nets, and shaking bags at early panicle emergence and during flowering.

Cylindrical exclusion cages of wire frames covered by fine-meshed cloth were placed over 120 newly emerged panicles to prevent natural infestation. Each panicle was infested with 25 eggs from female millet head miners collected in the field or reared in a laboratory. One group of panicles remained covered after infestation and until prepupae dropped to the base 6f the cage to prepare for the dry season, The other groups of panicles were uncovered at 3, 13, 23, and 36 days after infestation to allow access of natural enemies to millet head miner eggs, early-instar larvae, late-instar larvae, and prepupae. The groups of panicles were harvested at 3,10, 10, and 13 days after being uncovered and were taken to a laboratory, where emerging parasitoids were collected and identified.

In another experiment, 50 panicles at the boot stage were covered. Twenty-five eggs were placed 3, 6, or 9 cm from the distal end of each of 10 emerged panicles. Eggs were removed 48 h later, counted, and incubated in the laboratory. Partially destroyed eggs were assessed for predation. Another set of 10 panicles was examined 1 week later for parasitism of middle-instar larvae. The last set of 10 spikes was examined 1 week later for parasitism of full-grown larvae.

Natural enemies were abundant in farmers' fields. Ants of the genus *Cremastogaster* were most abundant, followed by the egg predator, *Orius* sp, and the egg and larval parasite, *Cardiochiles* sp. Also collected were *Bracon hebetor* in the field and *Copidosoma* sp in the field and from field-collected larvae reared in the laboratory. *Orius* sp and *Cardiochiles* sp were more abundant in September than in August or October

Many millet head miner eggs and larvae disappeared from panicles enclosed in exclusion cages. Natural enemies consumed more than 100 millet head miner eggs within 3 days after infestation. Large numbers of eggs were missing 14,24, and 37 days after infestation. Numbers of brown, wrinkled eggs, indicating predation by predators such as *Orius* sp, and total numbers of dead larvae were almost equal 4 and 37 days after infestation. Of 2400 millet head miner eggs placed on panicles in exclusion or open cages, 1016 (42.3%) were missing, 277 (11-5%) were nonhatched (attacked) brown eggs, and 40 (1.7%) hatched. Two-hundred-thirty (70%) live and 100 (30%) dead larvae developed from the 2400 eggs placed on panicles in exclusion cages,

Many eggs disappeared when exposed to natural enemies. In mid-September, fewer egg remains, indicating predation, were found than nonhatched brown eggs and more second than third or fourth instar larvae were dead. After 50 first instar larvae were exposed to natural enemies for 1 week, 3 (6%) were dead, 8 (16%) were missing, and 39 (78%) were alive,

Mortality of third, fourth, fifth, and sixth instar larvae was great between 8 and 30 September. Mortality throughout the growing season was greatest for fourth, fifth, and sixth instars. A total of 659 (33.5%) millet head miner larvae were live, 1307 (66.5%) dead, and 119 (9.1%) parasitized.

References

Gilstrap, F.E., Bayoun, I., Amadou, Z., and Kadi Kadi, H.A. 1995. Biological control of millet head caterpillar: needs, tactics and prospects. Pages 217-221 *in* Panicle insect pests of sorghum and pearl millet: proceedings of an International Consultative Workshop, ICRISAT Sahelian Center, Niger, 4-7 Oct 1993 (Nwanze, K.F., and Youm, O., eds.). Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Guevremont, H. 1983. Recherches sur l-entomofaune du mil. (In Fr.) Rapport annuel de recherches pour l'annee 1982. Maradi, Niger: Centre national de recherches agronomiques.

Vercambre, B. 1978. *Rhaguva* spp. et *Masalia* sp., chenilles des chandelles du mil en zone sahelienne. (In Fr.) Agronomic Tropicale 33:62-79.

Yield Loss Caused by *Coryna hermanniae* Fabritius (Coleoptera: Meloidae) on Pearl Millet in Nigeria

O Ajayi, T O Ajiboye, and B Abubakar (International Crops Research Institute for the Semi-Arid Tropics, PMB 3491, Kano Nigeria)

Introduction

Numerous beetles of the family Meloidae have been observed feeding on pearl millet (*Pennisetum glaucum* (L.) R. Br.) panicles in Nigeria (Ajayi 1985). They include *Coryna hermanniae* Fab., *Cylindrothorax audouini* Hagg., C. *westermanni* Makt., *Decapotoma afinis* Olivier, *Mylabris holosericae* Klug., *M. fimbriatus* Mars., *M. partinax* Per., *Psalydolytta aegytiaca Makl., P. jaloffa* Cast., *P. leprievri* Makl., *P. lecophaea*Makl., and *P. vestita* Daf. Since they feed on flowers, it has been assumed that they reduce pollination and, thereby, grain yield. Severe infestations by meloid beetles reportedly caused considerable yield losses in certain parts of West Africa (Gahukar 1984; Doumbia and Bonzi 1985,1986; Gahukar et al. 1986). However, there is little experimental evidence of the level of yield reduction attributable to these insects (Ajayi 1987). Jago et al. (1993) had argued that blister beetles should not be considered as economic pests of pearl millet (*Pennisetum glaucum* (L.) R. Br.). Recently, however, Tanzubil and Yakubu (1997) reported that meloid beetles caused up to 69% yield loss in millet in Ghana when 20 adults were caged per millet panicle, under no-choice conditions, from the onset of flowering until harvest. In Nigeria, a survey of farmers' fields in 1996 revealed that infestation of millet by *C. hermanniae* was widespread, and up to 40 adults per panicle were recorded (Dike and Ajayi, unpublished). Field trials were conducted in 1997 to determine grain yield losses caused by this insect under free-choice and no-choice conditions.

Materials and methods

To measure yield loss attributable to *Coryna,* millet panicles were artificially infested with varying numbers of adult beetles collected from neighboring millet fields. Head cages, designed for artificially infesting sorghum panicles with head bugs (Sharma et al. 1992), were used to confine 5,10,15,20,25, or 30 adults per panicle for 3 weeks from the beginning of flowering. There were five replications per level of infestation, with one panicle representing one replicate. As a control, an equal number of panicles at the same stage of development were covered with head cages but were not infested. Beetles were removed after 3 weeks but the cages were left in place. At maturity, measurements were made on panicle weight and grain weight; each panicle was weighed separately. Similar measurements were made on an equal number of neighboring panicles which had not been caged but were naturally infested by *C. hermanniae.* Data were expressed per 25 cm panicle length, and subjected to analysis of variance and regression.

Results and discussion

Table 1 shows that panicle weight declined from 43 g $(25\ cm)^{-1}$ in the control to 16 g $(25\ cm)^{-1}$ with 30 beetles panicle^{-1}. Reduction in panicle weight ranged from 14.9% with 5 beetles panicle^{-1} to 63% with 30 beetles panicle^{-1}. Similarly, grain yield decreased from 30 g (25 cm)$^{-1}$ in the control to 7 g with 30 beetles panicle^{-1}; grain yield loss ranged from 18% with 5 beetles panicle^{-1} to 75% with 30 beetles.

Table 1. Componential grain yield loss in pearl millet artificially infested with different densities of the blister beetle, *Coryna hermanniae,* during the 1997 rainy season, Bagauda, Nigeria.

No of beetles panicle[1]	Panicle weight $[g\ (25\ cm)^{-1}]$	Reduction (%)	Grain weight $[g\ (25\ cm)^{-1}]$	Reduction (%)
0	43.1	-	29.6	-
5	36.7	14.9	24.6	17.5
10	29.1	32.6	19.0	35.8
15	28.6	33.8	17.0	42.5
20	16.7	61.2	8.3	71.9
25	16.6	61.5	9.2	69.0
30	15.6	62.9	7.4	75.0
Mean	26.7		16.4	
SE	±3.47		±2.63	
CV(%)	29		36	

The relationship between beetle population and grain yield is expressed by the equation $y = 31.79-3.845x$ where y = grain yield and x = number of adult beetles per panicle (R^2 = 66.7%; df = 33; P = 0.001).

Yield loss on naturally infested panicles was calculated based on the yield of caged uninfested panicles. Naturally infested panicles weighed 38 g and yielded 24 g of grain. This represented a reduction of 12% for panicle weight and 19% for grain yield.

These results indicate that *Coryna* can cause severe yield losses, especially when high populations occur. However, such high numbers tend to occur sporadically and may be localized. This may explain why *Coryna hermanniae* is not usually reported as a serious pest of pearl millet (Ajayi 1987; Gahukar 1989; Jago 1993, Ndoye and Gahukar 1987; Nwanze 1992; Ratnadass and Ajayi 1995), and why Jago et.al (1993) did not consider *Coryna* spp as an economic pest. Nevertheless, the results presented here support the view expressed by Tanzubil and Yakubu (1997) that pollen beetles are potentially serious pests of pearl millet in West Africa. Further studies are needed to determine actual losses caused by these beetles in farmers' fields. Their bioecology needs to be studied with a view to understanding why they cause damage in some years and in some localities but not in others, so that an effective management strategy can be developed.

References

Ajayi, O. 1985. A checklist of millet insect pests and their natural enemies in Nigeria. Samaru Miscellaneous Paper no. 108. Samaru, Zaria, Nigeria: Institute for Agricultural Research.

Ajayi, O. 1987. The status of millet entomology in Nigeria. Pages 295-296 *in* Proceedings of the International Pearl Millet Workshop, ICRISAT Center, India, 7-11 Apr 1986 (Witcombe, J.R., and Beckerman, S.R., eds.). Patancheru, 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Doumbia, Y.O., and Bonzi, M.S. 1985. Les meloides au Mali. (In Fr.) Presented at the Commission technique des productions vivrieres et oleagineuses, Bamako, Mali, 9-12 avril 1985.

Doumbia, Y.O., and Bonzi, M.S. 1986. Les meloides au Mali. (In Fr.) Presented at the Commission technique des productions vivrieres et oleagineuses, Bamako, Mali, 25-29 mars 1986.

Gahukar, R.T. 1984. Insect pests of pearl millet in West Africa: a review. Tropical Pest Management 30:142-147.

Gahukar, R.T. 1989. Insect pests of pearl millet and their management: a review. Tropical Pest Management 35:382-391.

Gahukar, R.T., Sagnia, S.B., and Pierrard, G. 1986. Rapport du seminaire regional sur les meloides. (In Fr.) Projet CILSS de lutte integree, Dakar, Senegal, 5-7 aout 1986. Dakar, Senegal. Project CILSS de lutte integree.

Jago, N.D. 1993. Millet pests of the Sahel. Biology, monitoring, and control: an identification guide. Chatham, UK: Natural Resources Institute.

Jago, N.D., Kremer, A.R., and West, C. 1993. Pesticides in millet in Mali. NRI Bulletin no. 50. Chatham, UK: Natural Resources Institute, 45 pp.

Ndoye, M., and Gahukar, R.T. 1987. Insect pests of pearl millet in West Africa and their control. Pages 195-205 *in* Proceedings of the International Pearl Millet Workshop, ICRISAT Center, India, 7-11 Apr 1986 (Witcombe, J.R., and Beckerman, S.R., eds.). Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Nwanze, K.F. 1992. Insect pests of pearl millet in West Africa. Review of Agricultural Entomology 80:1133-1155.

Ratnadass, A., and Ajayi, O. 1995. Panicle insect pests of sorghum in West Africa. Pages 29-38 *in* Panicle insect pests of sorghum and pearl millet: proceedings of the International Consultative Workshop, ICRISAT Sahelian Center, Niamey, Niger, 4-7 Oct 1993. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Sharma, H.C., Taneja, S.L., Leuschner, K., and Nwanze, K.F. 1992. Techniques to screen sorghums for resistance to insect pests. Information Bulletin no. 32. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 48 pp.

Tanzubil, P.B., and Yakubu, E. A. 1997. Insect pests of millet in northern Ghana. 1. Farmers' perceptions and damage potential. International Journal of Pest Management 43:133-136.

Helicoverpa armigera Incidence in Finger Millet (*Eleusine coracana* Gaertn.) at Kiboko, Kenya

H C Sharma[1], S Z Mukuru[2], and J Kibuka[2]
(1. Genetic Resources Enhancement Program, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India; and 2. ICRISAT, East African Research Program for Cereals and Legumes (EARCAL), Nairobi, Kenya).

Abstract

Finger millet is an important cereal crop in Africa and South Asia, and there is considerable variability in finger millet germplasm for susceptibility to cotton bollworm, *Helicoverpa armigera* (Hub.). *Helicoverpa* incidence varied from 8% in IE 46 to 37% in Nagaikuro. AICSMIP 6, AICSMIP 11, AICSMIP 10, IE 581, IE 97, IE 120, IE 17, IE 2154, IE 2323, IE 46, AICSMIP 8, and Ending had <15% panicles with *H. armigera* damage compared with 37% in Nagaikuro. Lines resistant to *H. armigera* can be used to develop finger millet cultivars with resistance to this insect.

Introduction

Finger millet, *Eleusine coracana* Gaertn., also known as ragi in India, is cultivated for human food in Africa and