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A not of Resurgence of the Cotton Stemborer *Sphenoptera gossypii* Conte as a Serious Pest in the Irrigated Schemes in Sudan

Tag Elsir E. Abdalla[1], Abdelmagid A. Hamad[2], Usama M. Ahmed[3], Omer A. Elnour[4] and Mohamed A. Salih[5]

Agricultural Research Corporations (ARC), Gezira Research Station, Wad Medani, Sudan

Abstract: this study was conducted to investigate complaints by farmers in New Halfa Agricultural Corporation (NHAC), Gezira Scheme, Rahad and Suki agricultural schemes about wilting, drying and death of cotton plants during the 2012-2013 season which was the first season for planting the genetically-modified Bt cotton (CN-CO2). A survey was conducted and showed drying and death of young plants and wilting of older ones. A longitudinal section of the stem revealed the presence of white worms of up to 3 cm in length and white shiny pupae, together with coleopteran beetles. The insect was identified as *Sphenoptera gossypii*. The damage was mainly in the variety CNCO2 but individual plants of the local varieties Hamid, Abdeen and Barakat were also infestation. The highest percentage of infestation was 30% in NHAC while the average infestation was 2% to 3% in the Gezira scheme and was little in the Rahd scheme. The stem borer was a serious pest of cotton in the 1920s and 1903s but as a result of clean-up campaigns and adherence to technical guidelines the local varieties, except Sakel, could survive unaffected. Introduction of the extremely susceptible variety (CNCO2) in large areas in the irrigated schemes, which are plentiful of the pest, led to serious damage to the crop.

During October 2012**,** farmers from New Halfa Agricultural Corporation (NHAC) complained of drying**,** wilting and death of cotton plants in their fields**;** the incident was especially higher in the introduced genetically modified Bt cotton variety (CN-CO2) than on the local variety "Hamid"**.** The season (2012-13) ranked first**,** for commercial planting of the Bt cotton in NHAC**,** and other irrigated schemes in Sudan**.** Thus**,** the Bt cotton was blamed as a causative of the incident**.** The CN-CO2 seeds

[1] [4]Crop Protection Research Centre, Entomology Research Section
[2] Crop Protection Research Centre, Plant Pathology Research Section
[3] Cotton Research Program, Agronomy Section
[5] Soil and Water Research Centre

were obtained from the Chinese Research Centre in El Faw, and from China. In response, a survey was organized on 16 October 2012 to clarify the case. The symptoms appeared at the fields were: drying and death of the young plants, wilting and stunted growth of the older ones, ring cuts at the bottom of the stems and exit holes up the stems. The longitudinal sections made, showed long yellowish-white worms; whitish, open and shiny pupae, and coleopteran beetles, inside the stems. From these symptoms, damage and morphological characteristics, the insect was identified as the cotton stem borer *Sphenoptera gossypii* (Conte) (Coleoptera: Buprestidae), and later was confirmed by the counterpart specimens from the ARC Taxonomy Unit.

Visual assessment was done in seven blocks, of 90-180 feddan each, (2 at El-Gorashi, 2 at Argeen and 3 at Al-madina inspections), as representatives for the total area of the two varieties. Three blocks were sown with CN-CO_2 and four with Hamid; at total area of 345 and 450 feddan, respectively. The percentage of the dead, dried and wilted plants due to the stemborer attack was estimated.

The damage was mainly observed on the Bt CN-CO2 variety, from both sources. Hamid showed damage on individual plants. The highest percentage of infestation, 30%, was recorded in CN-CO2 variety, at "Bastan" block (Al-madina inspection). The average infestation for El-Gorashi inspection was 10%, and for the whole Gazira Scheme ranged between 2% and 3%.

No studies were carried-out on the cotton stemborer in the Sudan. The available information is meager and refers back to the twenties-sixties of the previous century (Johnson 1927; Schmutterer 1969). Therefore, the beetle's character, damage and symptoms, were mostly described in this study as they materialized in nature. The egg is 1.25-1.5 mm long, whitish, lemon shaped and irregularly crinkled (Fig.1a). The larva is yellowish-white, club-shaped, up to 3 cm long, with a greatly enlarged and flattened prothorax and slender abdomen (Fig1b). The pupa is spindle-shaped, 6-10 mm long, whitish, open and shiny (Fig1c). The adult beetle is spindle-shaped, 6-10 mm. long, reddish or greenish-bronze, with

metallic lustrous, head and thorax are smooth, slightly punctuate and the elytra with punctures arranged in striations. The flagellum is saw-like and consists of 11 triangle-shaped segments (Fig 1d).

The eggs are laid singly, from one to six at a time, in fissures of the bark at the base of the stem or top of the root, above or below the soil surface, and hatch within 4-7 days. The larva penetrates the bark and chambers and feeds first on the outer wood, below the bark. As it grows bigger and stronger it penetrates the xylem / phloem, feeds while moving mostly upwards, and secrets a reddish, floury and compressed matter in the backwards (Fig1ef). At the last larval stage, reached within two months, the larva bores an exit hole, outlet for the future adult, and prepares a chamber to pupate in. Pupation lasts 30 days (Husnain and Shaikh 1960). The larva frequently completely rings the stem just before pupating, below the ground level. More than one larva may exist inside a stem. The beetle is diurnal, fast runs and flies, feeds on the bark at the base of the stem, doing little damage.

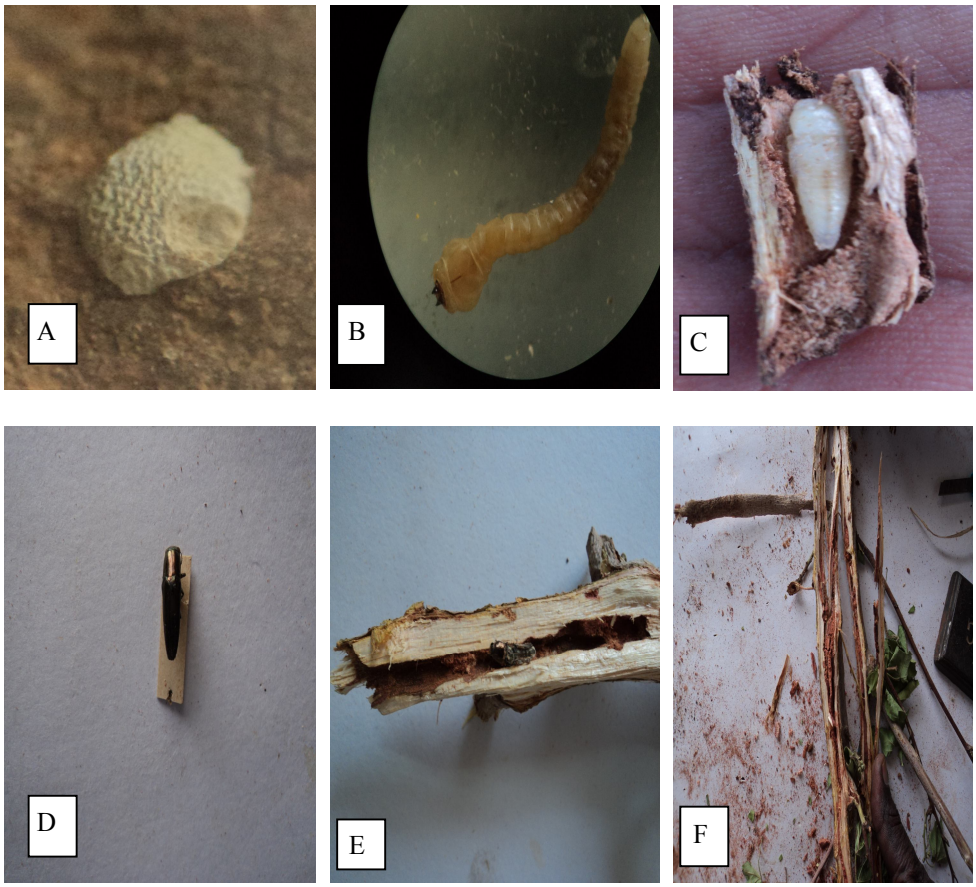

Fig 1. Development stages and damage caused by the cotton stemborer *Sphenoptera gossypii*. A. An egg. B. Larva. C. Pupa. D. Adult beetle. E. Adult beetle inside a stem. F. Damaged stem.

The cotton stemborer was, in the past, a serious pest of cotton in the Gezira, Gash delta, Nuba Mountains, and the Northern Pump Schemes (Gandato, Kitiab, Bouga, etc) (Schmutterer 1969; Bedford 1936). The first record of bored plants in the Gezira, referred back to 1926. Johnson (1927) reported an average of 0.45% stemborer attack on cotton in season 1926-27 at the Gezira Research Station Farm (GRSF). Examining the cotton stalks at the end of season 1932 from the Gezira Scheme, Cowland (1933) found 20% bored by the stemborer, and stated that the infestation was higher in the South than in the North Gezira. Bedford (1936) reported 26% cotton plants showing stemborer attack in 1934 in the GRSF. Maxwell *et al*. (1949) stated that, the stemborer was present all over the Gash Delta particularly in first rotation cotton causing some damage in October and November. Bedford (1938) indicated that, the stemborer was more plentiful than usual and caused marked injury at the Gash Delta in season 1935-36. Bedford (1936) reported 15% bored cotton plants in season 1935-36 at Gandato Pump Scheme, 6.5% at Kitiab and 4.6% at the Bouga Scheme. In season 1934-35, the practice of pulling out and stacking of the cotton sticks and sweeping of stubble and burning them all at the end of the season, was introduced (Bedford 1936). In result, a decrease in the percentage of the bored cotton plants was evident, starting form season 1935-36 onwards. In the later season, the percentage of bored cotton plants in the GRSF was dropped to 16% (Bedford, 1936). In season 1936-37, the percentage of the bored plants at the GRSF did not exceed 16%; and decreased to the half at the Gezira Scheme's Sections: Barakat (11.6%); Ghubshan (14.8%); Radma (14.8%); Umm Dagarsi (15.2%); Turabi (12.4%); Wad Sulfab (14.9%); Kab el Gidad (0.8%); Taiyba (7.2%); Wad Husein (4.4%) and Wad Sadalla (4%) (Bedford 1938). Few years later, the stemborer was dispossessed of being a "Pest" and brought down to an un-impairing level, then completely disregarded.

Regretfully, starting from the early nineties, the pioneer cleaning measures started to weaken and debilitate. Cotton sticks and stubble are being left in the fields, pass through the rainy season, re-grow, constituting suitable habitat for the stemborer re-production and increase from season to another. Husnain and Shaikh (1960) confirmed that stemborer infestation is carried over from one crop to the next by adults

hibernating in the stubble. Alternative host crops like bamia (*Hibiscus esculents*), cowpea *Vigna unguiculata* and lubia *Dolichos lablab* are abundant and frequently grown with, or near the cotton crop in these schemes. Schmutterer (1969) and Pearson (1958) revealed that Malvacae and Luguminacae plants are good hosts to the stemborer. Violation of the crops rotation became so common these days and host weeds are abundant in the fallow lands and canals. These, had ultimately led to increase of the stemborer populations through seasons and locations.

Fortunately, some of the local cotton varieties like Hamid, Abdin and Barakat are characterized, as appeared from this study, with high resistance against the stemborer, and managed to survive and subsist, un-affected. On the other hand, Sakel was said to be more badly attacked than the other varieties (Pearson 1958). This seems to be the reason why Sakel was discarded from planting in the Sudan.

Similar complains of drying, wilting and death of cotton plants appeared from the other irrigated schemes, Gezira, Rahad and Al-Suki. Hence, the survey was widened and covered six sections at the Gezira Scheme: (i) Messelamyia (Wad Sulfab and Alnidayana inspections); (ii) Tabat (Alrukn, Al-amara Kasir, Alkitair and Wad Al baseir); (iii) Abdelmagid (Al-Arek); (iv) Basatna (Hamad Alnil and Almehena); (v) Wad Alnaw (Hamad Alnil, and Albreiab) and; (vi) Hag Abdalla (Hazil, Tafal, Sabie Daleib, Malik, Hamed and Talib canals). Three regions at the Rahad Scheme: (i) Northern (Section 6); (ii) Middle (Section 4) and (iii) Southern (Sections 2 and 3). Two sections at Al-Suki Scheme: (i) Wad Taktyk (Canals No 5 and 9) and (ii) Mahala (Canals No 18, 20 and 26).

The six sections at the Gezira Scheme were sown with Hamid, Abdin, Barakat and CN-CO2 (with seeds brought from China), except south Hag Abdalla Section, that was sown with seeds from the Chinese Centre. The local cultivars and Chinese Centre`s seeds were dressed with imidacloprid, at 4.9 g.a.i./kg seeds. The seeds brought from China were also dressed with imidacloprid but the dose used was unknown.

The results illustrated in Table 1, reveal that the cotton stemborer returned to all irrigated schemes in Sudan. The infestation was severe at the six sections in the Gezira Scheme, except south Hag Abdalla Section. Its attack was exclusively observed on the Bt cotton variety CN-CO2. Hamid, Barakat and Abdin showed only some individual plants bored; they did not report stemborer infestation in the past. The sudden introduction of the CN-CO2 variety, that revealed extreme susceptibility to the stemborer, in these new agro ecosystems plentiful of the pest, led to serious damage to the crop.

Table 1. Percentage of stemborer infestation at the Gezira, Rahad and Al-Suki Schemes, 2012-13 season.

Gezira		Rahad		Al-Suki	
Section	%	Region	%	Section	%
Variety CN-CO2		CN-CO2		CN-CO2	
Messelamyia	35-35				
Tabat	15-30	Northern	5-30	Wad Taktyk	0.5-1.0
Abdelmagid	60-60	Middle	0-1	Mahala	0-2
Basatna	30-50	Southern	0-7		
Wad Alnaw	60-60				
Hag Abdalla	0-30				
Scheme's average / variety					
Hamid	0	Hamid	0	Hamid	0
Barakat	0				
Abdin	0				

The pest reservoir in the Gezira Scheme was likely to be high, due to extreme violations of the preventive requirements, taking place at present. This was proven by the high infestation recorded in Messelamyia, Tabat, Abdelmagid, Basatna, Wad Alnaw, and north Hag Abdalla Sections. A range from 15% to 60% of cotton plants were found bored by the stemborer (Table 1). Therefore, the declared high yield of CN-CO_2 (Ali and Lei Zhang 2012) is not expected to materialize in these locations. Husnain and Shaikh (1960) stated that high stemborer infestation prevents

gaining the potential yield of cotton; an outbreak of *S. gossypii* in 1958-59 in West Pakistan reduced the cotton yield by 80%.

At Southern Hag Abdalla Section, the condition was totally different; the CN-CO_2 seeds were dressed with imidacloprid. The farmers are much concerned with their crops and fields. They still practice the cleaning measures and follow the technical packages. The fallow lands and fields are relatively clean of host weeds. No alternate host crops (bamia and lubia) were seen intercropped with cotton. In result, the stemborer accumulation was negligible. No serious stemborer attacks were seen on the cotton crop. The highest percentage of bored plants did not exceed 1%. Hence, a breakthrough yield is expected to harvest in these localities. For instance, in block 11, "Hazil canal", 40 sacks /4 feddan were harvested from the first Hawasha, in the first pick (1400 kg/ fed).

In the Rahad Scheme, the infestation in the northern region was much higher than the middle and southern ones. The former was sown with the Chinese Centre`s seeds, locally dressed with imidacloprid. The middle and southern regions were sown with the seeds brought from China. The infestation was higher in the northern (5%-30%) than in the middle (0%-1%) and southern regions (0%-7%). This result confirmed that the CN-CO2 has a varietal sensitivity to the stemborer, irrespective of the seeds source. It also proved that infestation largely depends on abundance of the pest at a certain area.

Al-Suki Scheme reported the lowest percentage of the bored plants, 0% - 2% (Table 1). Al-Suki is an isolated scheme and surrounded with vast areas of the rain fed sorghum. The African bollworm *Helicoverpa armigera* Hb. (Lepidoptera: Noctuidae) is the only common economic insect pest between sorghum and cotton. Therefore, sorghum constitutes continuous source of *H. armigera* that migrates into the scheme and attacks cotton and other crops. This explains why *H. armigera* is the most harmful, annoying and plentiful pest at Al-Suki scheme. After harvest, and grazing of stalks and stubbles of sorghum, the zone turns harsh and arid and most of the insects' reservoir vanishes. Inside the scheme, relatively clean fields, fallow and canals and less alternative hosts were

observed. In result, few jassids *Jacobiasca lybica* De Berg (Homoptera: Cecadellidae), whitefly *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae) and aphids *Aphis gossypii* Glov. (Homoptera: Aphididae) occur at El-Suki Scheme. These characters make of Al-Suki Scheme the most suitable place for settlement of the CN-CO2 Bt variety in the Sudan.

Variations in stemborer infestation within a scheme, and between the schemes, were due to: (i) Susceptibility of the variety. (ii) Pest's reservoir in the area. (iii) Timing of infestation. (iv) Plant age and vigor. (v) Use of seed dressings. (vi) Biotic and/or a-biotic (irrigation shortage, lodging, jassid attacks etc). (vii) Other factor(s).

Pearson (1958) stated that American cottons showed more resistant than Asiatic`s in the Punjab, but were more susceptible than native cottons in French West Africa. In the Sudan, as stated by the later author, Sakel was found to be sensitive to the stemborer than the others varieties. The pest reservoir is directly correlated with the observance of the cleaning measures and technical packages. According to Schmutterer (1969), the stemborer may kill the young and stressed plants but older ones may tolerate the borer and survive, though they are unthrifty and set a reduced crop. Pearson (1958) stated that a severe attack was observed in French Equatorial Africa on cotton growing in badly drained areas and infested by *Rhizoctonia*, suggesting that plants in poor health may be especially susceptible. Use of seed dressing insecticides showed shaky results between southern Hag Abdalla Section and Al-Suki Scheme from one side, and southern region of the Rahad Scheme, from the other. Positive results were observed in the former locations, and negative, in the later one.

However, curative and prophylactic control measures should accompany planting of the CN-CO2 variety, in order to prevent multiplication and contain complication of this highly serious insect pest.

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عودة حافر ساق القطن *Sphenoptera gossypii* Conte مجدداً كآفة هامة بالمشاريع المروية بالسودان

تاج السر الأمين عبد الله[1]، عبد الماجد عدلان حمد[2] ، أسامة محمد أحمد[3] ، عمر عبدالقادر النور[4] و محمد أحمد صالح[5]

[1 ، 4] مركز بحوث وقاية المحاصيل، قسم بحوث الحشرات
[2] مركز بحوث وقاية المحاصيل، قسم بحوث أمراض النبات
[3] برنامج بحوث القطن، قسم الفلاحة
[5] مركز بحوث الأراضى و المياه

المستخلص : أجريت هذه الدراسة لتقصى شكوى المزارعين بهيئة حلفا الجديدة الزراعية ومشروع الجزيرة وهيئة الرهد الزراعية وهيئة السوكى الزراعية من ذبول وجفاف وموت نباتات القطن بمزارعهم خلال موسم 2012–2013 ، وهو الموسم الأول لزراعة القطن المحور وراثياً ، الصنف الصيني CN-CO2 بالسودان . مما حدا بالمزارعين إلقاء اللوم على هذا الصنف كمسبب للظاهرة . تم إجراء مسوح لهذه المشاريع ، حيث تلاحظ موت وجفاف النباتات الصغيرة ، ذبول النباتات الأكبر سنا . بشق الساق طولياً وجدت يرقة (دودة) بيضاء ، يصل طولها إلى 3 سم ، متضخمة الرأس ، وشرانق بيضاء مفتوحة لامعة ، وخنافس ذات لمعة براقة . تم تعريف الآفة كحافر ساق القطن *Sphenoptera gossypii* Conte (Coleoptera: Buprestidae).
إنحصرت الإصابة بشكل عام في القطن المحور ، وظهرت في الأصناف المحلية حامد وعابدين وبركات في نباتات فردية . بلغت أعلى نسبة للإصابة في حلفا الجديدة 30% ومتوسط الإصابة في تفتيش القرشي 10% ، والمتوسط لكل مشروع الجزيرة 2%–3% . وكانت قليلة في مشروع الرهد . كان حافر الساق آفة أساسية على القطن في عشرينيات وثلاثينيات القرن السابق . اختفت الآفة من الحقول بعد تطبيقات حملات النظافة والتقييد بالمحددات الفنية للزراعة المنظمة بالسودان . لحسن الحظ ، تعايشت أصناف القطن المحلية ومازالت مع هذه الآفة لتميزها بالمناعة ضدها وخرج الصنف ساكل من الاستزراع لحساسيته المفرطة لها . دخول القطن المحور المفاجئ في مساحات واسعة بالمشاريع المروية ، والذى أبدى حساسية مفرطة لحافر ساق القطن، في بيئات موبوءة به ، أدى إلى أضرار بالغة بمحصول القطن المحور بالمشاريع المروية بالسودان .