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Life cycle of maize weevil pdf

View PDFVolume 8, Issue 12, December 2022, e11859Author links open overlay panel, rights and contentUnder a Creative Commons licenseopen accessBotanicalMaizePest managementStorageWeevils© 2022 The Author(s). Published by Elsevier Ltd. Advances in Agriculture/2016/Article/Research Article | Open AccessVolume 2016 | Article ID 7836379 | Adebayo Ojo1and Adebayo Amos Omoloye2Academic Editor: Kassim Al-KhatibThe maize weevil, Sitophilus zeamais Motschulsky (Coleoptera: Curculionidae), is one of the most destructive pests of stored cereals. Knowledge of the life history and biology is important to the development of an integrated pest management program. Investigation was carried out on developmental biology of S. zeamais on four main cereal crops, maize, rice, sorghum, and millet, under laboratory conditions. Egg incubation, oviposition periods, and larval instar development were not different significantly among the food hosts. Number of eggs laid varied significantly among the cereal grains; mean fecundity was highest on maize () and lowest on millet (). Number of immature (larva and pupa) and adult stages varied significantly among the cereal grains. There exist four larval instars with a varied mean head capsule width, with a mean total instar larval developmental period of 23.1, 22.2, 22.2, and 21.6 d on maize, rice, sorghum, and millet, respectively. There was linear relationship and significant correlation between the stages of larval development and head capsule width. The mean developmental period from egg to adult varied, being highest on maize (34.7 d) and lowest on sorghum (33.5 d).1. IntroductionThe maize weevil, Sitophilus zeamais Motschulsky (Coleoptera: Curculionidae), is one of the most destructive stored product pests of grains, cereals, and other processed and unprocessed stored products in sub-Saharan Africa [1–4]. S. zeamais causes qualitative and quantitative damage to stored products, with grain weight loss ranging between 20 to 90% for untreated stored maize [5–7], and the severity of damage depends on factors which include storage structures and physical and chemical properties of the produce. Heavy infestation of adults and larvae of maize weevil which cause postharvest losses have become increasingly important constraints to storage entomology [8] and food security in the tropics. The common control methods for this pest are the use of chemical insecticides, biological control, and botanical insecticides [9–11] among others. There cannot be a realistic success in applied ecology and pest monitoring and management without a better understanding of the phenology and dynamics of insects' life cycle [12]. Several studies have been conducted on the reproductive biology of maize weevil on maize or modified maize diet [13–15]. However, there is a paucity of information on developmental biology on preferred food substrate [1, 16]. Therefore, this study seeks to investigate the developmental biology of S. zeamais under laboratory conditions on four main stored cereals in other to elucidate some important aspects of its life history.2. Material and MethodsA culture was established of maize weevils, S. zeamais, using a modified method as described by Ojo and Omoloye [17] that were first collected from cultures in the Entomology Research Laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan. Twenty five pairs of one-week-old S. zeamais were introduced into 100 g grains of maize in 4.5 kg capacity Kilner jars covered with mesh lids, replicated five times (). Weevils were allowed to feed, mate, and oviposit for 7 days and then removed. Culture arenas were observed daily until new progenies emerged; they were removed and sexed using morphological characters described by Halstead [18]. This stock culture was used as source of Sitophilus zeamais throughout the period this study was conducted in 2013.Presterilized samples (200 g), each of maize (var. TZPB-SW-R), rice (var.

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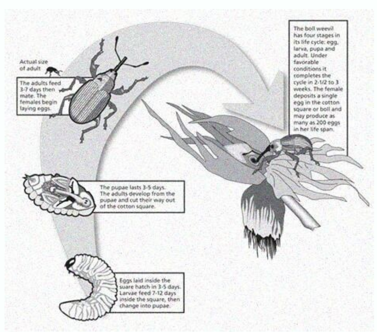

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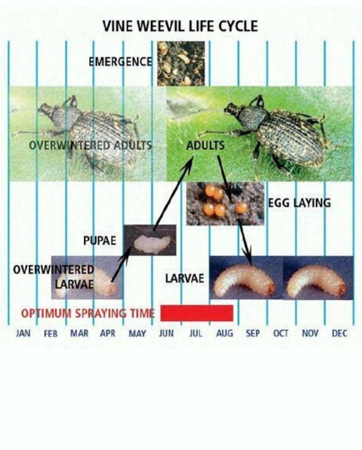

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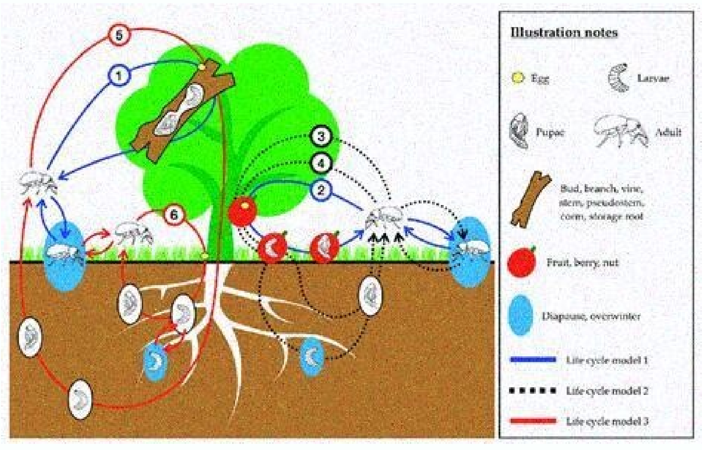

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Eggs hatch into a creamy white apodous larva with a sclerotized light brown head. The immature stages of maize weevil varied in relation to the grains on which it is cultured. The developmental period and body measurements of first instar larvae were not significantly different (> 0.05, F = 0.84, and DF = 3; > 0.05, F = 1.73) from one another regardless of the cereal grains tested. A significant difference (< 0.05, F = 1.45, and DF = 3) was observed from third instar larval onward, although, at 2nd instar stage, there were significant (< 0.05, F = 1.99, and DF = 3) shortest developmental days on sorghum, rice, and millet (5.5 and 5.7 days), the longest developmental period recorded being on maize (6.5 days). The newly hatched 1st instar larva (0.54 mm long) remained inside the grain, feeding voraciously until the end of the 4th instar when it hatched into prepupa/pupa. The developmental period of 3rd instar larvae on rice was significantly (< 0.05, F = 3.75) longer (6.5 days) and shortest on millet (5.3 days), whereas it was significantly (< 0.05, F = 44) longest on maize at 4th instar stage and shortest on rice and sorghum (4.7 days). There was significant difference (< 0.05, F = 10.7; < 0.05, F = 0.93) in the average body measurement at 3rd and 4th instar stage; weevil cultured on maize had the longest body length and width compared to those cultured on millet (body length mm, width mm) while the shortest body measurement was observed on weevil cultured on millet (length mm, width). The body measurement of 4th instar was not significantly (> 0.05; F = 9.17) longer between immature weevils on maize, rice, and sorghum (mm, mm, and mm), respectively, but significantly longer than weevil body length on millet. Basically, first instar larvae had an approximate developmental period of 5 days regardless of the food host used; second instar larva had 6.5, 5.7, 5.7, and 5.5 days on maize, rice, millet, and sorghum, respectively. The mean developmental period for third larval instar was 6.5, 5.7, 5.7, and 5.3 days on rice, maize, sorghum, and millet, respectively, whereas, at fourth larval stage, it was 4.7, 5.6, 5.7, and 5.3 days on rice, maize, sorghum, and millet. The mean total instar larval developmental period of maize weevil was 23.1 22.2, 22.2, and 21.6 days on maize, rice, sorghum, and millet, respectively, showing that weevil larvae develop faster on millet than other cereals. The fourth instar larva transformed into white, oval, and slender head prepupa which molted into pupa few hours later. The pupa is exarate and the wings and legs are glued to the body. The pupa stage ranged between 6 and 7 days. There was significant difference (< 0.05; F = 0.93) on the developmental period of maize weevil on food hosts, longest being recorded on both rice and sorghum (6.7 days) which was longer than the value obtained from millet and maize (6.5 and 6.3 days), respectively.

Food host also influenced the body measurement of maize weevil pupa, with longest body length and width being recorded on maize (mm and mm) and the shortest being observed on millet (mm and mm). The food hosts significantly influenced emerging body measurements of adult maize weevil. The adult male maize weevil was significantly (< 0.05, F = 1.73) bigger on maize (mm long and mm wide) and shortest on rice (mm long and mm wide) although not bigger than body measurement of weevil on millet (mm long and mm wide). Regardless of food host, female maize weevil was markedly bigger than its male counterpart (Table 2).The measurement of head capsule width of larval instars daily showed four frequency peaks as confirmed by Dyar's rule representing four larval instars (Table 3 and Figure 2). The head capsule width increased with successive instars regardless of food hosts (Table 3). The growth ratio (Dyar's ratio) varied across the larval instar stages ranging from 1.2 to 1.5, with the mean growth ratio of 1.3. The relationship between the larval developmental period and mean head capsule width was regular, and perfect geometric larval growth was observed in each instar across the food host when mean head capsule width was plotted against larval instar stage (Table 3 and Figure 1). Linear regression analysis depicted significant relationship between larval instars and head capsule width from all the food hosts (Figure 1).(a) (b) (c) (d) (a) (b) (c) (d) (a) (b) (c) (d) (a) (b) (c) (d) 5. DiscussionThe egg incubation period of five days observed among food hosts was similar to what was obtained in other related coleopterans, three to four days for S. rugicollis [21] and five days for S. oryzae when it was cultured on maize grains [22], whereas it was three days for S. linearis cultured on tamarind [17] and four days for Conotrachelus psidii [23]. There was variation in mean egg laid by mated female S. zeamais in relation to food hosts (range between 54 and 67 eggs) with more eggs laid on maize over a period of almost 22 days. S. zeamais could live for 117 to 126 days on cereals, with longest duration occurring on millet, maize, rice, and sorghum in that order. This variation could be a result of food hosts used and prevailing environmental conditions.

The developmental biology of S. zeamais could be influenced by this moderate fecundity and oviposition, shorter larval period, and ability to breed easily on any cereal crop.Regardless of the food hosts, this study showed that there were four larval instars of S. zeamais when the larval head capsule width was measured with successive instars and frequency distribution of head capsule multimodal curves which show four modal peaks. There was a distinct difference between the values of head capsule width for the successive larval instars. Body measurement is usually assumed to be normally distributed from insect of the same morphogenetic stage [24, 25]; this supports four peaks observed in the study.

The ratio varied from 1.2 to 1.5 across the four food hosts with a mean growth ratio of 1.3 on all the cereal crops used; these values showed that growth progresses at a constant rate in each molt which is relatively close to the constant Dyar's ratio of 1.4 for lepidopterous insects although it has been adopted for other insect orders [26, 27]; the slightest difference observed could be because S. zeamais is a coleopteran. Nevertheless, mean growth ratios obtained in this study were similar to what was obtained in other curculionids: 1.4 for Conotrachelus psidii [23]; 1.3 for Dendroctonus valens [28]; and 1.3 for Sitophilus linearis [17]. A linear relationship obtained between head capsule width and a high regression coefficient of 0.92 (on maize), 0.94 (on rice), 0.94 (on sorghum), and 0.98 (on millet) attested to the fact that no stadium was overlooked. The total larval developmental period was 23.1 days (on maize), 22.2 days (on rice), 22.2 days (on sorghum), and 21.6 days (on millet), and a prepupa/pupa developmental period was six to seven days which was different from what was obtained in other curculionids: 16 days for Conotrachelus psidii [23], 9.5 days for Hypothenemus hampei [29], and 14 to 16 days for Sitophilus linearis [17]. The prepupa/pupa period of 6.3 to 6.7 days observed across the food hosts used is relatively similar to what was obtained in other curculionids: 10 days for D. valens [28], 8 days for S. linearis [17], and 7.95 days for H. hampei [29]. Factors like food host conditions, type of insect species, geographical locations, and experimental conditions could play significant role in the developmental study of maize weevil. This study also showed that the comparative biological cycle of S.
zeamais from egg to adult was 34.7 days (on maize), 34 days (on rice), 34.1 days (on sorghum), and 33.5 days (on millet); this was similar to the S. zeamais mean developmental period obtained by other researchers using this insect species: 31–37 days [14], 35 days [2], and 34.8 days [4].

The significant variation in sizes between adult S. zeamais could be a result of the type of food crops used; also female maize weevil was observed to be bigger than their male counterpart regardless of the food host. S. zeamais bred on maize was bigger (4.11 mm long for male and 4.18 mm long for female) than those bred on other cereals, with a relative smallest body size recorded on both rice (3.34 mm long for male and 3.7 mm long for female) and millet (3.45 mm long for male and 3.94 mm long for female). Therefore, kind of food host coupled with the prevailing environmental condition played a significant role in maize weevil body size, as basic nutrients influenced the metabolic activities in insect.

The results obtained in this study on S. zeamais comparative phenology and dynamics of its life cycle on different main cereals provide a base for researcher for proper understanding of maize weevil ontogeny and bioecology which are needed in formulation of sustainable pest management practices and approach, as maize has been field to store pest of economic importance attacking different kinds of processed and unprocessed crop products worldwide.Competing InterestsThe authors declare that there is no conflict of interests regarding the publication of this article.AcknowledgmentsThe authors wish to acknowledge Adeniyi Aderinokun and Emmanuel Nnodim for their technical assistance in the laboratory.J. E. Throne, "Life history of immature maize weevils (Coleoptera: Curculionidae) on corn stored at constant temperatures and relative humidities in the laboratory," Environmental Entomology, vol. 23, no. 6, pp. 1459–1471, 1994.View at: Publisher Site | Google ScholarD. P. Rees, Insects of Stored Products, CSIRO Publishing, 2004.R. Plarre, "An attempt to reconstruct the natural and cultural history of the granary weevil, Sitophilus granarius (Coleoptera: Curculionidae)," European Journal of Entomology, vol. 107, no. 1, pp. 1–11, 2010.View at: Publisher Site | Google ScholarJ. A. Ojo and A. A. Omoloye, "Rearing the maize weevil, Sitophilus zeamais, on an artificial maizecassava diet," Journal of Insect Science, vol. 12, article 69, 2012.View at: Publisher Site | Google ScholarD. P. Giga, S. Mutemerewa, G. Moyo, and D. Neeley, "Assessment and control of losses caused by insect pests in small farmers' stores in Zimbabwe," Crop Protection, vol. 10, no. 4, pp. 287–292, 1991.View at: Publisher Site | Google ScholarS. Muzemu, J. Chitamba, and B. Mutetwa, "Evaluation of Eucalyptus tereticornis, Tagetes minuta and Carica papaya as stored maize grain protectants against Sitophilus zeamais (Motsch.) (Coleoptera: Curculionidae)," Agriculture, Forestry and Fisheries, vol. 2, no. 5, pp. 196–201, 2013.View at: Publisher Site | Google ScholarE. N. Nukenine, B. Monglo, L. Awason, L. S. T. Ngamo, F. F. N. Tchuenguem, and M. B. Ngassoum, "Farmer's percppection on some aspects of maize production, and infestation levels of stored maize by Sitophilus zeamais in the Ngaoundere region of Cameroon," Cam. J. Biol.
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