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The effect of time of harvest on the damage caused by the cowpea weevil *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae)

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The effect of time of harvest on the level of damage caused by *Callosobruchus maculatus* on cowpea was studied. Cowpea (*Vigna unguiculata*) (variety Asontem) was planted on 9 raised beds each measuring 2.4 x 2.4 m, 3 each for early, mid and late harvests that is, 60,70 and 80 days after germination respectively. Each plot had 20 plant stands. The plants were sprayed with PAWA (Lambda cyhalothrin) at 5 weeks after germination and with Cymethoate at flower bud and pod formation stages. Harvesting was done by hand-picking pods from the inner rows of plants. The harvested pods were sun-dried and the seeds were removed and stored in sealed transparent bottles. The number of adult weevils emerging were collected and counted weekly for 8 weeks. Percent weight loss, damaged seeds and seed holes were noted for each harvest time. Mean number of emerged adults ranged from 1.7 for 60 days of harvest to 136.7 for 80 days of harvest. Significantly higher percent damage was recorded for the 80 days harvest than the 60 and 70 days harvest (P= 0.0001). Percent weight loss for the different harvest times however did not differ significantly (P=0.571). Prompt harvest of matured cowpea pods would reduce the destruction of stored cowpea by *C. maculatus*.

Key words: *Callosobruchus maculatus*, cowpea, damaged seeds, holes, weight loss.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp., is one of the most widely cultivated, versatile and nutritious grain legumes (Ethlers and Halla, 1997). It has been consumed by humans since the earliest practice of agriculture in the developing countries of Asia, Latin America and Africa, where it is a valuable source of proteins, vitamins and mineral salts (Singh et al., 2003). Cowpea is now a broadly and highly adapted crop which is cultivated around the world as a vegetable, shelled dried pea and as a cover crop. The mature legume contains 23-25% protein, 50-67% carbohydrates, 1.9% fat, 6.35% fibre as well as some of the B-vitamins (Bressani, 1985). Cowpea seed is therefore valued as nutritional supplement to cereals in many parts of the developing world.

Even though cowpea is popular and nutritionally important to many people, its cultivation is under threat from insect pests, both in the field and in storage (Monti et al., 1997). Every stage in the life cycle of the crop has at least one major insect pest. At the beginning of the growing season one major pest is the hairy caterpillar (*Amsacta moorei*). A single wave of hairy caterpillars can destroy fields of cowpea seedlings by eating the leaves (Ndoye, 1978). Aphid, (*Aphis craccivora*) attack cowpea at the seedling stage, flower thrips (*Megalurothrips sjostedti*) at the flowering stage, the pod borer *Maruca vitrata* (IPMCSRP, 2000) and the storage weevil *Callosobruchus maculatus* (FSREU, 1999). Cowpea suffers heavily from insect infestation both on the field and in storage. Even though yields of 2500 kg/ha are achievable, several constraints have kept yields at low levels of 350-700 kg/ha (Ogbuinya, 1997). Yield reductions caused by insect pest can be as high as 95% depending upon location, year and variety (Gudrups et al., 1997). The low yields of cowpea are due to non availability of improved varieties and the effects of pests. However, in Ghana, the Crop

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Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR) in collaboration with the International Institute of Tropical Agriculture (IITA) has released 8 cowpea varieties which are high yielding (Rusoke and Fatunla, 1987). Thus in Ghana the most important constraint to increased cowpea yield is the problem of insect pests, the most important of which is *C. maculatus.*

C. maculatus infects the cowpea before harvest and causes quantitative and qualitative losses to seeds in storage (Mbata, 1993., Shade et al., 1996). Infestation levels are very low at the time of harvest and may sometimes be undetectable (Huignard et al., 1985). The cowpea weevil multiplies very fast in storage, giving rise to a new generation every month (Ouedrago et al., 1996). Infestations on stored grains may reach 50% within 3-4 months of storage (Pascual-Villalobus and Ballesta-Acosta, 2003). In Ghana, many of the resource-poor farmers do not treat their harvested grains with insecticides before storing them. Thus cowpea harvested and stored by these farmers becomes heavily infested with *C. maculatus* a few months in storage resulting in economic losses to the farmer. It is therefore necessary to reduce losses by knowing the best time to harvest the crop so that fewer weevils would be carried into storage. The study was therefore carried to determine the most appropriate time to harvest cowpea to reduce the level of *C. maculatus* infestation before storage.

MATERIALS AND METHODS

Experimental procedure

The experiment was carried out on an experimental farm near the Department of Theoretical and Applied Biology, Kwame Nkrumah University of Science and Technology, Kumasi during the minor rainy season of 2008. Cowpea seeds (variety Asontem) were obtained from an Agro Chemical shop in Kumasi. Nine raised planting beds, each measuring 2.4 x 2.4 m were prepared. There were 3 harvesting times with 3 replicates and the randomized complete block design (RCBD) was used. Each bed had 4 rows of cowpea plants, 0.6 m apart and 5 columns, 0.4 m apart. Thus there were 20 plant stands on each bed. An area of 2.4 x 0.6 m was allowed between adjacent beds and 0.6 x 2.4 m between opposite beds for easy movement between the beds.

Four seeds per hole were planted. Filling of gaps created by ungerminated seeds was done 2 days after germination. The seedlings were allowed to grow till day 14 before thinning out to 2 seedlings per hole. Clearing of weeds on the plots was done 2 weeks after germination and subsequently at 3 week interval. The cowpea plants were sprayed with PAWA 2.5 EC (Lambda cyhalothrin, 2.5g a.i/litre) at 5 weeks after germination and at the flower bud and pod formation with Cymethoate 25 EC (Dimethoate, 25g a.i /litre).

Harvesting

Harvesting was done by hand-picking pods from the inner rows of plants whilst neglecting those at the boarders in order to avoid boarder effect. Early harvesting was done at 60 days after germination (DAG), mid-harvesting at 70 DAG and late harvesting at 80 DAG. At each harvest, 100 pods were randomly selected from the inner row of plants from each bed. The pods were sun-dried for 5 days; the seeds were removed, weighed and stored in transparent bottles which were covered with nylon mesh and secured in place with a rubber band.

Data collection

The number of adult weevils emerging for each harvest was collected by sieving the weevils from the seeds and counted 10 days after the late harvest. The sieved out adult weevils were thrown away and the seeds put back into the container. Counting was done weekly for 8 continuous weeks and in each case the numbers of weevils for each harvesting time was recorded and the means calculated. At the end of the 8th week, the cowpeas for each harvest were weighed and the percent weight loss was calculated. Percent damaged seeds were determined by picking 100 seeds in a simple random sampling method and counting the ones that were damaged. Percent damaged seeds were calculated using the formula:

Percentage of damaged seeds = Number of damaged seeds x 100% / Total number of picked seeds

Percent of seed holes was calculated from the following formula:

Percentage of seed holes = Number of holes on damaged seeds x 100% / Total number of picked seeds

Data analysis

The general linear model (GLM) procedure of SAS (SAS, Institute, 1989) package was used to analyze the data. Analysis of variance (ANOVA) was done on the parameters studied. Where the difference was significant ($P<0.05$), the means were separated using the Student -Newman Keul's (SNK) test.

RESULTS

Number of weevils emerging

Weevil infestation was observed at all the harvest times. There was an increase in the number of emerged weevils from the early to the late harvest (Figure 1). In the early harvested cowpea, emerged adults were observed only after 4 weeks in storage. Infestation remained very low throughout the storage period. No adult weevils were recorded from the 5th - 7th week of storage (Figure 1). The early harvested crop also recorded the least number of emerged adults. On the other hand, the mid and late harvested crops were infested early and this resulted in adult emergence after only 1 week in storage. Weevil emergence was recorded throughout the storage period. At both harvests, adult emergence increased consistently throughout the storage period, reaching its peak in the 8th week. However, adult emergence was higher in the late harvested cowpea compared to the mid harvested crop (Figure 1). The differences in mean adult emergence for the 3 harvest times were significant ($P= 0.021$). Number of adult weevils that emerged from the early harvested crop was significantly different from that of the mid harvest which was also significantly different from that of the late harvested crop ($P=0.011$) (Table 1).

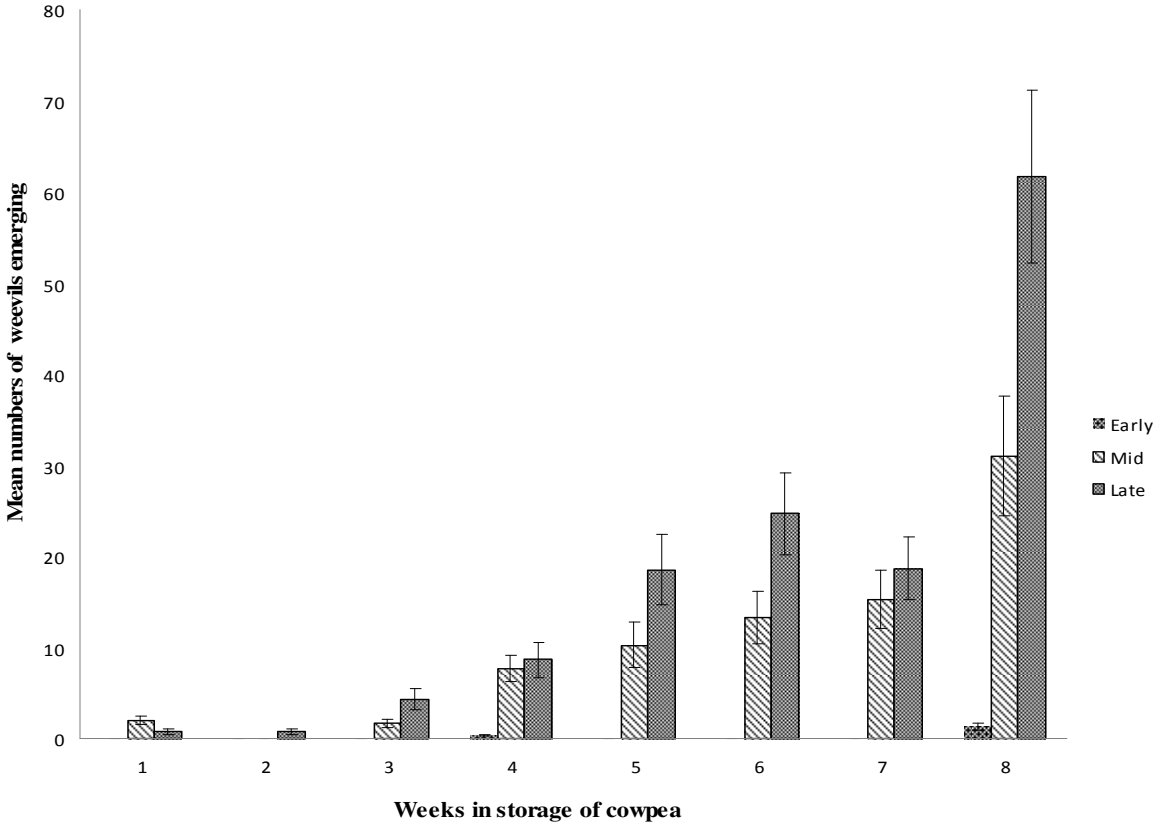

Figure 1. Weevil emergence from cowpea in storage.

Table 1. Time of harvesting and its effects on weevil emergence, % weight loss, % seed holes and damage done to cowpea seeds (Minor season 2008).

Time of harvest	No. of weevils emerging	% weight loss	% seed holes	% damage
Early	1.7a	12.5a	1.0a	1.0a
Mid	81.3b	8.7 a	10.1b	10.7b
Late	136.7c	11.2a	21.2c	23.3c

Within the same column, means with different letters are significantly different (P< 0.05).

Percent weight loss

As a result of the feeding activities of the weevils, weight loss was recorded from all the harvest times at the end of the storage period. Early harvested cowpea recorded a weight loss of 12.5% whilst the late harvested crop recorded a weight loss of 11.2% (Table 1). The differences in percent weight loss was not significant (F= 2.76; P= 0.571).

Percent damaged seeds and seed holes

Early harvested cowpea recorded the least percent damage whilst the late harvested cowpea had the largest percent damage (Table 1). A high significance difference was recorded for percent damage in the 3 harvesting times (F=225.7; P= 0.0001). Similarly, early harvested cowpea recorded the least number of holes (1.0) whilst the late harvested crop recorded the largest number of holes (21.2). The differences among the mean numbers of holes were highly significant (F = 424.6; P=0.001). There was a significant difference in percent seed holes between the early and mid harvested cowpea (P= 0.123). Similarly there was a significant difference in percent seed holes between the mid and late harvested cowpea (P=0.01).

DISCUSSION

The early stage of the life cycle of cowpea has a number of insect pests including *Aphis craccivora*, *Megalurothrips sjostedti* and *Maruca vitrata*. However the storage pest, *C. maculatus* causes the most damage. This insect infests the cowpea pods before harvest. Infestation of cowpea by *C. maculatus* on the field and in storage causes both quantitative and

qualitative losses (Mbata, 1993; Shade et al., 1996). They prefer green matured pods, but will also lay eggs on dry matured pods (Messina, 1987). These eggs are then carried from the field into storage from where the weevils start emerging after becoming adults. Thus the population of *C. maculatus* in storage depends on the initial level of infestation and length of time cowpea is stored. Thus the longer matured cowpea stays on the field before harvest the larger would be the initial infestation and consequently the greater the damage.

It can be seen that the longer cowpea is stored without treatment with insecticides, the larger the number adults emerging (Figure 1) especially in the mid and late harvested crops. Early harvested cowpea recorded very low numbers of emerged adults, an indication that at the time of harvest, infestation was very low (Huignard et al., 1985) and it took some time for the population to increase. The fact that the early harvested crop recorded the least adult emergence was also due to the fact that harvesting was done 1 week after application of the insecticide, which drastically reduced the numbers of *C. maculatus*. There was a progressive increase in adult emergence from the early to late harvest (Figure 1). The effects of the insecticides reduced with time, thus allowing the pest to increase in numbers during subsequent harvests. The fact that late harvested cowpea recorded the highest adult emergence throughout the storage period was an indication that initial field infestation was highest. It stayed longest on the field and was thus exposed to *C. maculatus* for much longer period.

Weight loss in cowpea seeds was as a result of the larvae and adults eating up the endosperm. They made use of the dry matter from the seeds thereby reducing the weight of cowpea. Even though the early harvested crop recorded the largest percent weight loss, this could not be attributed to *C. maculatus* infestation since it recorded the lowest weevil infestation. Weight loss could be attributed mainly to loss of water from the seeds during storage. The late harvested crop recorded larger percent weight loss than the mid harvested crop because it had the largest infestation and subsequently the larvae ate comparatively more of the stored food and thus had the largest adult emergence. Golob (1993) observed that in Northern Ghana, levels of cowpea damage varied from 15 to 94%. Golob et al. (1996) however concluded that even though *C. maculatus* attacked cowpea, weight loss was rarely in excess of 9% even after six months of storage. During the storage period percentage weight loss recorded was 12.5, 8.7 and 11.2 for early, mid and late harvested cowpea respectively. Even though differences were recorded these were not significant. According to Shade et al. (1990), bruchids can destroy as much as 80% of untreated grains in storage. Keita et al. (2000) also reported that *C. maculatus* can damage 100% of stored seeds causing weight loss of up to 60%. There was obviously some damage to the seeds when adult weevils emerged from them. The larger the number of adults that emerged the larger the number of seeds that were damaged and hence the larger percent seed holes. The late harvested crop which recorded significantly larger number of emerged adult weevils also had significantly larger percent holes and damage. On the other hand, early harvested cowpea which had the least number of emerged adults also recorded the least percent of holes and consequently the least damage. Studies conducted by Olubayo and Port (1997), showed that cowpea seeds harvested four weeks after the recommended harvest time was infested by storage bruchids to a significantly greater extent than cowpeas harvested early or at the recommended harvest time. Even though cowpea harvested at 60 days of germination had lower *C. maculatus* infestation, at that time the seeds were not fully formed and so some of the pods did not contain matured seeds. It is therefore best to harvest cowpea at 70 days after germination, at a time when seeds would be fully formed and infestation is relatively low.

Conclusion

C. maculatus is a major storage pest of cowpea which infects cowpea before harvest. The higher the infestation levels before harvest the greater the damage to the seeds in storage. This will result in higher weevil emergence causing a greater weight loss, larger number of holes and consequently loss of economic value. It is therefore important that cowpea is harvested at a time when *C. maculatus* numbers are low because it takes 3-4 months for *C. maculatus* population to reach damaging levels in unprotected seeds. Harvesting cowpea at 70 days will result in fewer *C. maculatus* being carried into storage. If cowpea seeds are to be stored for longer periods, then it is advisable to treat the seeds with recommended insecticides.

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