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RESEARCH ARTICLE

# ECOLOGY AND DISTRIBUTION OF STEM BORERS IN NIGERIA

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consequente u usual o une gi overing borni borni borni por se monte con entre consequente de con	and direct damage to the ears. Yeld loss due to stem forcers in Africa vary from a Old War more devological zones, regions and seasons, in sub Saharan Africa, particularly Nigeria, they can cause 20 - 40 % hosses during cultivation and 30 - 90% losses postharvest and during storage. However, estimated yield losses may be higher than of 40% are expected to occur at the smallholder level where suppression of the pest by chemicals is generally not practiced.
	cultivation and 30 - 90% tosses postbarvest and during storage. However, estim higher than of 40 % are expected to occur at the smallholder level where suppressio is generally not practiced.

#### 1. INTRODUCTION

Stem boners, Pests Larvae, Species, Maize

Malze (Zea mays L.) is a major staple food crop grown in diverse agroecological zones and is consumed by people with varying food preferences and socio-seconomic backgrounds in sub-Santan Africa (SAS) (Olanlyan, 2015), Of the 22 countries in the world where malze forms the highest percentage of colorie intake in the national date, Ca ner in Africa (Nuss and Tanumihard)o, 2011). The top 20 countries, namely South Africa, Nigeria, Ethiopia, Egypt, Tanzania, Malawi, Kenya, Zambia, Igenda, Ghanta, Rozambique, Cameron, Mali, Burktina Faso, Benin, DRC, Angola, Zimbabwe, Togo, and Core d'Ivotte. They account for 96 % of the total malze production in sub-Saharan Africas, Malze, which may be eaten as a vegetable or processed into various dishes, is regarded as a hunger breaker after a long dry period in developing countries, Additionally, malze is extensively traded as feed crop in livestock industries, and about 460 million (625 65) of total world malze production is used for this purpose (Olanlyan, 2015).

The major stem boring species associated with maize production in Nigeria are moths belonging to the families Noctuidae and Pyralidae, namely: the matze stalk borer [Gusscoin fuse Aulier), the pink stem borer (Sezonite colomistis fampson), the millet stem borer [Asigona inguissois Hampson) and the African super cane borer [Gildona socionira Walkers] [Balogun and Tanimola 2001], In fact, stem borers have been the most damaging group of linest pests in maize activation worldwide (Tefera et al., 2011). Nigeria is with nearly 8 million tonnes Africa's largest producer of maize (ITA, 2014) and stem borers cause 10-100%, issses in maize grain yield (Sean and Darmoha 2001). However, Kaichie et al. (1997) reported that within Africa, damage; to maize writes with locations/regions, with sub-Saharan Africa recording the highest population of stem borers being directly correlated with damage and grain

yield. Crop losses and grain yield reduction may result from the damage caused to growing points leading to loss of stands (dead heart), damage to leaf (whitow panel) stem tunneling; hole (as porta) of entry to secondary rot organisms), stem lodging, stem breakage, tassel and direct damage to ear shank and eart (Sosan and Daramola, 2001), However, the consequence on yield is variable and depends upon sowing, borer species composition and abundance as well as insecticide treatment (Ajala et al., 2010). (Thas been observed that early-planted maize suffers less from borer states than later-planted maize the hiddle Bell of Nigeria (Okweche et al., 2010). Heavy stem borer infestations have precluded seasond cropping of natize even in areas with potentials for two rain-fed crops (Ogunwolu, 1987).

### 1.1 World Maize Production

Maize is one of the major cereal crops and ranks third in production worldwide following wheat and rice. In more than 20 developing countries in the world, matze is the single largest source of calories and protein for the poor and is a primary wearing food for babies, in sub-Saharan Africa maize is one of the most important staple foods, providing food and income to over 300 million resource-poor smallholders (Romney et al., 2003). Over 650 million people consume an average of 43 kg of maize per year (a 35% increases since 1960), reaching 865–140 kg in Kenya, Lesotho, Malawi, South Africa, Zambia and Zimbabwe (Lumpkin and Armstrong, 2009). Is cultivation spans the entire continent and is the dominant cereal food crop in many countries, accounting for 56 % of total harvesced area of annual food crops and 30-70 % of total caloric consumption.

### 1.2 Maize Production in Africa

Maize is a monoecious plant grown from latitude 58oN to 40oS, adaptable

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### 2. YIELD DIMINISHING FACTORS

The yield potential for sub-Schram Africa is 5 timines (fie in troposal highwide, 7.0 in substrapted and mid-schools times and 4.5 in troposal inflammas, temperate to the entered yield of 0.6. 12-6 and 6.7 times five respectively (Pringil), 20(1), This issay yield gap is entriposition to local block constraints (Wannierga and Waldes, 20(2)). The schools is distributed and block constraints (Wannierga and waste lipid local and schools is 6.00(3), while the second model highways constraints is distributed and through the first states for the second model individual materials and (Princip Vision Constraints), former and school is 6.00(1), but in the school is 6.00(1), but in the first school is 6.00(1), but

#### 3. STEM BORERS

Busseold Jusco (Puller), also known as the African stem boten; is a north; indigenous to tropical Africa (Starris and Horanda, 1997), Alexandp indigenous to tropical Africa (Starris and Horanda, 1997), Alexandp indigenous, to was first exceptioned as a peac of indica to benefit Africa, and the second secondarios of the second secondarios of the secondar

Bussola Josca was first mentioned as Seconda Josca in a report by Fulber in 1911 and described inder the seams name by Hampson in 1912. In 1923 Affican species of Seconda and related spaces were more play-estationaries for the season of Seconda and related spaces were more play-estationaries reviewed and finally 8, fusco was placed in the Bussalda Thurau spinus (Tame et al., 1953). The first description of the orthopation step, eggs, learned and playmen in sub-Selaran Affica, and first recommendations on boar to control this pest were given in 1905, Sinca than, a plactions of information on its distribution, pest scause and high formess were produced (Min et al., 1907). It learned is escenared as in important peed of inside and on its distribution, pest scause and high formess were produced (Min et al., 1905). It learned is escenared as the first seam of the first

Busseld Juca larvas feed on the silverground parts of the gass locks, causing economically important yield losses to crops such as miscale feeding and tennelling by B. Jusca larvas can result in the destruction of the growing point (resulting in "dead hearts"), early leaf senecement, interference with unterfers and metabolitat translations trainfulling in mailternation of the grain, seam break-pag, plant starting, and direct damage to earts (18th et al. 2007). Tunnels in the plant start may also preclupose hosts to infection. Weld loss estimates may vary with region, B.

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Malitim destri, bister ile a militim pune in felicia, socia coccura da conservatare Militime transa. I molle especiare da distri conseguira il a l'approximatione se da il returna il base differen conservatare socia del biologica il socia programa Champ, molletare il ligarità il bartico PHD, quel di socia conseguira destrutare champes un programa il ligarità il bartico PHD, quel di socia consequira della manuali molletare programa il ligarità il ligarità il libera consequiratione della consequira di programa il ligarità di la mondia coloria. Nelle a distributiva accordinate consequiratione della consequiratione della CHMA). Il limitatione della socialità coloriana companie di consequiratione della consequiratione di la consequirazione della consequiratione di ligarità di consequiratione della consequiratione di la consequiratione della coloria consequiratione della consequiratione di la consequiratione della coloria consequiratione della consequiratione della consequiratione della coloria consequiratione della consequiratione della consequiratione della coloria consequiratione della consequiratione della consequiratione della consequiratione della coloria consequiratione della consequiratione della consequiratione della consequiratione della coloria consequiratione della consequiration

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### 4.2 General Stem Borer Damage and Larval Behaviour

Most stem borer species produce similar symptoms on maize and complying plants. Annual cerests, maize is changed more by stem borers because it has some of a similar acids, sugars, than the other graninous blooss (fright et al., 2013). In addition, maize entits volatile compounds such as gas chromatog spily electro-manual problems of the seed of the control of the compounds such as gas chromatog spily electro-manual problems. Of these volatile compounds such as gas chromatog spily electrons. Of these volatile compounds, those emitted by maize see more structure. Of these volatile compounds, those emitted by maize see more structure. Of these volatile compounds, those emitted by maize see more structure to be jound leaves after days these penetratify, soon after thatching, some borer larves a few days before penetratify not the sent fluxibility and the rolled lawes a few days before penetratify not the sent (fifth set of, 2009). As heaves grow sent from the funnel, a characteristic pattern of hotes and window panel; can be sent, seawing transparent upper contile referred to as window panel; (Chabi-Chaye et al., 2005). Window panel refer to early lavel lawes this lawy of transparent led epidernist, larves can also feed to leave a sink layer of transparent led epidernist, larves can also feed on basid meritienns of young maize plants resulting in the formation of death learn, lawed beart is caused by the boren boring into the smaller at the soil level and tunneling upward. Dead hearts cause death of cereds such

Cite the Articles Opende, N. O. Salandern, M. T., Mayaryi, L.J., Mallo, C.V. (2020). Kodony and Distribution of Scom Barers in Nigers Sentemodified in Articles Opende, N. O. Salanderin, M. T., Mallo, C.V. (2020). Kodony and Distribution of Scom Barers in Nigers

as maize, while sorghum, millet and rice compensate by tillering, Older larvae make holes and tunnels in stems where they feed for 3 to 5 weeks, causing extensive tunnels. Larval tunneling within the stalk may also predispose plants and ears to infection by fungla pathogens, further compromising the long-term storability, and quality of food products.

There is an evidence of variation in the lengths of stem tunneling associated with the different stem bover species. *B. fusco* larvae produce the largest stem tunneling, followed by C. parellus. Mostly, the holes are prepared for pupation. The feeding habit reduces the flow of water and nutrients throughout the plant, and can reduce grain weight, kernel number, thereby reducing yields (Ratnadass *et al.*, 2001). The extensive tunneling of stem bovers inside the stems weakens the plants, causing breakage and lodging (Benebet *et al.*, 2001). Lodged plants are likely to yield lower and make harvesting more difficult for instance, Memah *et al.* (2006) reported that yield losses as high as 40 % could result from hodging. Damage, Extensive damage can result in complete death of the plant. After killing the plant, harvae usually migrate to new plants and ener by borting into the stem near the base. Plants damaged by stem borers are often stunted and may die. Infested plants if they survive may or any not produce harveschabe ears. If they do, they are usually smaller than normal plants making them less markenshe eapselments that do not grounder ears competer with plants for water, nutrients and sunlight. The magnitude of the damage is influenced by soil fertility (Muyekho et al., 2008) and matze moths fly at night and lay eggs on maize plants between the leaf sheath and the stem on the youngest killy windoled leaf. Eggs hatch into caterpillars, which move into the growing points, where they start to feed.

## 5. YIELD LOSSES DUE TO MAIZE STEM BORERS IN AFRICA

Yield loss due to stem borers in Africa vary from 0-100 % among ecological zones, regions and seasons. In Sub Sharan Africa, they can cause 20-40 % losses during cultivation and 30-90 % losses during cultivation and 30-90 % losses postharers and during storage (Van Rensburg et al., 1997). The severity and nature of stem borer damage depends upon the borer species, the plant growth stage, the number of larvace feeding by the port and the plants smally results in crop losses as a consequence of death of the growing point (dead heart) darly leaf senescence, reduced translocation, lodging and direct damage to the earts. Estimated yield losses of 10-43 % are expected to occur at the smallholder level where suppression of the pest by chemicals is generally not practiced. Yield losses of 12 % for every 10 % plants infeated were resported in Tanzania and Kenya (Nalusi and Oktuk, 2013). Yield losses depend on the age of the plant strikeration. In Democratic Republic of Congo (DRC) B. fusca occusionally caused yield losses of 29 % in early planted makes, and 22-35 % of all maize losses (Szozniln et al., 2006). C. parcellus is the most damaging peer in Bastern and Southern Africa and causes significant grain yield losses, its control has been a challenge among smallholder farmers (Feliks et al., 213). B. fusca can feed on maize kernels at maturity (Felik et al., 213). B. fusca can feed on maize kernels at maturity (Felik et al., 213). B. fusca can feed on maize kernels at maturity (Felik et al., 213). B. fusca can feed on maize kernels at maturity (Felik et al., 213). B. fusca can feed on maize kernels at maturity (Felik et al., 213) and to 2 partellus in B. Bishopia, B. fuscar and C. 25 % for the ported yield losses of the ported on the section of the ported yield losses of the ported on the ported yield losses of the po

Maximum grain yield reduction and stalk damage in maize was reported due to C. portellus on 20-day-old cop, while there was insignificant larval effect on yields for 60-day-old cop, the leader was insignificant larval effect on yields for 60-day-old cop. The economic injury levels (EII)-of C. portellus in maize are 3 and 4 harvae per plantin maize 20 and 40 days after plant emergence, respectively. Generally, the amounts of yield loss vary greatly, depending upon the country, season, maize variety, fertilization, severity damage, stem tunneling and generation of stem borers involved. The first and second generations causes more yield losses than the third generation (\$ezonlin et al., 2006).

### 6. BIOLOGY OF MAIZE STEM BORERS

A good knowledge of the biology of B. factor is a prerequisite for understanding how this species interacts with plants. Most of the information produced for B. factor during the last century, which forms the basis of the knowledge of the biology and ecology of this pest, stemmed from South Africa. However, since the majority of the studies in South Africa addressed B. factor as high shitudes and in commercial farming systems, some aspects regarding its biology and interactions with the

Ote the Article Opewale, R. O., Salaudeen, M. T., Bamalyi, L.J., Bello, L.Y. (2020). Ecology and Distribution of Stem Borers in Nigeria.
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environment may differ from those in other agro ecological zenes.

A fusca exhibits complete metamorphosis, including egg, larval, pupal, and adult stages. B. fusca has 2-3 distinct generations in most locations. However, in areas that are warm and hunid, some B. fusca larvae may give rise to a fourth adult generation (Harris and Navaze, 1922). Another factor that play a role in the biology of B. face is larval dispasses. When the architecture is most locations during cold dry periods (Harris and Navaze 1922). The state of host plant maturity is bought to be a critical factor in the induction of dispasses white soil moistures in appears that harvae dispasses in most locations during cold dry periods (Harris and Navaze 1922). The state of host plant maturity is bought to be a critical factor in the induction of dispasses. It has been suggested that appears that prave dispasses, it has been suggested that appears that prave dispasses, it has been suggested that appears that prave dispasses, it has been suggested that appears that provide the stage of the provided papear not to influence dispasses. It has been suggested that dispasses in B. face are prefer the underside of the youngest fully the larvae provided leaf as oriposition are those that germinated 3-5 weeks prior to eclosion. Female B. fuctor prefer the underside of the youngest fully used to the stage of t

#### 6.1 Eggs of B. fusca

Busseolo fusca females oviposita highly variable number (from 100 up to 800) of round and flattened eggs in batches (Kruger et al., 2012). The batches are laid behind the vertical edgs of leaf sheaths of pre-traseling plants and also, but rarely, underneath the outer husk leaves of ears (Mally, 1290). Pan Rensburg et ad., 1997 recorded eggs on 12 to 16 week old plants, but only when these were planted very late in the season it appears that the position at which the eggs are found correlates with the developmental stage of the plant and with increasing plant age, egg batchs are increasingly found higher up on the plant (Van Rensburg et al., 1997). Studies have also shown that leaf steachs fixed more loosaly around stems as plants gets older, and that females preferred the sheaths of youngest unfolded leaves for oviposition. Although it is trare to find more than one B, faces egg batch per plant cases of between 2 and 4 egg batches per plant have been observed. This could be attributed to extremely high population pressure at late planting dates.

In South Africa, with its unimodal rainfall pattern allowing for one crop per annum, it was also observed that egg batches of spring moth generation were smaller than those of suriner moths (Kruger et al., 2012). A possible explanation is that body reserves of spring moths are smaller than those of the summer moth since the former would have utilized reserves during dispasse. Similarly, Usua (1967) in Nigeria reported that spring moths id ald approximately 65 % fewer eggs than summer moth. Field studies during which more than a thousand egg batches were collected in South Africa, showed that the average size of an egg batch of 1st and 2nd generation females were 22 and 35 eggs respectively. (Van Reneburg et al., 1997). Results from van Reneburg and colleagues indicate that a single moth lays 7-8 egg batches.

#### 6.2 Larvae of B. fusca

Eggs hatch after about one week and larvae nigrate first to the whorl where they feed on young and tender leaves deeprinside the whorl. In contrast to stem borer species from the Seamin and Chilo genera, young B, Jusca larvae do not consume any leaf tissue outside of the whorls of plants. Larvae can remain in the whorls of especially older plants [6-8 weeks old] up to the 4th

Instar. From the 3rd instar onwards, larvae migrate to the lower parts of the plant where they penetrate into the stem. Some larvae do however migrate away from natal plants with approximately 4 5 of larvae leaving the natal plant immediately after inatching. The larval stage lasts between 31 and 50 days (Kruger et al., 2012) and consists of 7-8 instars with a minimum of 6 (Inniham, 1987). More recently, continuous observations of larvae on an artificial diet indicated that, under optimum environmental

## The larval stage consisted of 5 can result in british sterna

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conditions (25 °C and 50%-60% r.h.). The lived stage constraint if a stages and was completed during approximately 35 days. Additional tractars were observed when the conditions were education for standard access vent into dispances (Mahatiand Ohaha, 2013). It is well between that B. Jacco undergoes a facultative dispance consisting mostly of a livest expension.

### 6.3 Larval migration patterns

Busseols faccs have nigrate throughout all larvel singer (Van Bensburg et al., 1907). This nigration commences immediately after aga harb and ceases during the last lates when have prepare pune sells in which they become pupes, or go into dispasse. Clear patients in the intra-seasonal progression of larvel infestations have been described by many researchers (Van Renatung et al., 1907), Although a small proportion of larves migrate off plants immediately after hatching, the great majority (01 %) of larves up to the 4th lates remain in the whord (Van it is Bert gand Van Renaturg, 1904). The low-degree of damage caused by stem hinter harves to whole lawres of whole houst indicate that they do not feed in whords for extended periods of time, in late infested matte and surghum, 1st insur harves may commence feeding on silk of ears, postelles or it young emerging pancies for some time before nilgrating and commencially feeding inside ears or stems.

Migration does not cease after the larvae leave plant whorls to feed inside matter stems. Larvaes migrate until the felt inside, a beinvoluur that stellarly density dependen. Migration of lare-inside larvae between plants a bio increases the likelihood of parasition and production. Studies have shown that large numbers of 5th and 6th instair larvae of 8t. Birto, parasitised by C. seesmine, are often observed inside the lare whorl hower of plants, when make plants commence anthesis and flowers energie, in areas where it force that the observed state of the stem of

Up to 70 % of larvae may migrate to adjacent rows over a 5-week period, and that the incidence of plants remaining with a single larva at this time may be as high, as 67 % (Arm hemburg et al., 1907). This extent of occurrences of a single larva per stem in spite of the pseudo-aggregated ovlposition behaviour illustrates the high migration potential of 8/1/arch. It also explains the particly infectation pattern of 18/arch in the field and the increased percentage of plants damaged by larvae over time.

#### 6.4 Adults of B. fusca

The mean sex ratio of B. (scot is 1.1 (make femalo ) (Kruper et al., 2013). The adults emerge about 13-14 days after pupation and they emerge mostly between sunset and midnight (Calianyaud et al., 2007). Most male insects emerge before onest of the excupaines, while most females do no one hour leare. The swerage life apan of moths ranges between 0 and 10 days (Rannadass et al., 2001; Caliatayaud et al., 2007).

### 7. ADULTS BEHAVIOUR AND PREFERENCES

#### 7.1 Moth flight patterns

## 7.2 African Pink Stem Borer (Sesamía calamístis, Hampson, 1910)

This species is found in sub-Saharan Africa and some of the Islands in the Indian Ocean. It commonly occurs in wetter localities at all altitudes. The main crops affected are maize, sorghum, pearl milllet, wheat, rice and sugarcane. The larvae (caterpillars) Larvae can tunnel into the stem which

can result in Notice seaso or drying and examined death of the principal point of the mates. The control relations are defected pile death on a part with boars pile and boars of engagement for the point found of the part of engagement for e

### Stenaburg 7.3 Eggs and larvas of 8. cultivatette

eag hatch and lega are inserted halvess the boars had elected and the when it has the which they if the did and arranged in won to have configures rises. He energies is used by many feminal always mound 400 again a partial of the days. English plays served programmation of the time shorts are twen weeks and until florieshing if the loses are programmating the time shorts are twen weeks and until florieshing if the loses are programmating damage, however, occurs as early plant stages (Van Heinfeitrig str.), the Van has lines

Host larves penetrate the stan chortly after they energy from hist right larvin feeting might result in dead hearts and the similaring and globbing larvin feeting might result in dead hearts and the similaring and globbing are trivity of the larves often castle in each response being the sea filling points, the majority of the larves care in the season when it is found to be season before the season when it is found to motive greace adapted given the trivial problem of the suspended development (debase larves purples within the season when it is finished to motive greace adapted goal of broadering morphisms). Seaton species of the season when it is indicated to motive greace adapted goal of broadering morphisms, it is finished to motive greace adapted goal of broadering becomes the season when it is dismisser and slightly flastened with relative the season when it is the season when it is dismisser and slightly flastened with relative the season when it must be dismissed with great great and lack privates later or markets already and slightly flastened with relative the season when the affects of the dismission with a distinctive pink sufficient globes sounds and slightly morphisms that on the district which and lack privates white out a distriction of the thorest in the distriction of the thorest part of the season when the season when

#### 7.4 Adults of S. calamistis

Pupae are up to about 18 mm long, brown to yellowish-brown with a wrinkled (creased) frental region of the head and a terminal "all" (creased) frental region of the head and a terminal "all" (creased) with four large and two small spines. The wringspaint file finales of the African pink stalk horer is 20-30 mm and in males a little seas. The forewings are pale-brownish, with writable but generally becomes file forewings are pale-brownish, with writable but generally becomes file and an overall silky appearance (flatmaless et al., 2001). Hind wings are white.

### 7.5 Millet Stem Borer, Confesta ignefusalis

The millet stem borer, Coniesta (gnefusalis (Hampson)), was first named and described by Hampson (1919) in the genus Distress. Since then, although its attuta as a good species has reover been in double, its correct generic placing has still not been determined. Toxonomies have assigned it to such different genera as Hambachia, Soreuma, and Domococapiesa. It was most recently assigned to Angurus but as the genus is now known to be a noctuid and not a pyralid, it has been recommended that the species should remain in Coniesta until a thorough teasonomic revision can be undertaken (Khan et al., 2000).

### 7.6 Eggs and larvae of C. Ignefusalls

Eggs are about i-mm long and are laid in batches of 200-25 between leaf sheaths and atems. They are yellow/shewhite and elliptical and are partially flattened by the pressure of growing stems against the leaf sheaths. Larvae grow to a length of about 20 mm and have a prominent, reddish-brown head. During the growing soason, the white body of active larvae is consplictuously marked with back spots, During the dry season, they enter into dispanse and lose these black markings. The pyralid larvae are easily distinguished from those of the nocutid stem horer by the circular series of crotchests on the ventral abdominal prolegs. Pupas are up to 15 mm long, yellow/sh to reddish brown and with them-like spikes on the abdominal segments. It lacked larvae remain clustered for approximately 24 hrs. then tunnel into the leaf sheaths dead heart caused by Conlests (inplicabili havea on peat fullets and eventually ancer the stable, During feeding and development, the stem borer causes different types of

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damage depending on the stage of millet growth and the generation of infecting larvae. First-generation larvae cause dead hearts and a consequent loss of crop stand-Scootal-generation larvae cause lodging, disrupt the plant vascular system and prevent or limit grain formation larvae can mitigate between plants, mortiga a maximum of 1.2 m in the insectury and i.8 m in the field (Harris, 1962), Larval survival during the growing season is high probably because larvae enter leaf sheaths or stems within 2.4 hater hatching During the wet season, larvae complete development in approximately 30 to 40 days (mean 34 days). There are usually six but cometimes seven instans, hale apupae develop in 7-12 days (9.3 average), and female 7-13 days (9.7 average).

The life history of the millet stem borer was described by Bako (1977). Adults are active mostly during scoophiase, but remain on the lower leaf surface or along stems, with head turned towards the ground during the day. In Nigeria, the sex ratio from light traps or by rearing adults from field-collected eggs, larvae, and pupae showed significantly more females than malest (Harris, 1962). In Nigeria exer ratio of 121 was reported based on a sample of 1687 pupae, suggesting that the ratio imbalance from light trap catches could be due to differential responses of males and females to light (CRISAT, 1988). Mating in the aboratory occurs late during the night of adult emergence or early the following flight-objection begins the first night after mating and peaks so on the third night after emergence. It can continue through the sixth night after mating, in the field, adult females place their eggs in batches, averaging 20 to 50 eggs between the leaf sheath and the stem, or on lower leaf blades (Harris, 1962), yourn (1990) reported that C. (gengizusio volposition is mostly ascondared with leaf sheath and rarely occurs on leaves. Each female may layover 200 eggs in total. Revoly deposited eggs are creamy white to yellow, turning dark after to the 11 days, and harch 24 h after darkening. Two or three generations occur during each millet-growing season.

### 8. GEOGRAPHICAL DISTRIBUTION OF C. IGNEFUSALIS

C (inglusals is restricted to mainland Mrica, south of the Sahara and has been most frequently recorded in West Mrica (Senegal, Mail, Gambia, Gainea Bissau, Benih, Burthan Esso, Chad, Mauritania, Ghana, Niger, and Nigeria), It has also been recorded in Sudan, Ethiopia, and Angola and is probably more widely distributed in tropical Mrica than published records indicate, in Nigeria, it occurs at altitudes up to about 1000 m (Youm et al., 1993a). ...

### 9. ADULT EMERGENCE, MATING, AND DISPERSAL

During the dry season, larvae remain in diapause until the onset of the next season rains and then pupate. Emerging adults infest the new millet plants. Nothing is known about adult incovernets and migratory habits. However, like most pyralids, the millet stem borer is unlikely to be a migratory pest. Mading is mediated by the famela, exc pheronnone which attracts males. Confesta (grefixedit sex pheromone consists of a three component blend: (2)-7-dotecen-1-ol. (20-5-decen-1-ol., 20-1) reported that female attractiveness was affected by age: males were more attracted to I-day old females than 4-day old ones probably because older females produce less pheromone. However, this needs to be further investigated.

#### 10. SUGARCANE STEM BORER, ELDANA SACCHARINA

E soccharina is indigenous to Africa. The African sugarcane stalk borer is widely distributed in sub-Saharan Africa including Burnudi, the Democratic Republic of Congo, Kenya, Navanda, Tanzania and Uganda. Sugarcane is the main crop host of the African sugarcane stalk borer but it will also attack maize (where it is a relatively minor pest), sorphum and rice, It attacks maize plants late in their development when it can affect grain filling which results in yield loss. Sugarcane stalk borer, African sugarcane stem borer, Eldana borer Eldana conjuyga Strand, 1912 (Youm et al., 1993a)

### 11. EGGS AND LARVAE OF E. SACCHARINA

The eggs of the African sugarcane stalk borer are yellow, oval and laidin batches, usually on thy dead make leaves. They become platk just before eintergence. The African sugarcane stalk bore; larves are light-brown to dark-grey coloured with brown pinacula (hardened - scierotized - areas that indicate points of muscle attachment), covered with very small dark coloured spots and have a distinct brown prothoract-shield (a plate on the dorsal surface of the borax). The head is reddish-brown to dark-brown. Larvae may be distinguished from other stem borer larvae by the circular arrangement of crochets (hooks) on the prolegs, pinacula and tubercles (small rounded projections) along the body, flegs are laid in batches of 50 - 100 eggs in folds of dead leaves, behind the leaf sheath or on dry leaves

at the bases of plants or on plant debris on soil. Fernalez may lay 400-600 eggs in their lifetime. Eggs batch within five-six days. Young larner feed externally on the green surface of the plant and their tumels thin the atems where they eat out tumels within which they pupate. Larner can develop in 21 days but development to plant pto the tree months. The inbrase do not go into a state of suspended development (diapause). Adults emerge in 7-14 days after the onset of pupation and only live for a few days (ICRISAT, 1988).

#### 12. ADULTS OF E. SACCHARINA

The adult African sugarcane stalk borer is small with a wingspan of 35 mm. The forewings are pale brown with two dark spots in the Gentre and elongate with a rounded front edge. The hind wings are which with a short fringe and brown longitudinal veins. At rest the wings are folded over the abdomen in such a manner that their outer edges are parallel to each other, and they cover the lighter coloured hind wings which are hidden from view. Both the adult or larval stages are unlikely to be confused with any other stem borers present in Africa Sugarcane is the main cropp host of the African sugarcane stalk borer but it will also attack maize, sorphum and rice (Ramadass et al., 2001). In the wild its hosts are wild grasses (Poaceae) such as Guinea grass (Panfeum maximum), wetland sedges (Opperceae) such as papyrus (Cyperus papyrus), rushes (Juncaceae) and typha (Typhaceae).

### HOST PLANTS OF MAIZE STEM BORERS

13.

The main crop hosts for B. fusca are maize and sorghum as well as pearl millet (Ferniteeum gluccum), finger millet (Elevisine coracina L), and sugarcane (Sociehram officianum), but to a much leser extent (Calasayud et al., 2006). Although the host plant on which B. fusco originally evolved is unknown, indigenous African grasses have been recorded as hosts, specifically Sorghum verticiliflorum (Steud) Penniteeum prapureum Schum, Fanicum maximum jacq, Hyparrhenia rufo Nees (Saspf), Ratiboellia exalicta (L), and Phragmites sp. (Harris and Nwanze, 1992).

### BEHAVIOURAL BASIS OF HOST PLANT SELECTION

14.

The different behavioural steps leading to host selection and oviposition have been well described in B, facar (Calatayud et al., 2009). Similar to 4 other noctuids, the behavioural steps leading to oviposition by a gravid moth follow a sequential pattern involving searching, orientation, encounter, landing, surface evaluation, and acceptance. Before handing, plant voiatiles influence the female orientation, indicating from a distance the suitability of the plant species; the female antennae bear numerous multiporous tricholdes sensilla able to collect voiatiles (Calatayud et al., 2006). Thereafter, the visual cues are also involved in the female's orientation and landing (Calatayud et al., 2006). It is after hading that the final decision for oriposition takes place. The female typically sweeps her oriposition on the plant surface as if evaluating the suitability of the plant, simultaneously touching it with the tips of her amtennae heart is accepted, origosition takes place. The tip of each antenna bears several uniporous sensilla (lae. taxes receptors) located within the inner bears several uniporous sensilla the to taxe the plant's surface (Calatayud et al., 2006). The difficulty of the plant are the control of the ventral surface of each hobe of this organ (Calatayud et al., 2006), combinations of tacifie and gustatory stimuli from the plant are received during the evipositor sweep behaviour. . . .

During this behavioural step, the claws at the distal part of the ovipositor leave small injuries on the plant surface, which are deep enough to liberate inner plant cudcular compounds, which differ between plant surface as the plant surface, which are deep enough to liberate inner plant cudcular compounds, which differ between plant species (e.g., between host and non-host plants) (Juma, 2005). These compounds are perceived by the tasts receptors on the ovipositor, which then activate the appropriate behaviour (acceptance or rejection) depending on the nature/composition of these sunticular chemicals. Like all notutid borer species, B. facca relative species to ovipositing at the stem (Kachimann, 1983). Bussiol (acceptance of melastics and the stem (Fachimann, 1983). Bussiol (acceptance for originate to sorgham plants of similar sizes (Robe et al., 2004). It can therefore be concluded that the physical properties of the leaf sheath and stem play a crudal/rule in plant acceptance for origination. In fact, B. facca prefers to oviposit at all on Mellins minutillora, a species with glandular trichones (Rom et al., 2000). It was also shown that 3-6 weeks old matize plants are most attractive for origination of the species with glandular trichones (Rom et al., 2001), to was also shown that 3-6 weeks old matize plants are most attractive for origination or origination or origination of the plants in the proposition rarely occurs on older matize plants (Van Rensburg et al., 1997), but (1997), but (1997), but (1997) as the insect they sharkes on the upper part of the plants in where the leaf sheaths are young and soft Origosition on maize plants in

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Sustainability in Paget and

authesis period has been reported by van it is (Van Renshwig et d., 1987) but, when provided refer plants during the vegetative stages of de-re currelation extats between stalk circumference f development A a Reneburg and ad with a choice,

All these reports and observations suggest that plant physical costs, such as surface isoture (e.g., pubescence), plant size (i.g., stem absenses), and leaf them the globy strong the property of the control of the co

liot selection in phytophagous insects is generally determined by the adults. However, in many Lepidoptora species the larvae can engage in bots plant selection (Edenga, 1991), After interling undermealt the lead sheath, R. Jaccar neomies larvae areas in the late wheel, solven they either feed on the leaves or disperse via ballooming-off (Kaufmann, 1903). This dispersal phenomenon to para quantity density dependent and might be influenced by host plant quality, After feeding in the leaf whorl, 3rd to oth instar harvae feecand and hore into the plant stem, Generally, judiquences have display food preferences who a phenomenon driven by chemoversphora located on the monthjurst (Schoonhoran and Vaniona, 2002). Like other Lapidoptera species, if, faced nevue possess sensory structures able to detect plant compounds, including viabiles (Isans et al., 2008), Athough the antennae of the larvae new short and simple, they have three multiporous cone-shaped basiconic sensitis able to detect volatiles. In fact, the 3rd Isansar larvae area able to recogniza the odours of their host plant at a distance.

The larvae possess also on their maxiliary galeas two uniporous styloconic sensilia, which are contact chemorecoptors. They have also maxiliary palps having eight small backonic sensilia at the tip, which were also found to be gastatory (luma et al., 2001). Plant sugars are often considered as primary feeding stimulia haviored among the compounds that induce the host plant acceptance by herbivorous injects (Schoonhoven et al., 2005). It was recently theore that sucrees is a feeding stimulian and positively influences food choice by B. furce in eve, whereas turnness (an itemer of sucross), as a ago deterrent, regatively contributes to invail food choice (una et al., 2013). The uniporous styloconic sensilia of the maxiliary galean are able to detect both sugars but the lateral styloconic appears more sensitive to sucrose at low concentrations whereas the modal styloconic is more assistive to turnose. These findings indicate that the balance in concentrations of these sugars as an advance of the concentrations of these sugars as a supersisting the supersisting the

Among the most important factors determining larval choice of host plant might be differenced in allicon (8) contant. In higher plants, allicom levels range between 0.1-10 % on a dry weight basist and they are generally higher in grasses than in dicoyledonous plants (8)psein, 1999), Flant resistance to insects, pathogans or abotic factors has been shown to be related to the level of accumulation and polymerization of \$1\$ in tissues (Reynolds et al., 2009), Fer all, Marca; It has been observed that \$1\$ in plant epidermal cells appears to provide a physical barrier by increasing leaf abrasion, which physically deter larval feeding (1ums, 2010). Consequently, B. face a larvae prefer to feed on grasses that have low levels of \$1\$.

Only the females emit pheromones. Males and females exhibit simple and

rapid contrible between militaria sin personan risustanten anna (1984). Ha sea plantamente di fond finicia que la personale de la contribució de la minima del 7 11 describución el 18 fond finicia (11 de 1923). La contribució de la minima del 7 11 describución (11 de 1924). La contribución de la co

The formulae was exiting a four tour ofter energies in distance principles as a security in the formulae of the following the security in the security through the security is a security to the security through the security is a security to the security terminates and the accumples of the security through the security through the security of the sec

(Huntban, 1970), indicating that polypodry is not obligately and on necessary latinatury studies also incomed that formes extragationary and male attraction over not influenced by the presence of glade, treaspective II is one a toroit or nominion (blue, 2077). The obligation period lead to 3 st night of Unidam, 1975; is commenced desirently period lead to 3 st night of Unidam, 1975; is commenced desirently in the multip period and former multip later multip period during the desirently december of the fifth night (Calvergud et al., 2007).

### MANAGEMENT OF STEM BORERS

16.

Host team haref stacks on cerest crisps result from inferencies by major than mus species and since there are important differences in violeting and earling that than the affectiveness of status electricisms, from grant page and the same from the state of the electricisms of the same from the electricisms, flang attents of the electricism the electricisms, flang affected the electricisms is large small from the electricism and the electricisms (1971), then makin elements of the introduction in modern 1974 programs are noted.

#### 17, CULTURAL CONTROL

Cultural methods and practices that can be used to control dean beens include appropriate crop residue disposal, planting data meniphalaten, but resistance, best planting practices, copy or administration and enables resistance of the control, best play to reduce infestance and another season between the control is useful because it combines effectiveness of despress services despendent and there is never the country over populations of disposars increased season after harvest can reduce carry over populations of disposars increased season forms and to limit initial establishments of the followings seasons earlier towings at the rupts that was affected by same forms former seasons are found to the season borner populations affected, because the start of the raily season, borner populations affected by the second seasons originally that at the start of the raily season, borner populations of these countries of the season of the following of the second apparent planting pineartion increased by the inference of these countries of the second proposal composition and by planted crops, in a study, the inference of the second original planting pinearties and the second pinearties of the following of the second planting and the second proposition and planting planting the second generation of the following of the second planting and planting pinearties of the second planting and planting planting the second planting and planting planting planting the second planting planting

Host resistance to insect is the greater property that enabless glass is avoid, minimize, tolerate or recover from highey caused by the speak State plants have genetic tribs which manifest as artificions, in which the plants have genetic tribs which manifest as artificions, in which the biology of the past is adversely sillected after feeding on the glass partnermore, they can have genetic tribs which manifest as subdemedad (non-preference) where the plant is not destrible as a local sade gene sade alternative hosts. They can also be softent and all the confident of the plants are not as the feeding of the confident and alternative hosts, they can also be softent and of the confident and alternative hosts they are the plant is not destrible as a local sade of the recover from the past damage (Fefor, 2004). Destruction of volunteers and alternative to the plants actives overvitativity and international because the plants and the plants source of initial same locater internation. The areas will be then exposed to the heat from the same and production the cattle agest (Univident bits) perspect of the heat from the same and predators the cattle agest (Univident bits) perspect of the heat from the same dependent movement from plant materials. This may lead to an increase in the number of peats and trust he avoided if some borrer mothe is less greated with inlater from plant materials. This may lead to an increase in the number of peats and must be avoided if some borrer southeress are to be reduced (Felix, 2009).

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Appropriate disposal of crop residues after harvest can reduce carry-over populations of diapause larvae and so limit initial establishment of the pest on the following season's crops, limit go thoughty deep ploughing are effective but in areas where stems of cereals are used as building and fending materials it may be better to devise means of destroying dispussing larvae without destroying the stems. Actsiyan and Ajayi (1980) showed that partial burning of sorghum stalks tills 95 % of B. Jasse larvae within them and also improves the quality of the stems as huilding material. Alternatively, simply leaving stems lying on the ground esquarity or the hill heat of the sun for a month or so after harvest has been shown to reduce populations of diapausing larvae, Using rop residues for fordefer and sliage has also been recommended. Cultivation by disking and ploughing may also be effective, and, when preceded by slashing, can reduce larval populations by almost 100 % interecropping mater and/or sorghum with cowpeas may reduce chamage caused by B. Jasco.

### 18, HOST-PLANT RESISTANCE

Screening maize and sorghum genotypes for resistance to B. fusca has until recently been limited by the lack of effective techniques, sepecially the inability to rear If fuzer on artificial diets. Much screening has therefore been against field infestations, often against complexes of different borer species. In Ethiopia, barely 1 8 of nearly 6000 indigenous sorghum genotypes showed promising levels of tolerance but in South Africa several lines of maize have intermediate levels of tolerance to whorl several all the screening by first-baser lavrage (increase, 1929) and the control of the several lines of maize have intermediate levels of tolerance to whorl feeding by first-baser lavrage (increase, 1929) and the several lines of maize have first leading to the several lines of the several lines of

#### 19. BIOLOGICAL CONTROL

Natural enemies play an important role in the control of ispidoparous borrer in Africa, Biological control is the use of parasitudity, prelabors, nematodes and/or pathogens to maintain density of a species at a lower level than would occur in their absence. The main attraction of this control, is that it lowers the need for using chemicals and there is limited environmental pollution, which may affect non-targued flora and fanna (felik, 2009). It wassally offers a lasting solution of stemberer control from one introduction hence beneficial to both smallholder and commercial farmers, Some parasitolist actacle ages, some attack harvae, while some attack pupae. Trichogramma spp. (lymenopters in egg parasitolist, and elaylerlenomous buseond (lymenopters) are egg parasitolist, and elaylerlenomous buseond (lymenopters) are egg parasitolist, and control in that its object the energence of the damaging larval steep spod control in that its sops the emergence of the damaging larval steep (felik, 2009). Deratchasmasias busseon el (felikarical) (lymenopters Edophalder) and Lepidoscello spp. Xantohopinpla assemmator (Thunberg) (flymenopters: Edonemonidae), Parasitolist as desembators of the damaging through the control in that its object the energence of the damaging larval steep (felik, 2009). Deratchasmasias busseon el (felikarical) (lymenopters: Edophalder) and Lepidoscello spp. Xantohopinpla assemmator (Thunberg) (flymenopters: Edophalder)

. .-

In South Africa, Procerochasmiasis nigromaculatus Cameron (Hymenopetra: Licheumonidae) was recorded with up to 100 % pupula parasitism on B. Jasca, in addition, in South Africa, bentfeisamiasis bassenhe caused up to 100 % pupul parasitism of C. parallus Ruthermore, in South Africa bentfeisamiasis bassenhe caused up to 100 % pupul parasitism of C. parallus Ruthermore, in South Africa bentfeision sender (Cameron) (Hymenopetra: Braconidae) accounted for up to 90 % of parasitized B. Jasca Internation thave not yet been able to maintain population below economic threshold levels (Malati and Oluku, 2013). Parasitoids of House works which feed in exposed situations usually pupuse in protective silhon which feed in exposed situations usually pupuse in protective silhon which feed in exposed situations usually pupuse in protective silhon which feed in exposed situations usually pupuse in protective silhon which feed the second pupuse within the eaten out body of the host (Filix, 2009). In Ghiana, exotic species which feed in exposed situations a showed high feed most important bential parasitoids of B. Jasca in Southern Bentin, Telenomus busscoia (Ghana) (Hymenopetra: Scilonidae) are the most important thatural control factors of stem bores, including B. Jasca on maize, in Babiopa the Benzond, Dalichogenides fusivenes was found to be the major farral parasitods of B. Jasca with parasitism as high as 71 % in the dry season and 13 % in the west season. Chessia seamies (Cameron) [Hymenopetra: Scilonidae) is, the most important haval parasitoid of B. Jasca with 20 to 25% parasitization in Ethiopa, Korega, 2012) it is sing a gregarious invarial endosparasitoid of S. evaluntists Ardioblus furus channis as gregarious invarial endosparasitoid of S. dealmistis Ardioblus furus channis as gregarious introl and socration in Stational of S. Santa S. Santa S. Jasca attacking matze and serphum in B. Shotola with 14% parasitistoid of S. Jasca tatacking matze and serphum in S. Santas S. Santas S. Jasca S. Jasca S. Santas S. Santas S. Ja

in Zimbabwe, many manjal susunise secolosed wat particularly have been recorded in the high yield seam particularly from the first beautiful particularly from the first beautiful particularly from the first beautiful particularly formanism and continuous formation of the first beautiful particularly which stated beautiful particularly full particularly par

Generally, the levels of stein houses potenthan by indigateire methys enumers are not substacting clinical florings (Ministry Periodicing) was imported and released into the beginning of the process of

Potentials for biological control are currently being investigated, especially in East and South Africa. Classical biological control by introduction of parasitods from Asia and/or the American has been produced by introduction of parasitods from Asia and/or the American has been part of the parasitods from Asia and/or the American has present a transfer of occasions but with little success to fee. The general struction in Africa has been reviewed by a number of substrate over the past 30 years (Harris and Howanse, 1972) and implementation from the production of the production of substrates of substrates of presided in the production of the production of substrates of presided in the production of the production of substrates and brocon assumite were most shundard, and discussed proposals for further turnoductions for the past as into south Africa, This could involve transfers within Africa of It, fuses parasitodis not known to occur in South Africa and/or introductions for the world.

#### 20. CHEMICAL CONTROL

in addition to cultural control measures aimed at the destruction of stubble to destroy overwintering propilations of leaves, early chemical control involved whord applications of lead areanize as soon as visible control involved whord applications of lead areanize as soon as visible symptoms of intentation became apparent. DIT, the first synthetic insecticide, replaced lead areanized using the 1958s, buring the early/1960s it became common practice in some areas to apply DIT preventatively 210 to 36 days fare planting. This inventibly led to some applications being given too early, whereas others were not economically justified in view of the pronounced spatial and temporal variability of infessation levels. DIT was withtrawn from the approximan derahemote free generation insecticies, including organophosphara and carbonate free generation insecticies, including organophosphara and carbonate free compounds, later followed by the synthetic prethroids (Krupe et al. 2012), Most of these were considerably more expensive and some less persistent than DIT. At the same time, a steep increase in production costs without a concentral increase in product prices of make placed the spoilight on the economics of stem bover control faur looking for signs of damage when plants are 2 to 4 weeks old depending on the area. If you find damage holes in the leaves then use any of the following chemicals:

Ote the Article: Oyewale, R. O., Sahaudeen, M. T., Bamalyi, L.J., Bello, L.Y. (2020). Ecology and Distribution of Stem Novem in Vigoria. Sectoring in Fraed and Agriculture, 1(1): 27-36.

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- 3% G a pinch into the funnel of each plant (4- 4 bg/he)
- Dipieres 2.5% G a pinch into the funnel of each plant (4 : 4 kg/ha)
- Bulldock 0.05% G one kg/ha). shake in the funnel of each plant (7.5
- · one sheke per plant in the funnel (9.5 : 10 kg/he)
- residue from pýrethrum Id be applied into the funn intende e .

(Billy)

#### 20.1 Integrated management

Since stem horers is an important peat of make it sub-Schwert Africa, a wide range of methods have been researcised, castal and implimitation in manage it is past. These include among their scantical by pastidates, caltural practices, host plant resistance as well as thoughted non-trial agains (Rfr et al., 2002). Although control is a long-scalabland included in modifying the habitat to rander the environment understands the best and exprediction of peak. Moreover, it is the mast relevant best worked and reproduction of peak. Moreover, it is the mast relevant best and among the oldest relational peak into all fermions against peak may be searched as seen better control of cup residues, interrupphils, study reaction, manipulation of planting dates, things includes and training the closed residues, interrupphils, study reaction, and particulation of planting dates, things included and improvement of soil fertility, in addition, the align of these control reduced that increased plant thereafty in (mass crapting) and a sound peak and in conjunction with other methods. Diagnostic work in West Africandidated in a control of the control and its and the control of the potential options for pest management.

#### REFERENCES

- Adestyun, A. A. & Ajayi, O. 1980. Control of the stem horer, Husseila fuscu, by partial Burning of stalks. Tropical Feet Management, 26, Pp. 113-117.
- Ajala, S. O., Nour, A. M., Ampsong-Physics, E. & Odinds, M. O. (2016).
   Evaluation of males (Zea mays 1.) genoupes as a component of treagment seem hore (Chilo partellus Swiphor) management in coastal region of Kenya. African. Journal of Agricultural Research, 5(0), Pp. 758-763.
- Aleghejo, M. D., Olojeda, S.O., Kashina, B.D. & Aho, M.H. 2002. Maiza streak master virus in Africa: distribution, transmission, epidemiology, economic significance and management strategies, Journal of Sustainable Agriculture, 19(4), Pp. 35-45
- Alata, P., Hu, A. P. O., Anjo A. E. U., Ilvain P.& Frrot, B. 2008. Importance of plant physical cues in host acceptance for oviposition by *Husseala fusca*. Entomology Expression Application, 126, Pp. 233–243.
- Balogun, O. S. & Tanimola, O. S. 2001. Preliminary studies on the occurrence of stem borer and incidence stalk rot under varying plant population densities in matza, journal of Agricultural Research and Development, 1, Pp. 67-73. , O. 1977. Etude biologique de Haimbachia ignefusalis (Hamps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. MSc. Thesis, University of Laval, Quebec, Canada.
- Bamalyi, L.J. and Onlemayin, M.I.J. 2011. Management of Stem borers on some Quality Protein. Malze Varieties. Journal of Agricultural Sciences, 56 (3), Pp. 197-205.
- Byerlee, D. & Helsey, P.W. 1996. Past and potential Impacts of malza research in sub-Saharan Africa: a critical assessment. Pond Policy, 21(3), Pp. 255-277.
- Cahanyud, A., Quénégo, H., Le Ru, H., Silvain, J. F.& Fréror, D. 2007.
  Cahanyud, P.A., Quénégo, H., Le Ru, H., Silvain, J. F.& Fréror, D. 2007.
  Perployaltram of merganera, calling behaviour and origination period of the males stem borer, Busseolu fuscu (Fuller) (Lephotpera: Nocyaldas). Annual Société Entomologique France. 43, Pp. 65–68.
- Calatayud, P. A., Guénégo, H., Ahuya, P., Wanjoya, A., Le Ru, B., Silvain, J. F.

- the state of the second management of the second The state of the s
- Heir Phays, b., 1995, b., decinations, F. de lengton of the F. 1996, delicing and the second of the secon
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- aola, P., Ameriga, F. A. Beltrariotis, W.E. 1984. Societista de comencia de Ombolomo Procuscia da Ala sucia la internicia deplacia Martipas Ambolomo, Ph.A. Thomas, Vanyara, Amerika (P.). De de Adj
- 3, Grante, H. 2007, Make Selanca Application Hald begans being manifestors in Easte history.
- Brunnsha, h. h., Yan dan Harig, f. ib Yan dan Tandar f. is. 1889a Yangsaban and rahatru ahmidania of andib birnara of madita and benghawa ia Lawithir, februari Pinna Probassion, h., by FF 497.
- Epstein, E. 6. 1949. Annual Partistin of Plans Physiology Plans Bolacular Biology, 60, Pp. 641–666.
- 1811), f. N. (2014). Chamited scripty and phylogenesis experimental scripts.

  African Laphdopur expende of provide Scription of Mondelding 19(4).

  Thanks, Physiology and Physiological Scription of Script of Scriptions (Scription).

  Paths, Prance philip, J. B., Jeannaches, J., Jederson, J., Zederson, J. B., Landerson, J. La
- FEIIX, 5. h. E. Small, T., Frierd, B. 2013. Stopp plants and experiments individum in the African makes deministrat, fluorische dema fluiter 1993. (Laphdapuna, Marcaldian). Amount Sociétés Embourologique Francia, 44, Pp. 64-712.
- Pi Grat, B., Pilly, A. E., Eun, S. ("alwayput, P. Is.) La 80, 80, Stateshigh, 1986.
  Gunrality inhariou of the followin milita exercisioner: Succeedinfuses
  (Fullar) (Lephispere: Musculdas) under laborationer conditioner.
  Annual Società lammatophysique France, 11, Pp. 413, 414.
- Grottia, M., Das, B., Mobambil, D., Babu, B., Semego, K., Maksida, S., Shen, M. S., High, J.M., Beyne, T. & Pressure, B. of 2015. Genomendae association and general production of resistance so audio jettal natural ghazas in veryleas make groupheno. Theoretical aid Applied Generals, 12B, Pp. 1957–1968.
- Halle , A. & Hofsvang, T. 2002, Host borsr,Busseola fusca (Fuller) 1 Protection, 21, 227-233 t plant preference of sie Lepidoptera: Noosuiges). Cosp
- Harris, s, K. M. 1962, Lepidopterous stem borers of cereals in higeria. Bulletin of Entomological Research, 33, Pp. 139–171.
- Harris, C.W. & Hwanza, K.S. 1992. Bussello fusca (Suber), the Africae states stalk borer: A Handbook of Information. In Information Suberies so. 33; ICRESKT, CAB Internationals Ozon, UK, Pp. 85.
- ICRISAT (International Crops Research Institute for the Sent-Arid Tropics), 1988, ICRISAT Annual report Patanchieru, A.P. Pp. 592-396, India: ICRISAT.
- IITA (International Institute of Tropical Agriculture).2014, Maine Research to nourish Africa. Available http://www.ita.arg/maine. Beview date: 14 February 2014)
- Juma, G. 2005. No.le of plants volastile and surface metabolities is isodiating host selection and onlyposition of Busseoid Jupa. (Saller) (Lepidappers in Nocuolala), Mos. Thesis, Janoo Kenyata Visiversity of Agriculture and Technology, Nairobi, Kenya.
- Juma, G. 2010. Basis of host recognition and acceptance of Busselo fueco (Fuller) (Lepidoptera: Hoctuidae) Jarvae. Ph.D. Thesis, Jones Kanyatta University of Agriculture and Technology, Natrob. Kenya.
- Juma, G., Thiongo, M., Dutaur, L., Rharrabe, K., Marlon-Poll, F., Le Sa,

## Sustainability in Food and Agriculture (SFNA) 1(1) (2020) 27-36

- Magoma, G., Silvaint, J. F.B. Callatayud, P. Jr. 2013. Two sugar isomers influence flost plant acceptance by a cereal caerpillar pest. Balledn of Entomological Research, 103, Pp. 20–28.
- Kakolie, T. O. Lartigo, M. Vila. Olicolis, V. A. O. 1997. Discribination and damage by Chillo partellius (Swinkoel). Buseole Jacca (Fuller). Elementa-sociclarition (Visiller) and Searchino colombiato (Hampson). In two locaritions in Uganda. Mérican Journal of Crop Science, 5 (4), Pp. 365-
- Kamara, A.Y., Menkit, A. Badu-Aprako, B.& Ibikuale, O. 2003. The influence of drought stress on growth, yield and yield components of selected mains genotypes, journal of Agricultural Science, 141, Pp. 43-50.
- Khan, Z. N., Pickert, J. A., Van den Berg, J., Wadhams, L.J. & Woodcock, C. M. 2000. Exploiting Chemical ecology and species diversity: Sem borer and Strips control for manke and corphum, in Africa. Post Management Science, 56, Pp. 957–962.
- Kautinanu, T. 1983. Behavioural biology, feeting habits and ecology of the species of makes semisorers: Educa occlorino (Lapidopara: Pyrilidas), Sesomio colomistis and Buseolo fosco (Nocmidas) in Budias, Wigeria, Wass. Micro. pournal. of Georgia Entomological Society, 18, Pp. 259–2712.
- Klir, R. 1997. Compatitive displacement of Busseola Jusca (Lepidoptera: Noctuidae) by Ohlo partellus (Lepidoptera: Pyralidae). Annual Entuniological Society of America, 5, Pp. 619–624.
- Khr, R., Overholt, W. A., Khan, Z. R. &Polaszek, A. 2002. Biology and management of economically important lepidopteran cereal stem bovers in Africa. Annual Review of Entomology, 47, Pp. 701–731.
- Kruger, M., Van Rensburg, J. B. J.&. Van den Berg, J. 2012. Reproductive biology of 8t resistant and susceptible field-collected larvae of the mains stem borer, Busseola fisica (Lepidoptera: Noctuidae). African Entomology, 20, Pp. 35-43.
- Mallusi, P. & Okuku, G. 2013. ICIPE, Nairobi, Kenya. Personal observations.
  Tropical Pest Management, 26, Pp. 113-117.
- Meyekho, F.N., Barrion, A.T. & Khan, Z. R. 2005. Host range for stemborers and associated natural enemies in different fartising systems of Kenya. Insect Science and its Application, 3, Pp. 173–183.
- Ndemah, R., Schnichess, F., Korte, S., Borgemeister, C.& Cardwell, K. F. 2001. Distribution, relative importance and effect of lepidoperous boriers on midrat yields in the forest zone and mid-altitude of Cameroom. Journal of Economic Entomology, 94, Pp. 1434–1444.
- Ndemath, R., Schnithess, F. & Noize, C. 2006. The effect of grassy field margins and fertilizer on soil water, plant murfient levels, etemborer stateds and spide of mades in the humid forest (Cameroon, Annual Societé Entemologique France, 42, Pp. 461–470.
- Nsami, E., Pallangyo, B., Mgoo, V. & Omwega, C.O. 2001. Distribution and species Composition of cereal stem borers in the eastern Zone of Tanzania. Insect Science and its Application, 21, Pp. 289-295.
- Nuss, E.T. & Tanumihardjo, S. A. 2011. Quality protein maize for Africa: Closing the protein inadequacy gap in vulnerable populations. Advances in Nutrition, 2, Pp. 217–224
- Obhlokherian, A. A., Usua, E. J. & Umoetok S. B. A. 2002. Distribution of Lepidoptereus stemborers of maize (Zea mays L.) in ecological zones of Cross River State of Nigeria. Global journal of Agricultural Science, 1, Pp. 89-92
- Ogunwoliu, E. O. 1987. Efficacy of carbofuran against lepidopterous stem borer of maize. Nigerian Journal of Agronomy.2 (2), Pp. 27-32.
- Okereche, S. L., Ulesh, D. A.& Openwolu E. O. 2010. Field infestation of three malos. (Ma. mays. L.) genotypes by lepidopterous stem borers in Malourdi, Nigeria. Global Journal of Agricultural Science, 9 (1). Pp. 41-45.
- Olambyan, A. B. 2015, Malze: Panacea for hunger in Nigeria. African journal of Plant Science, 9(3), Pp. 155-174.
- Pingall, P.L. 2001. CIMMYT 1999-2000 World maize facts and trends. Meeting world maize needs: Technological opportunities and priorities for the public sector. Mexico, D.F. CIMMYT

Cle the Article Oyenske, R. O. Salandern, M. T., Bainayi, L.J., Ballo, L.Y. (2020). Ecology and Distribution of Stem Borers in Nigeria.

Sertimochility in Frad and Agriculture, 1(1): 27-36.

- Polaszek A. (ed.) 1998. African cereal stemborers; economic importance, taxonomy, natural enemies and control CAB laternational. Wallingford, Oxon, UK. 530pp.
- Ratzadáss, A., Traore, T., Sylla, M. & Diarra, D. 2001. Improved techniques for mass-rearing Busseolo fusca (Lepidoptera: Noctuidae) on an artificial diet. African Journal of Entomology, 9, Pp. 1–9.
- Rebe, M., Van den Berg, J. &McGeogh, M. A. 2004. Colonization of cultivated and wild graminaceous host plants by Busseola fusca (Fuller) (Lepidoptera: Noctuidae) and Chilo partellus (Winhoe) (Lepidoptera: Crambidae) under field conditions. Africa Journal of Entomology, 12, Pp. 187-199.
- Revington, J., Van Rencburg, J. B., I. Burkhardt, G.& Knauf, W. 1994. Preliminary field trials with a pheromone-based monitority system for the maize stalk borer, Buseolo Jusco [Fuller] (Lep Nexuldae) Journal of Entomological Society of South Africa, 47, Pp. 107–113.
- Reynolds, O.L., Keeping, M.G. & Meyer, J.H. 2009. Slicon-augmented resistance of plants to herbivorous insects. Annual Applied Biology. 155, Pp. 171-186
- Romney, D.L., Thorne, P., Lukuyu, B. &Thornton, P.K. 2003. Naize as food and feed in intensive smallholder systems: management options for improved integration in mixed farming systems of east and southern Africa. Field Crops African. Journal of Biotechnological Research, 84, Pp. 159-168.
- Saxena R. C. 1987. Antifeedants in tropical pest management insect Science and its Application 8, Pp. 731-736.
- Schoonhoven, L. M. & Van Loon, J. J. A. 2002. An inventory of taste in caterpillars: each species its own key. Acta Zoological Academiae Sciendarum Hungaricae, 48, Pp. 215–263.
- Schoonhoven, L. M., Van Loon, J. J. A. & Dicke, P. 2005. Insect Plant Biology. 2nd ed.; Oxford University Press: Oxford, UK.
- Sezonlin, M., Dupas, S., Le Ru, B., Le Gall, P., Moyal, P., Calustyud, P.A., Faure, N. & Silvain, J. F. 2006. Phylogeography and population genetics of the maize static borer Bussooin fusor (Lepidoptera, Noctuidae) in sub-Saharan Africa. Journal of Molecular Ecology, 15. Pp. 407-420.
- Sosan, M. B. & Daramolia, A. M. 2001. Studies on the relationship between methods of assessing lepidopterous stem borer infestudion and grain yield losses in maize (Zea mays L.). Nigerian Journal of Plant Protection, 18, Pp. 12-20.
- Tams, W.H.& Bowden, J. A. 1953. Revision of the african species of Sesamia Guenée and related genera (Agrotidae-Lepidoptera). Bulletin of Entomological Research, 43, Pp. 645–678.
- Tefera T., Mugo S., Tende R., & Likhayo P., 2011. Methods of Screening Maize for Resistance to Stem Borers and Post-harvest Insect Pests CIMMYT. Nairobi, Kenya.
- Unnithan, G. C., Paye, S.O. 1990. Factors involved in mating, longerity, fecundity and egg fertflity in the maize stem-borer, Busceolo factor (Fuller) (Lepidoptera: Noctuidae). Journal of Applied Entomology, 109, Pp. 295–301. Unnithan, G. C. 1987. Development and reproductive biology of the maize stemborer Busseola fusca Fuller (Lepidoptera: Noctuidae). Journal of Applied Entomology, 104, Pp. 172–179.
- Usua, E.J. 1966. Stem borers of maize in western Nigerian with particular reference to Busseolo fusco (Fuller) and Sesania species (Lepidoptera: Nocuidae), M.Scthesis, University of Ibadan, Nigeria. Pp. 169
- Usua, J. (1967). Observations on diapausing larvae of Busseola fusca-Journal of Economic Entomology, 60, Pp. 1466–1467.
- Usua, E. J. 1997. Distribution of stem borers of maize in the eastern states of Nigeria. Nigerian Journal of Science and Education. 4, Pp. 1-15.
- Van den Berg, I, Van Rensburg, I. B. , &Pringle, K. L. 1991, Comparative injuriousness of Busseola fusca (Lepidoptera: Nocuaidae) and Chilo partellus (Lepidoptera: Pyralidae) on grain sorghum. Bulletin of Entomological Research, 82, Pp. 137-143.

- Sustainability in Reed and Agriculture (SFNA) 1(1) (2020) 27-36
- a den Berg, J. & Van Bensburg, J. B. J. 1996, Effect of various directional insectiode sprays against Susseoia Meen (Legisloptens: Noceaidae) and Chilo partelliss (Lepisloptens: Pyralidae) in maite and socybum. South African Journal of Plant and Soil, 13, Pp. 51.–54.
- Van Remsburg, J. B. J., Walters, M. C. & Gillomee, J. H. 1987. Ecology of the maine stalk borer, Busseolia fiusca (Fuller) (Lepidoptera: Noctoidae). Builetin of Entomological Research, 77, Pp. 255–268.
- Van Rensburg, J.B.J., Walters, M.C.&Gillomee, J. H. 1989. Selective oviposition by the maine stalk bores, Bussecha fusca (Fuller). Journal of Entomological Society of South Africa, S2, 7p. 105–108.
- Van Rensburg, J.B.J. 1992. Evaluation of pheromone trapping systems in relation to light trap captures of the males stalls bover, Basseoia fasca (Fulley (Lep. Northidae), South Africa Journal of Plant and Soil, 9, Pp. 144–149.
- Van den Berg, J. 1955. The potential value of stem borer resistance in the management of Busseoin fusca (Expidospera: Nocuidae) and Chilo partilla (Lepidospera: Prazildae) populations in sorghum, Insect Science and its Application, 18, Pp. 31–36.
- Van Rensburg, J. B., L. Van Rensburg, G. D. J. Gilbonne, J.-H., Walters, M. C. 1957. The influence of rainfall on the seasonal abundance and flight activity of the maize static borrer, Busseola facta in South Africa. South Africa Journal of Plant and Soil, 4, Pp. 183–187.
- Waladde, S.M., Van den Berg, J., Botloble, P. M. & Mlanjeni, N. 2001. Survey of the abundance and distribution of maine stemborers in the Eastern Cape province of South Africa. In Proceedings of the

- Southern African Stem Borer Management Project, Van den Berg, J. Uys, V.M., Eds., Pietermaritzhurg, Natal, South Africa, Pp. 13–16.
- Wambuga, E.M. & Wafula, J. 2000. International Service for the Acquisition of Agri-Storech Applications Kenya Agricultural Research Institute Advances in malize streak virus disease research. In flattern and Seethern Africa: Worlshop Report. KARI and ISAMA AfriCenter, B. Pp. 35.
- Willmeet, J. A., Martin, D. P., Rybicki, E.P., 2001. Analysis of the illversity of Affician streak mastreviruses using PCR-generated RFLP's and partial sequence data. Journal of Virology, 93, Pp. 75-6.
- Yourn, O. 1990. Evaluation of natural enemies associated with the millet stem borer, Baim-bachta ignefusalis (Hampson) (Lepidopiera: Pyra lidae) an Niger, FhD thesis, Texas A&M University, College Station, Texas, USA, Pp. 145.
- Youm, Q., Mamalo A.K., & Nwanze, K.F. 1998a. Bioscology and integrated banagement of the millet stalk borer [Lepidoptera: Byralline]: A review and highlights of current research at the ICRISAT Sahellan Concer. Proceedings of the Regional. Foarl Millet Workshop, 19-21 Sep 1990, ICRISAT Sahellan Context, Miger (Youm, Q., and Annal Sep 1990, ICRISAT Sahellan Context, Miger (Young, Q., and Annal Sep 1990, ICRISAT Sahellan Context, Ph. 55-63.
- Yourn, O., Beevor, P. S., & Hall, R. 1993b, Trap design studies with the pheromone of Comiesta iprefusalis (Hampson) (Lepidoptera: Pyra-lidae) in sub-saharanAfrica. IOBC WPRS Bulletin 16 (10), Pp. 5B-63.

