Available online at www.sciencedirect.com
ScienceDirect
Crop Protection 25 (2006) 1153–1160
Crop Protection
www.elsevier.com/locate/cropro

Effects of mulch on banana weevil *Cosmopolites sordidus* (Germar) populations and damage in Uganda

C.S. Gold[a,*], S.H. Okech[a,1], B.D. McIntyre[b,2], G. Kagezi[a], P.E. Ragama[a], G. Night[a]

[a]*International Institute of Tropical Agriculture, P.O. Box 7878, Kampala, Uganda*
[b]*National Banana Research Programme, P.O. Box 7065, Kampala, Uganda*

Received 26 August 2005; received in revised form 18 October 2005; accepted 27 October 2005

Abstract

Mulches have been shown to encourage banana weevils, presumably through enhanced water conservation. Some farmers report that leaving the soil at base of the banana mat free of mulch reduces banana weevil damage. Trials were conducted at the Kawanda Agriculture Research Institute and on a farm in Ntungamo District, Uganda to investigate the effect of mulch recessed from the mat versus mulches applied to the base of the banana mat on banana weevil populations, banana weevil damage, plant growth and fruit production. In both trials, banana weevil populations were higher in mulched than in unmulched systems, while damage was greater in mulched systems in Kawanda, but not in Ntungamo. Damage was similar between recessed and full mulched systems in Kawanda, while, contrary to expectation, damage was lower in full than in recessed mulches in Ntungamo. In both sites plants were larger in mulched than in unmulched systems with yield advantages of 18–27%. We conclude that mulching is beneficial for banana production, but that there are no banana weevil management advantages to mulching away from the base of the banana mat.

Keywords: Banana weevil; *Cosmopolites sordidus*; Highland banana; Mulch

1. Introduction

The banana weevil *Cosmopolites sordidus* (Germar) is a key pest on East African highland cooking banana (*Musa* spp., genome group AAA-EA) in Uganda (Gold et al., 2001; Kiggundu et al., 2003). The larvae bore in the corm, damaging the vascular system and weakening the stability of the plant. Banana weevil damage can result in plant loss (death, snapping, toppling), reduced bunch weights, mat failure to sucker and shortened plantation life (Rukazambuga et al., 1998; Gold et al., 2004a). The banana weevil has been a principle factor in the decline and disappearance of highland banana in the crop's traditional growing areas in central Uganda (Gold et al., 1999a).

The biology of the banana weevil has been reviewed by Gold et al. (2001). Its host range is restricted to the genera *Musa* and *Ensete* (Musaceae). The adults are long-lived (commonly >1 year), produce few eggs (1–4 week^{-1}), and are relatively sedentary (few disperse more than 25 m in 6 months). Adults are soil dwelling and most often found around the base of the banana mat or closely associated with crop residues (Gold et al., 2004b). Banana weevils are strongly hydrotrophic and sensitive to desiccation (Cuille, 1950; Delattre, 1980).

Mulching in banana systems is important for providing organic matter to the soil and contributing to soil moisture retention (Tezenas du Montcel, 1987; McIntyre et al., 2000). In an on-station trial, Rukazambuga et al. (2002) found that mulched banana fields out-yielded unmulched banana fields by 39% over four crop cycles. However, improved moisture conservation under mulched systems can help sustain banana weevils, especially during dry seasons. For example, Price (1994) and Rukazambuga et al. (2002) found banana weevil populations to be up to

*Corresponding author. Tel.: +256 41 223445; fax: +256 41 223494.
E-mail address: c.gold@cgiar.org (C.S. Gold).
[1]Current address: Jomo Kenyatta University, P.O. Box 62000, Nairobi, Kenya.
[2]Current address: World Bank, 1818 H St. NW Washington, DC, USA.

0261-2194/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cropro.2005.10.013

2.5 times higher in mulched than in unmulched plots. Rukazambuga et al. (2002) also found yield losses to banana weevil to average 3.4 ton ha^{-1} $crop^{-1}$ cycle in mulched banana fields compared to 1.8 ton ha^{-1} $crop^{-1}$ cycle in unmulched plots. This suggests that the yield advantages in mulched systems reported by Rukazambuga et al. (2002) would have been even greater with effective banana weevil management.

In Uganda, most farmers who apply mulches in banana stands do so up to the base of the banana mat. However, some farmers mulch away from the mat so as not to encourage banana weevils. These farmers report lower banana weevil damage when the base of the mat is left bare. Such anecdotal reports have never been confirmed by controlled studies. Nevertheless, since banana weevils are most commonly found around the base of the mat and because they are extremely sensitive to moisture conditions, we hypothesized that placement of recessed mulches (i.e. >50 cm from the base of the mat) might create less favorable conditions for the banana weevil in its preferred niche.

The objectives of this study were: (1) to compare banana weevil populations and damage in mulched and unmulched plots; and (2) to evaluate the effects of mulch location on plant performance and banana weevil pest status. The research was conducted in an on-station and an on-farm trial. The effects of mulch location on soil water, plant and soil nutrient status, plant growth and fruit production in the on-station trial are reported by McIntyre et al. (2003).

2. Materials and methods

2.1. Site descriptions

An on-station trial on the effects of mulch location on banana weevil populations and damage was conducted at the Kawanda Agricultural Research Institute (0°25′ N., 32°32′ E., 1190 m.a.s.l.), 13 km north of Kampala, Uganda. The site has two rainy seasons (March–May and September–December), with mean annual rainfall of 1250 mm. Average daily temperatures are 15.3 °C (minimum) and 27.3 °C (maximum) and relative humidity 76.3%. Kawanda has 12 h day-length throughout the year. The soil at the site is classified as an isohyperthermic Kandiudalfic Eutrudox (USDA taxonomy) and is derived from schist and phyllite (Yost and Eswaran, 1990) with slopes averaging 3% and pH ranging from 5.9 to 6.3.

A second trial was placed on Mr. Simei Turyaija's farm in Kikoni Parish, Ntungamo District (0°53′ S., 30°16′ E, 1400 m.a.s.l.). The site has two rainy seasons (March–May and September–December). Rainfall data for the Mr. Turyaija's farm were not available although he reports that it is on the upper end for the subcounty (i.e. between 1400 and 1500 mm $year^{-1}$). The soil was a sandy loam.

2.2. Trial 1: on-station trial: Kawanda

2.2.1. Experimental design

Trial 1 included three treatments: (1) *no mulch* (control) consisting of banana plots (cv Nakyetengu, AAA-EA) that were never mulched; (2) *recessed mulch* in which mulch was placed beyond a 1-m radius of the banana mat; and (3) *full mulch* in which mulch was placed up to the base of the banana mat. The three treatments were laid in a randomized complete block design with four replicates. Plots (360 m^2) consisted of 8 rows of 5 mats, spaced in a 3×3 m arrangement. Plots were contiguous (i.e. without alleys), thereby allowing free movement of weevils between treatments and facilitated aggregation in preferred environments.

2.2.2. Planting, management and weevil release

The trial was placed in a field that had earlier supported a banana germplasm screening trial. Thus, it is likely that low to moderate levels of weevils were present in the field at the time of planting. The trial was bordered on two sides by other banana stands that served as additional sources of banana weevil.

Planting was in May 1997, after the field was ploughed and harrowed and 1 month after existing bananas had been uprooted. Banana suckers were collected from existing trials within Kawanda. These were pared to reduce initial weevil and nematode infestation. Suckers showing high levels of pest infestation were rejected. Planting holes were $0.6 \times 0.6 \times 0.6$ m. Replanting for the few suckers that failed was in June.

All treatments received inorganic fertilizer (50, 15, 50 and 12.5 kg ha^{-1} yr^{-1} of N, P, K, and Mg, respectively), applied in a band 0.5 m from the plants. Nitrogen (as urea; 46% N) was added four times a year (at the beginning of the rainy seasons and then again six weeks later); P (as triple superphosphate; 20% P) was added once a year; and K (as muriate of potash; 52% K) and Mg (as magnesium sulfate septahydrate; 9.7% Mg) were added at the beginning of each rainy season.

All plots were weeded manually or sprayed with glyphosate (Roundup) every 1–2 months. Plant density was maintained at 3 plants mat^{-1} by desuckering. Old leaves and pseudostems of harvested plants were removed and left as surface mulch in all treatments including the control.

The residues used for mulching consisted of maize (*Zea mays*) stover and grasses (*Pennisetum purpureum*, *Panicum maximum*, *Imperata cylindrica* and *Brachnia* spp.). Mulch was maintained at depth of 0.05–0.1 m throughout the course of the trial, with additions of approximately 30 Mg ha^{-1} $year^{-1}$. Similar quantities of material were applied to each plot. Therefore, mulches in the recessed mulch were 50% thicker than those in the full mulch plots.

Ten adult banana weevils (5 males and 5 females) were released at the base of each mat (including border rows) at dusk in March 1998 to supplement existing populations in