Field Occurrence of Bruchid Pests of Cowpea and Associated Parasitoids in a Sub Humid Zone of Burkina Faso: Importance on the Infestation of Two Cowpea Varieties at Harvest

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Abstract: The cowpea is a very important legume for peasant farmers in West Africa but this crop is very sensitive to bruchid attacks during storage. A study was carried out in a sub humid zone of Burkina Faso to determine the relation between the dynamic of bruchid and parasitoid populations in the fields and cowpea infestation at harvest. The variations in insect numbers were weekly estimated by net captures during the growth of an early and a late cowpea variety. Adults of two bruchid species, Callosobruchus maculatus (Fab.), and Bruchidius atrolineatus (Pic.) appeared early in the fields before cowpea flowering and their population regularly increased over time and from early to late cowpea variety. The Pteromalid Dinarmus basalis Rond was the only larval parasitoid encountered. Its adults appeared later than bruchids and their parasitism activity increased over time. At harvest, 35% of the early cowpea pods and 74.5% of the late cowpea pods were infested by bruchid eggs. 58.5 and 72% of the bruchid eggs laid respectively on the early and the late cowpea variety were parasitized by Uscana sp. The level of cowpea seed infestation by bruchids at the beginning of storage was estimated to be 1 and 2.7% for the early and late cowpea variety respectively. The parasitism rate of bruchid larvae by D. basalis was estimated at this period to be 7.8% for early cowpea variety and 18.2% for the late variety. These results are discussed in view of developing an integrated control method based on the enhancement of the pest natural enemies in the fields and/or into storage systems in combination with beneficial farming practices.

Key words: Population dynamic, pests, parasitoids, integrated control method, beneficial farming practices

INTRODUCTION

Cowpea (Vigna unguiculata Walpers) is an important food crop for many people in West Africa1-2. This area is the world’s major producer of the crop with some 4.8 million ha cultivated3-4. The main constraint faced by the farmers is the difficulty of storing cowpeas. The larvae of several bruchid species develop in the cowpea seeds and cause considerable losses4-5. In the Niamey region of Niger, adults of two bruchid species Bruchidius atrolineatus (Pic.) and Callosobruchus maculatus (Fabricius) appear in the fields soon after the cowpea pod setting at the end of the rainy season5-10. The females lay eggs on the maturing pods before they are harvested. Then, the bruchid populations continue to develop in stored cowpeas. Adults of B. atrolineatus enter a reproductive diapause after one generation10. In contrast, C. maculatus grows rapidly in numbers during the storage period and is responsible for major losses5,11. In Niger, the Trichogrammatidae Uscana lariophaga (Steffan) (Hymenoptera) parasitizes the eggs of both bruchid species in the fields and can reduce the rates of cowpea infestation at harvest8,12. Other parasitoids of the Hymenoptera order including Eupelmus spp. (Eupelmidae) and Dinarmus basalis Rondani (Pteromalidae) attack the larvae but were only recorded in the storage systems13,14. Biological control of bruchids using these parasitoids has been investigated. The strategy of conserving and enhancing indigenous parasitoids seems to be a viable option15,16. However, the development of such a method involves a good knowledge of ecology and interactions between bruchids and their parasitoids in the fields as

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well as in granaries. Unfortunately, studies on the occurrence of these parasitoids in the cowpea fields are virtually lacking. The parasitoid species present in each region, their abundance and reproductive abilities could influence the cowpea contamination by bruchids and their population building during storage.

This study reports the fluctuations of bruchid and their larval parasitoid populations in the crops of two cowpea varieties in a sub humid zone of Burkina Faso. Cowpea pods were harvested at the end of the rainy season and examined to determine the number of bruchid eggs and the rates of their parasitism by the endophagous parasitoid of the genus *Uscana*. It is known that the initial parasitism at the beginning of storage influences the outcome of biological control in the granaries. For this reason, we also analysed the level of cowpea seed infestation during the first month of storage and the occurrence of larval parasitoid at this period.

**MATERIALS AND METHODS**

**Cowpea varieties:** Cowpeas used in the present study belonged to the early KN-1 and the late Local Moussa varieties. The KN-1, with brown seeds, develops in sixty days under optimal conditions while Local Moussa exhibits white seeds and matures in eighty days.

**Experimental conditions:** The studies were carried out during the rainy season in 1999 and 2000, in the Sudanian sub humid zone of Bobo-Dioulasso, in western Burkina Faso. In this area, the mean annual rainfall is estimated to be 900 to 1300 mm\(^{17}\). The main part of the rainy season occurred between June and October. During this period, mean temperature and relative humidity are 21-35°C and 67-83%, respectively.

**Experimental design:** The trial design used was a 2x4 Randomised Complete Block design. The two varieties were considered as treatment and there were 4 replicates. Each plot was 10x10 m with a buffer of 50 cm between plots. Two consecutive blocks were separated by 3 m. The cowpea varieties were planted, during the two years, in early July. Visual observations on the phenology of the crops were used to determine the main stages of cowpea growth, i.e. 50% flowering, 50% pod setting and maturing. To fight against flower Thrips (*Thysanoptera*), the crops were sprayed, at 50% flowering, with 11 ha\(^{-1}\) of Decis® containing 12.5 g Deltamethrin/kg.

**Infestation of cowpea by bruchid adults and their larval parasitoids:** By 28 days after planting (DAP) onwards, samples of insects were taken each week in the crops until harvest time. The insects, sampled by 25 sweep nets on two rows in each experimental plot, were collected into sampling bottles (100 cc each) containing 70% diluted ethanol. They were brought back in the laboratory and then were identified and counted.

**Reproductive activity of the larval parasitoids in the cowpea fields:** The reproductive activity of the bruchids’ larval parasitoids was also analysed by traps placed in the crops. Each trap was made of a 60 cm iron stake surmounted by a cylindrical cage. The cage exhibited a little opening front door and screen bars all around. A waterproof iron hut covered the top of the cage to protect against rainfall water. One trap was implemented per experimental plot. Each week, cowpea seeds containing 40 *C. maculatus* L\(_4\) larvae were placed into petri dishes and introduced in the cages. Previous studies demonstrated that bruchid L\(_4\) larvae were suitable for parasitization by the known larval parasitoid species\(^{18}\). After a 72 h exposure, the seeds containing the hosts, parasitized or not, were removed from the cages and brought back to the laboratory. The seeds were then opened and the bruchid larvae were extracted. The number of host attacked by each parasitoid species and the number of eggs laid were recorded. The eggs of the main larval parasitoids are different and easy to recognize. The eggs of *E. vuilleti* (L = 800 \(\mu\)m, L = 160 \(\mu\)m) have a 60 \(\mu\)m pedicle. Those of *D. basalis* are smaller (L = 600 \(\mu\)m, L = 150 \(\mu\)m) and have no pedicle\(^{19,20}\). The rate of host patches exploited was determined each week by the percentage of parasitized patches among the 8 patches displayed in the fields.

**Infestation of cowpea pods by bruchid eggs and parasitism by *Uscana* sp.:** At harvest time, 75 ripe pods were randomly sampled in each plot and brought back to the laboratory. The pods were carefully examined and the number of eggs laid by each bruchid species was determined. The eggs of *B. atrolineatus* and *C. maculatus* were easily distinguishable using the same criteria than Alzouma\(^{21}\). The number of eggs parasitized by *Uscana* sp., rapidly turning black, was also recorded. Data were used to estimate the rates of infestation of the cowpea pods [(number of pods bearing bruchid eggs/total number of pods examined) × 100] and the parasitism rates of the bruchid eggs [(number of parasitized eggs/total number of eggs recorded) × 100].

**Insects emerging from the pods during the first month of storage:** After the above observations, the pod samples were placed into separate Plexiglas boxes (26x14x8 cm) in local indoor ambient conditions. Adults of bruchids and parasitoids, which emerged from the pods, were daily
collected, identified and counted for 30 days. This duration allowed the development of the first generation of bruchid at this period[9]. At the end of the survey, the seeds were shelled and we determined the total number of cowpea seeds and the number of seeds presenting at least one bruchid emergence hole. The data were used to estimate the rates of cowpea seed contamination by bruchids ([number of seeds with bruchid emergence hole/total number of cowpea seeds] 100) and the importance of larval parasitoids at the beginning of storage.

**Statistical analysis:** The mean number of insects adults collected in the fields and the standard deviations were calculated for each sampling date. When necessary, data were transformed using the formula Ln (x+1) for direct counting data, or Arcsin transformation for calculated percentages before Analysis of Variance (ANOVA). In cases where significant differences existed between means, the ANOVA was followed by a Fischer PLSD test. Means were regarded as different when the test provided discrimination at the 5% level.

**RESULTS**

**Fluctuation of the bruchid and larval parasitoid populations in the cowpea fields:** Adults of two bruchid species, *C. maculatus* and *B. atrolineatus* were caught in the fields (Fig. 1). *B. atrolineatus* was numerically dominant with some 51-53% of the bruchids collected during the two years of study. Bruchids were recorded early, before 50% flowering, whatever the cowpea variety (Fig 1). The early KN-1 variety was first infested in all the cases. *D. basalis* was the only larval parasitoid encountered. Its adults appeared later than bruchids in the crops. The densities of bruchid and their larval parasitoid regularly increased and remained high at the end of the study (Fig. 1).

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**Fig. 1:** Variations in mean numbers (±SD) of bruchids and larval parasitoids caught in the cultures of two cowpea varieties during the crop growth in 1999 and 2000.
Reproductive activity of the larval parasitoids in the cowpea fields: Trapping the larval parasitoids by displaying host patches in the crops confirmed that *D. basalis* was the only larval parasitoid species present in the zone of study. Although the adults appeared in the fields 49 DAP, parasitism of the hosts occurred only on 56-63 DAP onwards. The rates of exploiting the host patches, their parasitism and the number of eggs deposited on the hosts regularly increased up to the end of the study (Fig. 2A and 2B).

Infestation of cowpea pods by bruchid eggs and attack by *Uscana* sp.: Cowpea pods were infested by the eggs of *C. maculatus* and *B. atrolineatus*. The Local Moussa was significantly more infested than the KN-1 during the two years of study (Table 1). *B. atrolineatus* eggs were numerically dominant (Table 2). Although *B. atrolineatus* females laid the larger number of eggs on the pods, parasitism by *Uscana* sp. was higher on *C. maculatus* eggs (Fig. 3). Global parasitism rates ranged between 57.5 and 59.5% for eggs deposited on KN-1 pods and 69.5-74.5% for eggs laid on Local Moussa.

Insect emerging from the pods during the first month after harvest: Insects, which had emerged from the cowpea pods, belonged to *C. maculatus*, *B. atrolineatus* and *D. basalis*. Their number was relatively low but significantly more bruchid and larval parasitoids were collected from the pods of Local Moussa (Table 3). Considering all the data recorded during the two years of study, only 30.6 and 20.5% of the bruchid eggs...
harvest, were infested by the eggs of both bruchid species but those of *B. atrolineatus* were numerically dominant. This observation is consistent with previous studies carried out in different areas of West Africa\cite{11, 21, 22}. Nevertheless the cowpea infestation by bruchids seems to be less important in Burkina Faso in comparison to Niger where *B. atrolineatus* is so far very important in numbers. As a matter of fact, 70-90% of cowpea pods were infested by *B. atrolineatus* in Niger whilst only 25-40% of the pods carried *C. maculatus* eggs\cite{9}.

Results of this study also show that larval and oophagous parasitoids were associated with the bruchid populations in the fields. *D. basalis* was the only larval parasitoid species caught by net and traps displayed in the fields. The present study is the first complete report on field occurrence of bruchid’s larval parasitoids. Previous reports particularly focused on parasitoids collected in the granaries during cowpea storage\cite{11, 21, 22}. In this study, the parasitoids appeared later than bruchids in the fields and their parasitism activity increased over time and from early to late variety. However, the impact of larval parasitoids in reducing the level of cowpea infestation at harvest seemed to be relatively low. Laboratory studies under concentrated host distribution demonstrated that *D. basalis* had high parasitism and host location abilities\cite{22, 27}. Probably, the capacity of finding the host under field conditions, where the host are scarce, is more difficult. Survey of granaries in Niamey and Ouagadougou revealed the presence of two larval parasitoid species, *D. basalis* and *E. viilleti* during cowpea storage\cite{11, 14, 26}. In Niger, a third species, *E. orientalis*, was temporarily observed but it disappeared after a few month of cowpea storage\cite{28}. From these results and those of the present study, it could be supposed that *D. basalis* is a cosmopolitan species while *Eupelmus* spp. are confined to dry areas. Such hypothesis has also been reported in the literature\cite{29}.

More than 60% of the bruchid eggs were parasitized in the fields by *Uscana* sp. Parasitism rates were particularly important in comparison to those of previous studies in Niger\cite{9}. In the Niamey region *Uscana* sp. parasitized only 4% of *B. atrolineatus* eggs and 25% of *C. maculatus* eggs in the fields during the year 1983. In 1984, the rates were 8 and 35%, respectively. As previously observed\cite{9}, *C. maculatus* eggs were more often parasitized than those of *B. atrolineatus*. A host selection process may explain the preference of *Uscana* sp. for *C. maculatus* eggs. Previous studies\cite{29} demonstrated that in a choice situation, *U. lariophaga* parasitizes the host species from which it had been reared. This hypothesis is consistent since in West Africa,
B. atrolineatus enters into diapause during the early months of storage and C. maculatus becomes the dominant species during most of the year. Probably, the parasitoids found in the field have developed on C. maculatus eggs for a long period.

The high parasitism of bruchid eggs partly explains the small number of F1 bruchids emerging during the first month of cowpea storage. Present results also show that the early cowpea variety was less infested by bruchids because it developed in the presence of a low pest population and that of associated parasitoids. The use of early cowpea varieties and early harvest[19] could be an efficient alternative for reducing the field infestation of cowpea by bruchids.

This study demonstrated the importance of the parasitoid activity in the fields on the level of cowpea infestation by the pests at harvest in the zone of study. A preventive biological control strategy could consist in enhancing the oophagous Uscana sp. in the cowpea fields to minimize the initial level of contamination by bruchid. Larval parasitoids, particularly D. basalis, seemed to be less active in the fields compared to storage situation. So, its population could be reinforced at the beginning of storage by augmentations in the granaries to limit the build up of the pest population[21]. This strategy, combined with a judicious choice of the cowpea variety, could allow a sustainable control of bruchid pests of cowpea in West Africa. However, the development of an efficient method at a large scale should consider the ecological variations, which determine the species distribution and their population dynamic[20].

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REFERENCES


