Luxor, Qena, and Sohag Governorates. Later, it invaded Assuit Governorate in 2021; causing damage to maize fields. The dispersal ability of FAW into the new areas without their natural enemies led to a huge risk in the food security and livelihoods of millions' smallholder farmers and consumers. Currently, several studies have been focused on its damage in maize crops as "a preferable host" in different infested countries, but the alternative hosts are still poorly documented. Sorghum is considered the fifth most important cereal crop in the world (FAO, 2010) and ranked second after maize in Africa. Therefore, an early prediction and integrated management approach are urgently needed to prevent the FAW risk. For this purpose, this study reports the first information and early appearance of *S. frugiperda* infestation on sorghum crops, in Assuit Governorate, Upper Egypt.

MATERIALS AND METHODS

Field Survey:

Routine field visits on different farmers' growing summer crops were conducted for the initial survey and data collection of FAW in Assuit Governorate, Upper Egypt, 2021. Sorghum, *Sorghum bicolor* (L.) (Dorado, Baladi & Hindi varieties) were sown on the 20th of June either for grains or fodder purposes and mostly cultivated along with maize and others with alfalfa and/or cotton crops. For record FAW in sorghum as the main alternative host, 40 plants were randomly selected with a zigzag method from various locations of 6 cities (Abo-Teg, Sahel-Seleem, Assuit, Manfalout, El-Kosia, and Dairout) (Fig. 1) and inspected weekly from July to September to observe the damage symptoms in the field according to (FAO, 2018; CABI, 2018 & 2019).

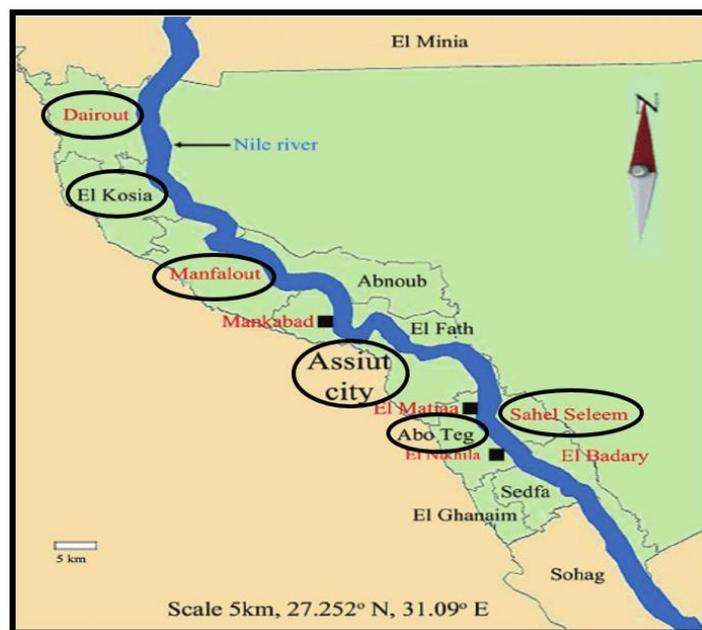


Fig. 1: Map of Assuit Governorate showing the location of field survey for FAW inspection on sorghum.

Identification of Fall Armyworm:

The collected samples (egg-masses, larvae) from infested sorghum plants were transferred to the insect rearing laboratory, Plant Protection Research Institute, Agricultural Research Center (ARC), Assiut Governorate for confirming the pest identification. Some of the samples were reared on fresh sorghum leaves in plastic boxes (20 x 13 x 8 cm), covered with a piece of cloth and maintained under rearing conditions (27 ± 1 °C; > 60% RH and 12L: 12D) till adult emergence for better identification. Others of the late larval instars were easily identified based on the distinctive FAW morphological characteristics based on the key of (Passoa, 1991; CABI, 2018 & 2019).

RESULTS

Based on fields' scouting in sorghum crops, FAW was identified by its characteristic damage symptoms or through its morphological characteristics of larvae. Consequently, the first appearance of FAW damage was on the 6th of August with an infestation rate (3-5%) coincided with 47 days of plant age in 4 of the 6 cities surveyed (Abo-Teg, Sahel-Seleem, Assuit, and Manfalout). Then, the damage increased gradually (15-20%) by late August and September. Assuit and Manfalout cities had the maximum FAW incidence rate. Based on field observation, the FAW infestation was recorded only on the sorghum leaves not on the grains.

Damage Symptoms:

The characteristic FAW damage symptoms were observed by naked eyes (Fig. 2) as transparent elongated patches "scratches on the leaf" (Fig. 2a) and irregular holes-like windows on the leaves leading to ragged appearance (Fig. 2b) due to larval feeding. Afterward, the damage increased on the leaves related to the extensive feeding of late larval instars; causing holes in stems (Fig. 2c, d) and large quantities of sawdust-like larval faeces (Fig. 2e, f).

Identification of Fall Armyworm:**a. Larval Identification:**

The first photo-documentation of FAW mature larvae on the sorghum plants was noticed by mid-August with color variation from green to almost dark brown. The distinctive morphological marks of FAW larvae were inverted "white Y-shape" on the head capsule between the compound eyes, 4 large black spots arranged in a square on the 2nd last abdominal segment (8th segment) and 4 small black dots with half-circle formation "crescent-like structure" on the dorsal surface of all other segments (Fig. 3).

b. Laboratory Confirmation:

The egg masses obtained from infested sorghum were reared till adult emergence under laboratory conditions for identification of this fall armyworm (Fig. 4). The emerged adults were confirmed as FAW based on their morphological characteristics. FAW male was greyish-brown color recognized by conspicuous markings on the forewing such as a white patch near the apical margin and a light brownish oval or oblique orbital spots "Racket-like structure" on the center. Contrary, the forewing of the female was uniformly greyish brown lacking distinct markings.

Ultimately, Larvae and adults from the field and laboratory rearing were confirmed as *S. frugiperda* based on their morphological characteristics.

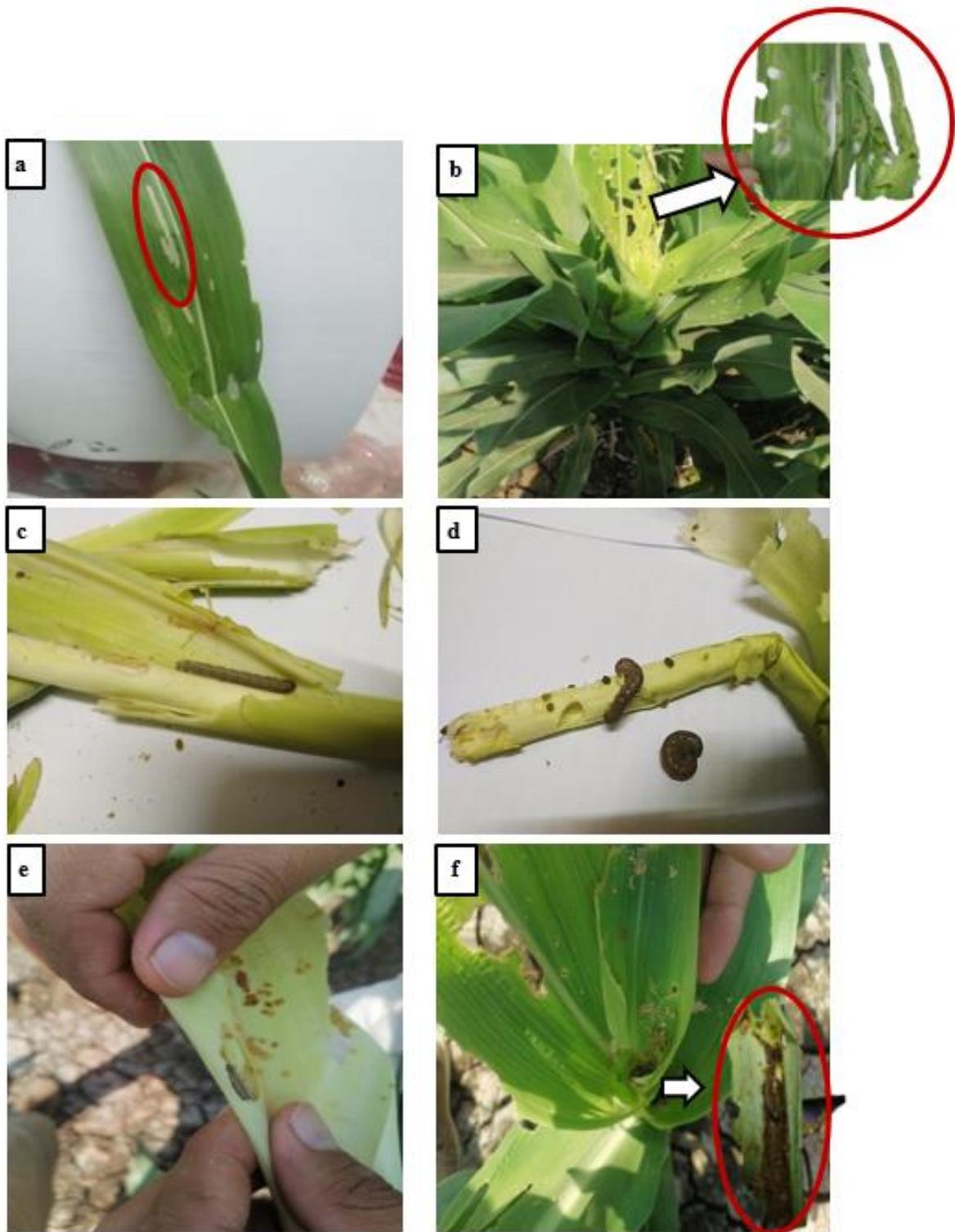


Fig. 2: Damage symptoms caused by the fall armyworm larvae on sorghum crops: **a-** Feeding by larvae causing scratches on the leaf; **b-** irregular holes-like windows on the leaves "ragged-appearance"; **c, d-** holes in stems; **e, f-** large quantities of sawdust-like larval feces.

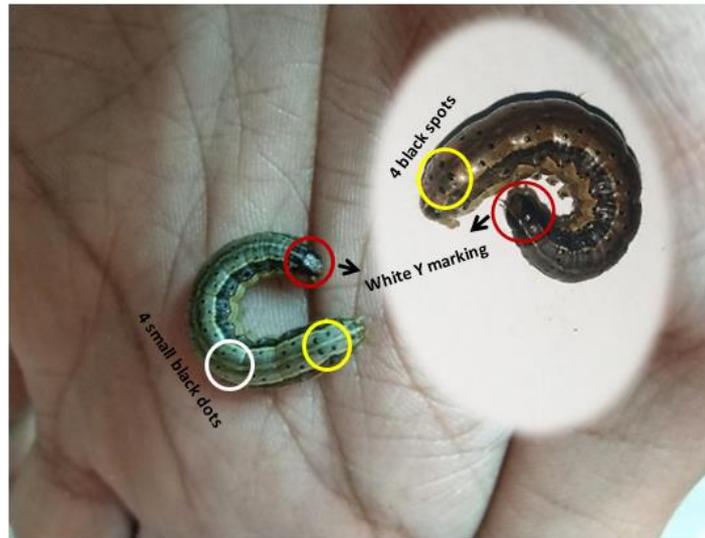


Fig. 3: Last instar larvae of the fall armyworm have 4 black spots on the 2nd abdominal segment, 4 small black dots on each other segment and an inverted white Y-shape on the head capsule.

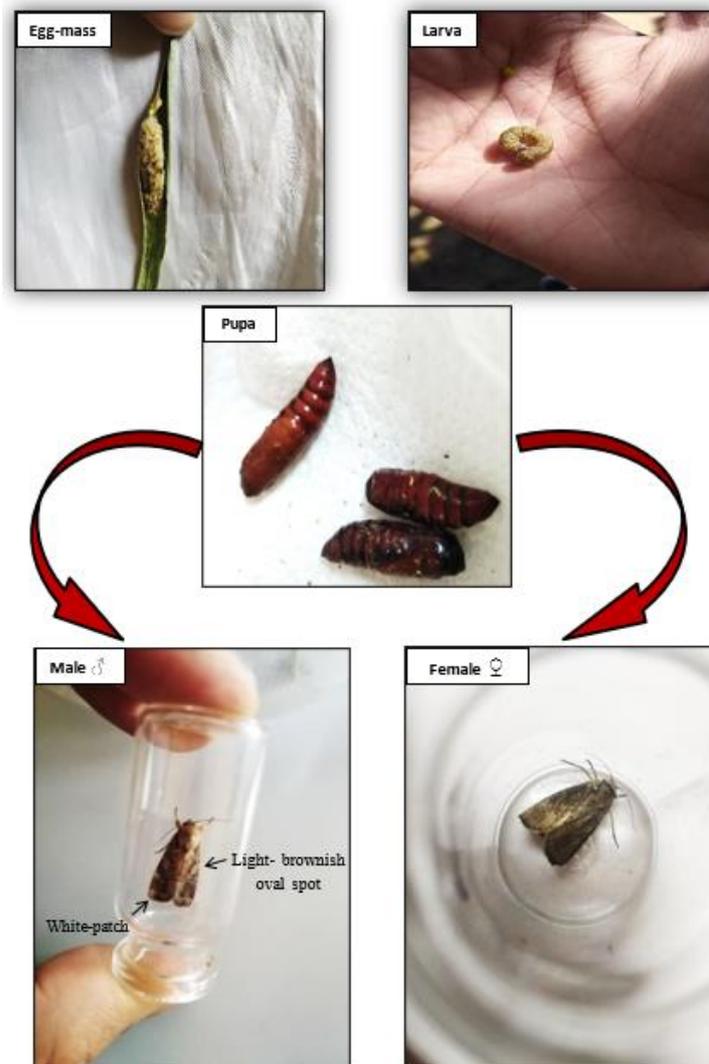


Fig. 4: Rearing of egg patches from infested sorghum till adult emergence for laboratory confirmation of fall armyworm.

DISCUSSION

FAW is a recent alien invasive pest threatening the food security and livelihoods of millions' smallholder farmers and consumers worldwide due to its ability to spread fast into new areas, high reproductive rate, strong flier, polyphagous feeding behavior and overlapping generations (Favetti *et al.*, 2017; Prasanna *et al.*, 2018; Chormule *et al.*, 2019). Another problem of this pest is typically its fast movements into a new invaded region without their natural enemies, and subsequently the population levels outbreaks. Besides, the cropping of possible preferable plants near each other at different planting dates among the seasons of the year facilitates the movement and spread between crops, and the presence of new food preferences (Barros *et al.*, 2010). As a result of these obstacles, the control of FAW is challenging. For improving effective integrated management strategies against FAW, it is vital to survey and record its alternative host plants, particularly of the high value or cash food crops (Montezano *et al.*, 2018). Hence, the present study provides the first information on the registration of FAW infestation on sorghum crops in different districts in Assuit Governorate, Upper Egypt, although the preferable maize crops cultivated along with them. This may be the growing conditions of this preferred host became unsuitable led to disperse them on another plant. One of the insects adaptive (survival) strategies are preserving their populations and forthcoming offspring throughout a year by selecting the suitable host plant when its preferred ones are not present (McGraw and Koppenhöfer, 2010). Sorghum is the second most important summer staple crop after maize in Assuit Governorate and is cultivated on 61,998 feddan (Statistical Information, Directorate of Agriculture, Assuit, 2021). The obtained results reported the incidence of FAW on sorghum fields based on the damage and morphological characteristics of larvae and adults. The damage symptoms were confirmed with those previously identified the FAW infestation on different crops in many countries (FAO, 2018; Ganiger *et al.*, 2018; Chormule *et al.*, 2019; CABI, 2019; Navasero *et al.*, 2019; Sartiami *et al.*, 2020). In addition, larvae and adults from the field and laboratory rearing were confirmed as *S. frugiperda* through their morphological characteristics as reported by (Passoa, 1991; EPPO, 2015; Day *et al.*, 2017; Ganiger *et al.*, 2018; Sharanabasappa *et al.*, 2018; CABI, 2019; Sartiami *et al.*, 2020). This is the first record in Upper Egypt on sorghum crops; however, it has already been reported from the neighboring countries such as India, China, Cameroon and Uganda (Venkateswarlu *et al.*, 2018; Jiang *et al.*, 2019; Fotso Kuate *et al.*, 2019; Chen *et al.*, 2020; Hailu *et al.*, 2021). Later, FAW has seriously threatened the production of local alternative crops, besides the preferable maize crop. Survey and data collection from different plants would provide information about FAW host range, damage and subsequently, help the farmers to manage this pest before reaching the economic injury level. Thus, there is an urgent need to predict the further risk on different crops and understand how to prevent its further spread for better management strategies.

Conclusions:

This study is the first record of *S. frugiperda* incidence on sorghum fields in Assuit Governorate, Upper Egypt based on the distinctive infestation symptoms and morphological characteristics as well as laboratory rearing for confirmation. The field observation proved the ability of this invasive pest to threaten the second important summer crop (sorghum) as an alternative host rather than the preferable one (maize) if present. So, effective control practices against FAW are through considering the host plants cultivated around maize fields during the year.

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ARABIC SUMMARY

التسجيل الأول لدودة الحشد الخريفية علي نباتات الذرة الرفيعة كافة غازية جديدة في صعيد مصر

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تعتبر دودة الحشد الخريفية آفة حشرية غازية مدمرة جديدة؛ تسبب تهديداً كبيراً للأمن الغذائي وسبل العيش لملايين المزارعين من أصحاب الحيازات الصغيرة في جميع أنحاء العالم. في عام 2019 تم تسجيل هذه الآفة لأول مرة في حقول الذرة الشامية في محافظة أسوان - صعيد مصر ثم انتشرت بسرعة كبيرة شمالاً إلى محافظات الأقصر وقنا وسوهاج. أما في محافظة أسيوط موضوع الدراسة تم تسجيل أضرار هذه الآفة الغازية لأول مرة على محاصيل الذرة الرفيعة في 6 أغسطس 2021 من خلال الخصائص المورفولوجية و التربيية المعملية للآفة للتأكد من النوع. بالإضافة إلي رؤية مظاهر الضرر الناجمة عن تغذية وتواجد دودة الحشد علي النباتات بالعين المجردة مثل: بقع مستطيلة شفافة ، ثقب غير منتظمة على الأوراق، ثقب في السيقان، وبراز اليرقات بما يشبه نشارة الخشب عند جفافه. علاوة على ذلك، تحتوي اليرقات على علامات مورفولوجية شكلية مميزة مثل وجود "شكل Y" الأبيض المقلوب على الرأس، وجود أربع بقع سوداء كبيرة مرتبة في شكل مربع على الحلقة الجسمية الثامنة بالإضافة إلي أربع نقاط سوداء صغيرة على شكل هلال (نصف دائرة) على السطح الظهري لجميع حلقات الجسم. تعتبر هذه الدراسة الأولى لتسجيل تواجد وإصابة دودة الحشد الخريفية لنباتات الذرة الرفيعة كعائل بديل بالرغم من وجود الذرة الشامية (عائلها المفضل) في محافظة أسيوط بصعيد مصر. يمكن أن تساعد هذه المعلومات في التنبؤ لتقليل انتشار هذه الآفة إلى المحاصيل المختلفة المنزرعة مع الإدارة السليمة.