The Efficacy of Harvest Time Modification and Intercropping as Methods of Reducing the Field Infestation of Cowpeas by Storage Bruchids in Kenya

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Abstract—A study was carried out in Eastern Province, Kenya to evaluate whether the harvesting of cowpeas at different times and intercropping with maize were effective in reducing field infestation by storage bruchids.

Cowpea seed harvested very late (4 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. The intercropping experiments showed that bruchid infestation was significantly reduced in the intercropped cowpeas. These results are discussed in view of the current cowpea farming systems in Kenya. © 1997 Elsevier Science Ltd. All rights reserved.

Key words Callosobruchus rhodesianus, C. chinensis, C. maculatus, cowpeas, intercropping

INTRODUCTION

The cowpea is a very important legume for peasant farmers in Africa because it is a cheap source of protein. The crop is grown either as a monocrop or in different crop mixtures, and most of it is stored and consumed at the farm level, with small amounts marketed locally. Cowpea storage bruchids are known to infest cowpeas in the field and this infestation increases in the stores (Booker, 1967; Alzouma, 1981; Ouedraogo and Huignard, 1981; Warui, 1984; Germain et al., 1987). Most research work carried out on the control of storage bruchids on cowpeas has tended to concentrate on the control of the pests after harvest. Few studies have addressed the problem at field infestation level, but the results of work in Nigeria (Caswell, 1970), Tanzania (Karel et al., 1982) and Niger (Leroi et al., 1990) indicate that further investigations into cultural control methods at field level are necessary in all cowpea growing areas.

The main objective of this study was to examine some of the common cultural practices used by farmers for the efficient minimization of field infestation of cowpeas by storage bruchids in Kenya. The distribution of storage bruchid species in cowpea seed harvested at different times and from monocropped and intercropped (maize/cowpea) cowpea plots was investigated. Cultural practices found to be effective in reducing the field infestation of the cowpea crop by storage bruchids might form part of an integrated pest management programme for the control of these pests on the crop in Kenya.

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MATERIALS AND METHODS

The effect of harvest time on the field infestation of cowpeas by storage bruchids

The work was carried out at the National Dryland Research Station at Katumani, Kenya. The station is 1596 m above sea level with an average rainfall of 500-800 mm in two seasons (long and short rains). The annual mean maximum temperature ranges from 22 to 27°C and the minimum from 12 to 15°C.

An experimental plot of 400 m² was sown with an early maturing cowpea variety, Katumani 419, at the beginning of the long rains in March 1992. A double superphosphate fertilizer was applied at planting (200 kg/ha). The seeds were spaced at 60 cm × 20 cm. Seed germination took 6-7 d; the crop was kept weed-free throughout the growing period and observed regularly. Flowering occurred at 42 d and pod setting at 46 d after germination. Katumani 419 normally matures within 75-85 d. In this experiment, most pods matured between 80 and 82 d after germination. The harvests started 1 week later, a time when threshing was possible and could be done immediately after harvest. The early harvest was done at 88 d after seed germination. The recommended harvest time for this variety under Katumani conditions is 95-105 d after germination (Ngugi, personal communication). The second harvest was made within the recommended harvest time, at 101 d after germination. The late and very late harvests followed at 117 and 131 d after germination respectively. The plot was divided into four equal parts to allow for four different harvest times, with two rows of plants left as a guard between plots. The plot to be harvested at each stage was randomly selected. A very late harvest is included here because it is not unusual for small-scale farmers to leave a food crop in the field long after it has matured. This often happens in areas in which farmers have a cash crop and/or are engaged in livestock farming.

At each harvest, all the pods in the selected plot were collected and threshed. The seed was then taken to the laboratory, where the moisture content was determined using a Burrows grain moisture meter. Three subsamples were used for this determination. Five samples of about 200 g each were examined for any visible bruchid damage. The weighed seed samples were placed in sterilized Kilner jars and covered with muslin. These jars were labelled and held in the laboratory in ambient conditions (19-24°C and 48-68% relative humidity). The jars were checked for adult emergence at 30 and 45 d after harvesting. Adults in the jars were removed at each stage. Sixty days after harvesting there were no visible bruchid windows on the seeds, indicating that all the bruchids had emerged. The bruchids from each replicate were counted and identified. Other insects that emerged from the seeds were also recorded. The data collected were subjected to analysis of variance using Minitab.

The effect of intercropping on the field infestation of cowpeas by storage bruchids

Three monocropped (cowpea) and three intercropped (cowpea/maize) plots were planted in the field at the beginning of the long rains in March 1992 (first season) and the short rains in October 1992 (second season). Katumani composite B, an early maturing maize variety, was used as the intercrop. Cowpea variety Katumani 419 was used in the intercrop and in the monocrop. The experimental plots (3 m × 5 m) were arranged in the field in a randomized design. The maize seed was spaced at 120 cm × 20 cm and the cowpea seed at 60 cm × 20 cm. This cowpea spacing was used both in the intercrop and the monocrop. A double superphosphate fertilizer was applied on both crops at sowing time at the rate of 200 kg/ha. Maize received calcium ammonium nitrate fertilizer as top dressing at the rate of 200 kg/ha after the first weeding. The crop was checked regularly and kept weed-free throughout the growing period. Harvesting was done 101 d after germination.

At harvest time, pods from each plot were harvested and threshed separately. The threshed crop was then taken to the laboratory where the moisture content was determined on three subsamples from each field replicate as indicated above. In the laboratory, grain from each field replicate was well mixed and three 200 g samples were taken from each to be incubated for bruchid emergence. The rest of the experimental procedure was the same as in the previous experiment. At the end of the sampling period (45 d after harvest), determined by the absence of bruchid windows on the seed, the grain was weighed. The data were subjected to statistical analysis using a nested analysis of variance because of the laboratory subsamples from each field replicate.
RESULTS

The effect of harvest time on the field infestation of cowpeas by storage bruchids

The average moisture content was 17.1 ± 0.1% (mean ± S.D.) for the early harvested seed, 13.7 ± 0.1% for the seed harvested at the correct harvest time, 13.5 ± 0.1% for the late harvested seed and 13.2 ± 0.1% for the seed harvested very late.

None of the samples had any visible bruchid damage at harvest time. However, bruchids did emerge later from seed harvested at the four harvest times. There were differences in the numbers of bruchids emerging from seed harvested at the different harvest times with significantly ($P < 0.05$) more bruchids in seed harvested last compared with the first two harvests (Fig. 1). The species distribution at the different harvest times is shown in Fig. 2. Four bruchid species emerged from the seed. These were: *Callosobruchus rhodesianus* (Pic), *C. maculatus* (F.), *C. chinensis* (L.) and *Acanthoscelides obtectus* (Say). The most abundant species was *C. rhodesianus* and there were no significant differences in the relative numbers of the *Callosobruchus* species among harvest times. *Piezotrachelus tartum* (Wagner) (Coleoptera; Curculionidae), hymenopterans (*Mesopolobus* and *Habrocytus* spp.) and a dipteran were also recorded emerging from the seed.

The effect of intercropping on the field infestation of cowpeas by storage bruchids

The average moisture content was 13.6 ± 0.1% (mean ± S.D.) for monocropped seed and 13.9 ± 0.1% for intercropped seed in the long rains and 14.7 ± 0.1% for monocropped seed and 16.4 ± 0.2% for intercropped seed in the short rains.

The mean numbers of adult bruchids that emerged from the seed of each cropping system and the corresponding mean losses in the weight of the seed are shown in Table 1. The wet weight of the seeds was used as they still contained live beetles. There was a significantly higher bruchid
infestation in the monocropped cowpea seed than in the intercropped seed during the short rains \( (P < 0.01) \), but not during the long rains \( (P > 0.05) \).

The reduction in the weight of the seed was largely due to moisture loss, but also to the feeding of the developing bruchids. The short rains seed showed a greater weight loss than the long rains seed due to the higher moisture content recorded at the time of harvest. Seed from intercropped plots in the short rains, with a very high moisture content, showed a significantly \( (P < 0.001) \) greater weight loss than seed from monocropped plots, but there was no difference in the weight loss between the long rain crops. Regression analysis showed that bruchid feeding caused a loss of up to 0.18 g per individual bruchid emerging.

The distribution of the bruchid species that emerged from the cowpea seed samples is shown in Fig. 3. Three species of cowpea bruchids infested the cowpea in the field, both in the monocrop and in the intercrop. There were no significant differences in the relative numbers of the species either between monocrop and intercrop or between seasons. *C. rhodesianus* was the most abundant

Table 1. Mean number of bruchids emerging and seed weight loss \( (\pm\) standard error) in 200 g samples of monocropped and intercropped cowpeas grown at Katumani during the long and short rains of 1992 (after one bruchid generation) \( (n = 9) \)

<table>
<thead>
<tr>
<th></th>
<th>Number of bruchids</th>
<th>Seed weight loss (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ( \pm S.E. )</td>
<td>Mean ( \pm S.E. )</td>
</tr>
<tr>
<td>Monocrop</td>
<td></td>
<td></td>
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<tr>
<td>Long rains</td>
<td>5.89 ( \pm 1.45 )</td>
<td>1.65 ( \pm 0.12 )</td>
</tr>
<tr>
<td>Short rains</td>
<td>5.22 ( \pm 0.46 )</td>
<td>8.66 ( \pm 0.09 )</td>
</tr>
<tr>
<td>Intercrop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long rains</td>
<td>2.33 ( \pm 0.50 )</td>
<td>1.53 ( \pm 0.09 )</td>
</tr>
<tr>
<td>Short rains</td>
<td>2.22 ( \pm 0.46 )</td>
<td>12.50 ( \pm 0.13 )</td>
</tr>
</tbody>
</table>

Statistical comparison of bruchid numbers between intercrop and monocrop treatments: long rains, \( F_{0.05} = 2.60, P > 0.05 \); short rains, \( F_{0.05} = 16.86, P < 0.05 \).
DISCUSSION

The effect of harvest time on the field infestation of cowpeas by storage bruchids

The results reported here show that cowpea seed harvested very late (4 weeks after the recommended harvest time) at Katumani was significantly more infested by storage bruchids than cowpeas harvested early (2 weeks before the recommended harvest time) or at the recommended harvest time. In terms of the prevention of loss due to bruchid attack in the field, a farmer would not benefit by harvesting his crop earlier than the recommended harvest time. However, a late harvested crop would carry greater bruchid infestation into the store. Such infestation can build up to high populations more rapidly and thus cause greater loss to stored cowpea seed.

Similar investigations have not been reported in the East African region. However, in Nigeria, regular weekly harvesting of cowpea has been shown to reduce bruchid attack by two-thirds when compared with one single harvest (Prevett, 1961; Caswell, 1970). This piecemeal harvesting method is appropriate for the West African system, where the cowpea crop is generally stored in the pod form (Caswell, 1974). In Kenya, the crop is stored in seed form and, if farmers were to harvest the pods as they matured, the most practical way of handling the produce would be to keep the pods in the homestead until all the crop was harvested. The pods would then be threshed together and the seed stored. During this process, the pods are likely to be left exposed to further bruchid infestation.

It is evident that a crop harvested either early or on time during the harvesting season in the Katumani area would minimize bruchid damage in the field and, subsequently, in stores. Additional
studies, similar to that reported here, should be undertaken in different cowpea growing areas. Such studies would provide information to be used in the preparation of cowpea harvesting schedules.

The effect of intercropping on the field infestation of cowpeas by storage bruchids

Under the conditions at Katumani, bruchid infestation was significantly less in the intercropped cowpea than in the monocropped cowpea. These results are in agreement with those of Karel et al. (1982) at Morogoro in Tanzania, where C. maculatus populations were significantly reduced in a maize/cowpea intercrop compared with a monocrop. In the study reported here, the bruchid species involved (C. rhodesianus, C. maculatus and C. chinensis) collectively showed reduced field infestation in the intercrop. However, in the Niamey region of Niger, another cowpea bruchid, B. atrolineatus, showed the same levels of infestation in the millet/cowpea intercrop as in the cowpea monocrop (Leroi et al., 1990). B. atrolineatus occurs in Kenya (Warui, 1984) and has been found in cowpea seed harvested from other experiments in the same station (unpublished data), but this species was not among the bruchid species recorded in this experiment. Therefore, it is not possible to predict what its behaviour would have been in the intercrop (maize/cowpea) used.

Various crop mixtures are used by farmers in the cowpea growing areas in Kenya. These include cowpea/millet, cowpea/sorghum and cowpea/cassava. It would be interesting to determine the pest infestation levels in these crop mixtures in comparison with cowpea monocrops. The results could be used in the selection of the most effective crop mixture in terms of the reduction in pest infestation of the cowpeas within the mixture. This would facilitate selection of the most suitable mixture for cowpea production in the country.

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