Journal of Stored Products Research 72 (2017) 117–120

Contents lists available at ScienceDirect

Journal of Stored Products Research

journal homepage: www.elsevier.com/locate/jspr

Species diversity and relative abundance of *Callosobruchus* (Coleoptera: Chrysomelidae) in stored cowpea in four major agricultural produce markets in the central region, Ghana

Samuel Abukari Bawa [a, *], Enoch Kofi Selorm Ofori [b], Michael Osae [b]

[a] *Asuansi Agricultural Research Station, Box 520, Cape Coast, Ghana*
[b] *Ghana Atomic Energy Commission, P.O. Box LG 80, Legon, Accra, Ghana*

ARTICLE INFO

Article history:
Received 13 April 2017
Accepted 15 April 2017

Keywords:
Relative abundance
Cowpea stock
Burkina Faso
Ejura
Niger
Callosobruchus species
Infestation

ABSTRACT

A study was conducted to investigate species diversity and relative abundance of *Callosobruchus* (Coleoptera: Chrysomelidae), a major insect pest infesting stored cowpea in the central region of Ghana. Cowpea stocks from Burkina Faso, Ejura, Ghana and Niger were obtained from the markets, and held to collect adults emerging from the cowpeas. Adult *Callosobruchus* spp. were identified based on the pattern of their hind femora and elytra. Five species, *Callosobruchus maculatus, Callosobruchus rhodesianus, Callosobruchus chinensis Callosobruchus analis* and *Callosobruchus subinnotatus*, were identified, with *C. maculatus* being the most abundant.

1. Introduction

Cowpea, *Vigna unguiculata,* also known as black-eye peas or southern peas, is an important grain legume that is widely cultivated in different parts of the world (FAO, 2004). It is one of the most widely grown grain legumes in Ghana but commercial production is restricted to parts of the Volta, Brong-Ahafo and the three northern regions (Tweneboah, 2000). Cowpea is a good source of protein and also provides income to farmers (Langyintuo et al., 2003). However, it is susceptible to pest infestation at all stages of the value chain. The pest problem on cowpea is more serious in Africa than Asia or Latin America (Singh et al., 1990). According to Singh and Jackai (1985), most of the damage caused by insect pests of cowpea occurs in storage, and among the economically important insect pests of stored cowpea are *Callosobruchus* species (Coleoptera: Bruchidae) (CRI, 2006). These insects cause severe damage and loss of seeds of many legumes (CRI, 2006). Feeding on cowpea seeds by the larvae causes significant loss in seed weight, viability and marketability (Southgate, 1979; FAO, 2004). Since the quality, quantity and nutrition of stored products can be affected by *Callosobruchus* species, they pose a major threat to food security.

Understanding the species responsible for infestation is key to the development of effective management strategies for any pest situation. The genus *Callosobruchus* includes approximately 20 species (Borowiec, 1987), with several morphological similarities (Giga and Smith, 1981, 1991). However, which species are present on the African continent and their distribution is not well understood. Free trade among African countries, especially West Africa has resulted in the spread of several pest species. In Ghana, cowpea, sold on the markets originate from neighbouring countries such as Burkina Faso, Niger, Togo, Ivory Coast among others.

This study was done to describe the diversity and abundance of *Callosobruchus* species relative to the origin of cowpea sold in the four major agricultural produce markets in the central region of Ghana. Understanding these will enable the development of management strategies against *Callosobruchus* pests along the post-harvest value chain of cowpea in Ghana.

* Corresponding author.
E-mail address: ambiasin@yahoo.com (S.A. Bawa).

http://dx.doi.org/10.1016/j.jspr.2017.04.007
0022-474X/

2. Material and methods

2.1. Study sites and insect culture

The study was conducted in four selected major agricultural produce markets in the Central region of Ghana. They include: Assin Foso in the Assin North Municipality, Mankessim in the Mfantsiman Municipality, Kasoa in the Awutu Senya East Municipality and Kotokroba market in Cape Coast Metropolis. Cowpea stocks from three different countries (Ghana, Burkina Faso and Niger) were obtained from the market centres mentioned above and stored separately in improvised specimen jars (1 L) made of plastics at the Asuansi Agricultural Research Station Laboratory. The cover of the plastic was cut open with a knife and covered with a mosquito net less than 2 mm in diameter. The jars were monitored but undisturbed for 21 days for emergence of adult insects at 27 ± 2 °C and 70 ± 5% relative humidity. The emerged adult insects were sieved off and counted, and then 100 insects from each jar was randomly selected into vials and put into a fridge at 4 °C for 12 h to kill them.

2.2. Identification of Callosobruchus species

The adult insects were examined under a dissecting microscope and identified based on their hind femora as described by Rees (2004) and elytral pattern as described by Metcalf et al. (1962). *Callosobruchus maculatus* have prominent black spots at the mid-length and tips of each elytron; *C. chinensis* has less prominent spots, which are found above the midpoint of the elytra. *Callosobruchus analis* had no black colouration. *Callosobruchus subinnotatus and C. rhodesianus* were very similar in colour. They both have relatively smaller black spots on the mid-length of each elytron. *Callosobruchus subinnotatus* has many specks of white pubescence while *C. rhodesianus* has two prominent lines of white pubescence. The spine on the hind femora was used to confirm the identification as described by (Haines, 1991).

2.3. Data analysis

The data were square root transformed. ANOVA followed by mean separation using Tukey's HSD (honest significant difference) test was performed on data from each market separately. All analyses were carried out using the Minitab statistical package version 17.

3. Results and discussion

3.1. Callosobruchus diversity and abundance

In all, 5876 *Callosobruchus* species were collected from 6.5 kg of cowpea from the four markets surveyed of which 2393 were identified individually. Five species of *Callosobruchus* were identified based on the hind femora and elythral pattern as described by Rees (2004) and Metcalf et al. (1962) respectively (Table 1). The species include; *C. Maculatus* (46.5%), *C. analis* (15.04%), *C. chinensis* (17.40%), *C. rhodesianus* (9.91%) *and C. subinnotatus* (11.50%) of which *C. maculatus* was the most abundant and *C. rhodesianus* the least abundant.

In Assin Foso market, *C. maculatus* was the most abundant (35%), followed by *C. chinensis* (21%), *C. analis* (17%), *C. subinnotatus* (14%) and *C. rhodesianus* (13%). There was significant difference ($P < 0.05$) between *C. maculatus* and the other species (Fig. 1A). The second dominant species *C. Chinensis* was also significantly different from *C. subinnotatus* and *C. rhodesianus* but not with *C. analis.* In this market, *C. maculatus* was significantly most abundant on samples originating from Burkina Faso and Ghana (Ejura) than on those from Niger (Fig. 1A). In all, five different species of *Callosobruchus* (*C. maculatus, C. chinensis, C. Analis, C. subinnotatus* and *C. rhodesianus*) belonging to the *Maculatus* and *Chinesis* clades were identified in this study. The members of the *Maculatus* clade are of West African origin and are more adapted to dry beans than the *Chinesis* clade, which are of Asian origin (Tuda et al., 2006). *C. maculatus* was the most abundant across all the markets, probably because it is of West African origin (Hill, 1983). *Callosobruchus maculatus* and *C. chinensis* have long been known to be widespread on the African continent than the rest of the identified species, which originally have been limited in their distribution on the continent (Southgate, 1965; Southgate et al., 1978). Trade has been established as the main factor that influence the introduction and distribution of Bruchid pests on the African continent (Taylor, 1981). Cowpea sold on all the markets surveyed originated from different West African countries including Burkina Faso, Niger and Ghana. This kind of inter-regional trade has been established to influence the distribution of *Callosbruchus* sp (Taylor, 1981)., being more pronounced for *C. maculatus* in Asia than in Africa.

Table 1
Percentage mean distribution of *Callosobruchus* species in four different markets in the central region, Ghana.

Insect	Mean Percentage Abundance			
	Assin Foso	Cape Coast Kotokrba	Mankessim	Kasoa
Cm	34.90 ± 3.61a	28.80 ± 2.69a	48.23 ± 5.99a	54.57 ± 3.33a
Cc	20.72 ± 0.82b	18.00 ± 0.49b	16.03 ± 2.49b	16.53 ± 1.57b
Ca	17.33 ± 1.99b	19.95 ± 1.23b	15.20 ± 4.34b	13.03 ± 1.76b
Cs	14.23 ± 0.53b	17.90 ± 1.08b	11.40 ± 1.69b	8.50 ± 0.82b
Cr	12.83 ± 1.72b	15.27 ± 1.77b	9.07 ± 2.24b	7.43 ± 1.43b
Df	14	14	14	14
F	18.88	10.22	18.74	100.34
P	0.00	0.001	0.00	0.00

Mean values (±SE) within a column followed by the same letter are not significantly different by Tukey's HSD test ($P = 0.05$).
Cm: *Callosobruchus maculatus*, Cc: *Callosubruchus chinensis*, Ca: *Callosubruchus analis*, Cs: *Callosubruchus subinnotatus,* Cr: *Callosubruchus rhodesianus*.

Callosobruchus maculatus was the most dominant species in all the markets. The dominance of *C. maculatus* in all the markets may be due to the fact that it originated from West Africa and is better adapted to the prevailing conditions in the markets. This confirms the findings of Hill (1983) that *C. maculatus* originates from West Africa. Another reason for *C. maculatus* dominance may be due to its aggressiveness compared to the other species making it able to compete well and take dominance. This is similar to other studies that said among the *Callosobruchus* genus, *C. maculatus* is a principal cause of cowpea losses during storage (Golob et al., 1996; FAO, 2004).

In Cape Coast Kotokroba market, *C. maculatus* was also the most abundant (30%), followed by *C. analis* (20%), *C. chinensis* (18%), *C. subinnotatus* (17.6%) and *C. rhodesianus* (14.4%) (Table 1). Relative abundance of *C. maculatus* was significantly highest ($P < 0.05$) on samples from Burkina Faso than those from Ghana (Ejura) and Niger (Fig. 1 B). Similar trend was observed for samples collected from Mankesim and Kasoa markets (Fig. 1C and D respectively).

The study also revealed that, among the stored cowpea seeds tested, seeds from Burkina Faso and Ghana had the highest infestation with *C. maculatus*. It is however not clear whether the seeds were infested from the origin or became infested on the markets. That notwithstanding, it has been established that seed characteristics such as seed coat texture and presence of antimetabolic compounds influence the susceptibility of cowpea cultivars to *C. maculatus* (Akintola and Oyegoke, 2004; Messina and Renwick, 1985). Because *C. maculatus* originated from West Africa, it is well