Chemical and botanical protection of transplanted sorghum from stem borer (*Sesamia cretica*) damage in northern Cameroon

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Introduction

In the plains of northern Cameroon, dry season transplanted sorghum (*Sorghum bicolor*) is grown over a vast area on clay soils (Vertisols). During the last two decades, cultivation of this postrainy season crop, locally called *muskuwaari*, has dramatically extended beyond its traditional soils (typical Vertisols), to intermediate and degraded Vertisols lying close to upland/rainfed crop areas (Mathieu et al. 2002). This extension could account for the recent increase in the damage caused by lepidopterous stem borers to *muskuwaari* crops, due to cross infestation from rainfed to transplanted sorghum (Mathieu et al. 2006).

In earlier surveys conducted in northern Cameroon and Chad, Ajayi et al. (1996) reported three lepidopterous stem borer species of the genus *Sesamia* (Lepidoptera, Noctuidae) as the major pests of dry season transplanted sorghum. Experiments carried out in Chad, near Ndjamena showed dominance of *Sesamia cretica* in both rainfed and dry season sorghum crops (Ratnadass and Djimadoumngar 2002). In loss-assessment experiments conducted from 2001 to 2003 in the region of Maroua in the Far-North Province of Cameroon, where *S. cretica* was also the dominant species, the mean grain yield difference between stem borer damaged and undamaged plants was 330 kg ha^{-1} (about 40%) (Mathieu et al. 2006).

Setting up protection techniques against stem borers is therefore a prerequisite to the sustainable development of both rainfed and dry season sorghum farming in northern Cameroon. During the 2003–04 *muskuwaari* cropping season, insecticidal protection tests were conducted with three chemical active ingredients [namely imidacloprid (CONFIDOR®), acetamiprid (MATADOR® 80EG) and thiametoxam (ACTARA® 25WG), neonicotinoids already used, or considered for registration and use for cotton crop protection in northern Cameroon], and plant extracts of physic nut (*Jatropha curcas*) and neem (*Azadirachta indica*). Acetamiprid and neem were the most effective active ingredient (ai) and plant extract, respectively (Aboubakary et al. 2005).

New tests were conducted during the 2004–05 cropping season with both products at several dosage rates, in view of setting up references, maximizing effectiveness vis-à-vis insect pest and economic benefit and minimizing environmental impact.

Materials and methods

Two trials were conducted. Trial I was conducted in farmers' fields at two sites (Balaza and Djarengol). Sorghum cultivars were *Safraari* at Balaza and *Majeeri* at Djarengol, two of the most popular landraces of *muskuwaari* cultivated in the Far-North Province of Cameroon (Barrault et al. 1972). In addition, a chemical protection demonstration test (Trial II) where acetamiprid was compared with controls was conducted on *Safraari* farmers' fields at six sites (Balaza, Barlang, Djangal, Kolara, Moditané and Palazamakoï). All study sites were located in the vicinity of the city of Maroua (10°5' N latitude, 14°3' W longitude, 550 m altitude), Far-North Province of Cameroon.

Trial I was conducted in a randomized complete block design (RCBD), each farmer's field serving as a block. Individual plots were 100 m² in size, with a central observation sub-plot of 7×5 m² consisting of 20 sorghum hills. There were nine treatments, as detailed in Table 1.

Leaf application was performed using knapsack sprayers (OSATU®). For treatments with neem, kernels were ground to a fine meal. The meal was soaked in water for 12 h (overnight) at the dose of 200 g L^{-1} and this was filtered before spraying.

In Trial II, chemical protection with three foliar sprays of acetamiprid at the dosage rate of 50 g ai ha^{-1} after transplanting and at 30 and 60 days after transplanting (DAT) was compared to untreated controls in paired experiments conducted in six *Safraari* farmers' fields (0.25-ha plots).

In both trials, at harvest, the stems damaged by borers (namely those showing borer holes externally, and, after dissection, stem tunnelling) were separated before harvest (120 DAT), which made it possible to calculate percentage damaged stems. Grain weight was taken in each plot and converted to grain yield per ha.

Analysis of variance was performed on data from Trial I. Differences between treatments were determined with the *F*-test, and means were compared using LSD at $P < 0.05$. For trial II, Student *t* test at $P < 0.05$ was used for statistical comparisons of means of paired samples, both for percentage damage and grain yield of insecticide-protected and control fields.

Results and discussion

In Trial I, differences between treatments were not significant in terms of damage, with a general mean of 48.1%, due to large differences in attack levels between the two locations. We therefore present results from the two farmers' fields separately in Figure 1. On the other hand, differences were significant ($P < 0.05$) in terms of yields (Fig. 2).

Acetamiprid with three foliar sprays at 50 g ai ha^{-1} per application, at transplanting, and at 45 and 75 DAT, or filtrate from ground neem kernels at 200 g L^{-1} in seven foliar sprays at transplanting, and at 30, 45, 60, 75, 90 and 105 DAT, considerably reduced losses caused by *Sesamia* stem borers. Thus acetamiprid, from level 2, and *a fortiori* level 3, gave better results than neem at levels 3 and 4. However, from level 2, neem did better than the controls.

In the paired tests (Trial II), *Safraari* protection with acetamiprid resulted in significant reduction of stem borer damage and grain yield increase of more than 75% (Table 2).

Our results confirmed the status of major pests of recession cropped or transplanted sorghums of *Sesamia* stem borers in northern Cameroon, like in several other areas of West and Central Africa (Ratnadass and Djimadoumngar 2002).

Our results also provide new insights in terms of chemical or botanical control of these pests. Contrary to neonicotinoids, which are known for their systemic mode of action (Drinkwater 2003), the neem extract has mainly repellent and contact modes of action, and its effectiveness indicates that unlike other *Sesamia* species,

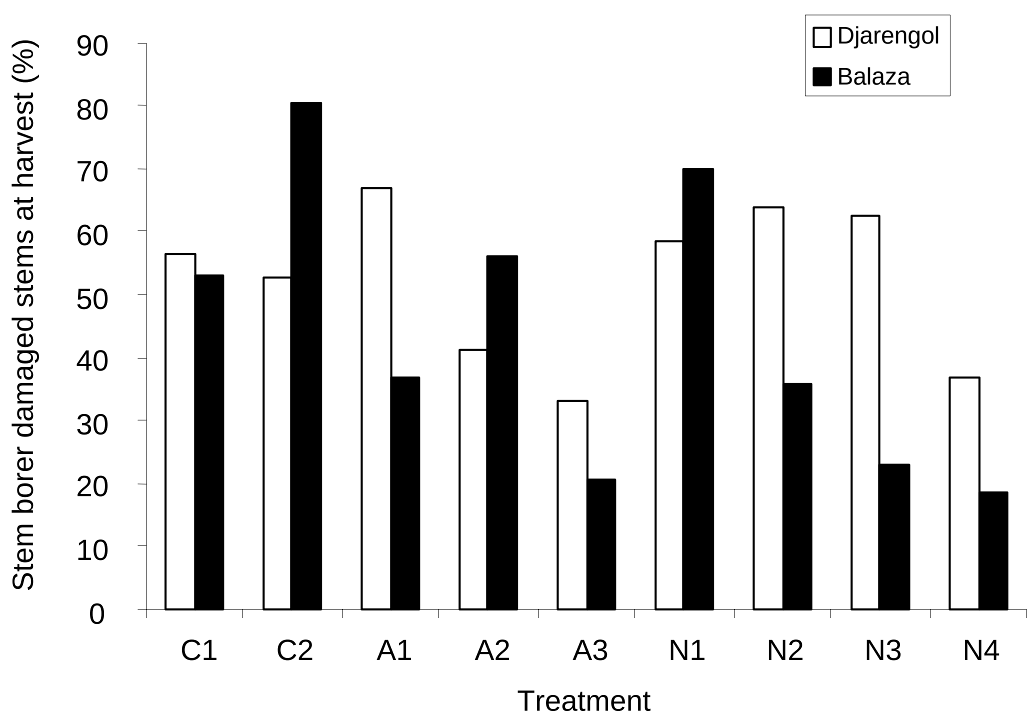

Figure 1. Effect of plant protection against stem borer damage on *muskuwaari* sorghum damaged stems at two locations (Trial I) (Note: For treatments, see Table 1).

all larval instars of *S. cretica* are probably not cryptic. This is supported by earlier observations from northern Cameroon of generalized presence of foliar attack symptoms (Mathieu 2005), and also by results from Mauritania showing the effectiveness of both the non-systemic ai beta-cyfluthrin (BULLDOCK®) and neem extracts as dry treatments in the sorghum whorl (Sow 2004). In these studies, in terms of efficiency, beta-cyfluthrin was at par with imidacloprid and benfuracarb, which were more efficient than carbaryl and carbofuran. Beta-cyfluthrin was selected for further extension since it is less toxic.

On the other hand, given the wide availability of neem trees in northern Cameroon (as compared to Mauritania,

Table 1. Treatments in the Trial I for sorghum stem borer management conducted at Balaza (cv *Safraari*) and Djarengol (cv *Majeeri*).

Treatment	Level 1	Level 2	Level 3	Level 4
Control	C1: No application of any kind at all	C2: 7 foliar sprays of plain water at 30, 45, 60, 75, 90 and 105 days after transplanting (DAT)		
Acetamiprid	A1: 1 foliar spray after transplanting at 50 g ai ha^{-1}	A2: 2 foliar sprays with acetamiprid at 45 and 75 DAT at 50 g ai ha^{-1}	A3: 1 foliar spray after transplanting plus 2 foliar sprays at 45 and 75 DAT at 50 g ai ha^{-1}	
Neem	N1: 1 foliar spray after transplanting at 200 g L^{-1}	N2: 1 foliar spray after transplanting and 2 foliar sprays at 45 and 75 DAT at 200 g L^{-1}	N3: 1 foliar spray after transplanting and 4 foliar sprays at 30, 45, 75 and 105 DAT at 200 g L^{-1}	N4: 1 foliar spray after transplanting and 6 foliar sprays at 30, 45, 60, 75, 90 and 105 DAT at 200 g L^{-1}

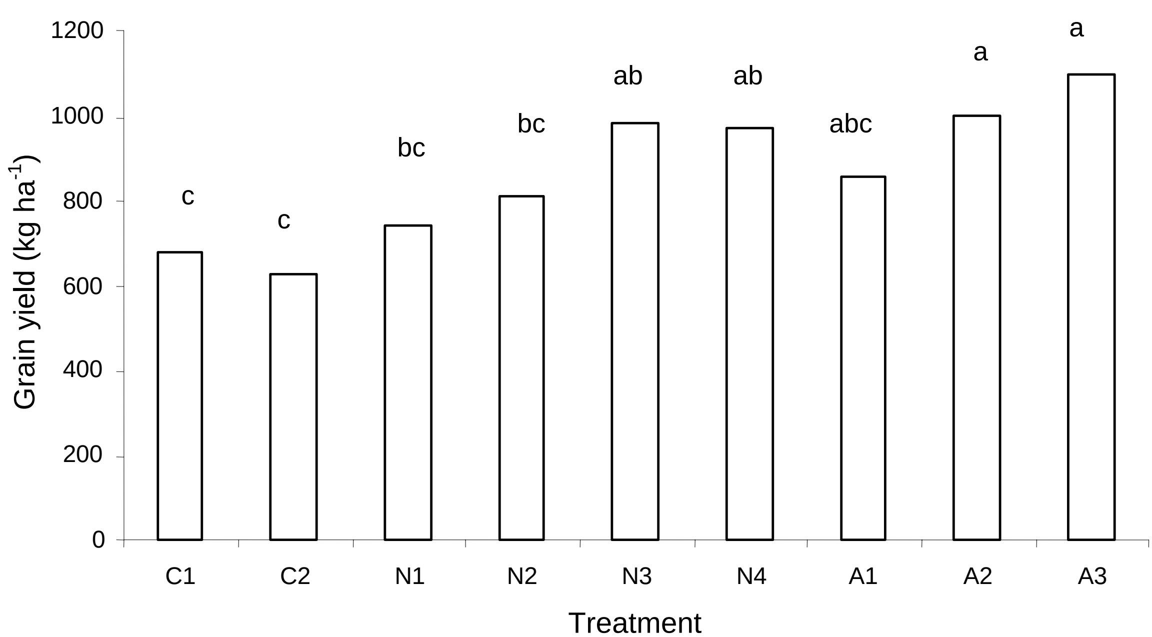

Figure 2. Effect of plant protection against stem borer damage on *muskuwaari* sorghum grain yield (Trial I) (Note: For treatments, see Table 1. Means with the same letter do not differ significantly at LSD test at $P < 0.05$).

Table 2. Stem damage by stem borers and grain yield on acetamiprid-protected vs unprotected *muskuwaari* sorghum (cv *Safraari*) (Trial II)[1].

Insecticidal protection	% damage	Grain yield (kg ha^{-1})
None (control)	60.11 (±1.33) a	675.91 (±396.95) b
Acetamiprid (3 foliar sprays at 50 g ai ha^{-1} after transplanting and 30 and 60 DAT)	13.45 (±0.55) b	1192.88 (±209.69) a

1. Data expressed as mean (±standard deviation).
Means within columns followed by the same letter do not differ significantly at *t* test at P <0.05.
DAT = Days after transplanting.

where they are scarce in stem borer-affected sorghum growing regions) and the likely low adverse environmental impacts of its application vs that of synthetic pesticides, the neem-based technique is probably the "best-bet" option for northern Cameroon. Dry neem extract application in the sorghum whorl, as it is recommended in Mauritania, should also be tested in northern Cameroon. This could save water, which is a scarce resource during the *muskuwaari* growing period, particularly on Vertisol fields remote from villages, and would not require sprayers, that smallholders do not always have access to.

In any case, the evaluation of future pest control and management methods should rely on a better knowledge of *S. cretica* bioecology, of factors influencing the extent of damage (phenology of the plant at the time of damage, water nutrition conditions of the field, distance from rainfed sorghum fields, etc.) and of their interactions. Such references are a prerequisite to orientate control strategies toward integrated pest management (IPM) methods including for instance adjusting insecticide applications to the water reserves of the field, determined from previous cropping season rainfall and soil characteristics, and pest population/damage symptoms thresholds observed at different times during the crop cycle.

Such potential for moderating the level of insecticide application is based on earlier observations that stem borer attacks result in a drastic reduction of grain production mainly when they are combined with water nutrition problems, both stresses being synergistic (Mathieu 2005). On the other hand, a moderate level of stem borer attack can produce more productive tillers, hence a number of panicles and yield per attacked hill higher than for undamaged hills. This compensation can take place under good conditions of water nutrition (eg on modal Vertisol temporarily inundated).

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