Proceedings of the International Society of Sugar Cane Technologists, volume 29, 1278-1282, 2016

Management of an isopteran pest, *Coptotermes gestroi,* in the Fiji sugar industry

M Naidu, SN Prakash and BV Padayachi

Sugar Research Institute of Fiji, Drasa, Lautoka, Republic of Fiji Islands; monisha@srif.org.fj

Abstract Sugarcane is the major sugar producing crop in Fiji. However, this crop is now under attack by Asian subterranean termites *Coptotermes gestroi* (AST). After a survey of termite incidence and infestation in three sugarcane sectors, Lautoka, Lovu and Drasa, in 2014, a field trial was designed in an effort to control this emerging pest. Termite colonies are hard to locate due to termite biology. Cellulose bait traps using the sugarcane variety Mana were used to lure the termites. A total of 20 farms with termite infestations were baited. The bait boxes were monitored over a 7-21 day period and incidence was noted. The sugarcane billet bait was changed after 21 days if the cellulose bait trap was not infested by termites. Soil sampling was also carried out in the infested farms to investigate the soil physical and chemical properties. The bait boxes infested with AST were sprayed with Termidor powder (fipronil) and monitored. Termite incidence declined by 78.6% over a 12-month period in the cellulose bait boxes in Lovu Sector, whilst there was a decrease of 66.7% incidence in the Lautoka Sector. Cane yield on farms infested with the pest decreased by an average of 6.0% in 2015, but there may be many causes for this. The use of bait stations to control *Coptotermes gestroi* has been proven successful. However, an integrated pest management for *Coptotermes gestroi* will be initiated with longer-term data collected from this management field experiment.

Key words *Coptotermes gestroi*, fipronil, cellulose bait trap, pest management

INTRODUCTION

Sugarcane has been the dominant agricultural crop in Fiji since 1874 and is of great significance socially, culturally and economically Singh *et al.* (2012). However, this industry is now under attack by termites which are becoming one of the major pests of sugarcane in Fiji. According to the Biosecurity Authority of Fiji (2014), in late 2009 and early 2010 there was an outbreak of Asian subterranean termites in areas of Lautoka causing massive damage to homes and schools and resulting in loss of millions of dollars. The species was identified as *Coptotermes gestroi*, an exotic pest to Fiji that may have been introduced through infested shipping pallets.

Termite infestation in sugarcane fields in Lautoka was reported in 2014 (Ram *et al.* 2015). A preliminary survey conducted by the Sugar Research Institute of Fiji highlighted Asian subterranean termites *Coptotermis gestroi* as the only species of termite infesting the cane fields in Fiji (Ram *et al.* 2015).

The high cellulose content of sugarcane renders it highly vulnerable to termite attack (Jaipal and Chaudhary 2010). Sugarcane crops infested by termites show symptoms of yellowing and drying of outer leaves. The millable canes are tunneled and filled with soil as termites feed on inner tissues leaving the rind intact. Termite soldiers and workers have been noticed in infested sugarcane stalks and germinating setts (Ram *et al.* 2015). According to Alam *et al*. (2012), termite infestation causes 30-60% destruction of buds in germinating setts. Termites excavate through the germinating setts, leading to death of the buds and young shoot (Ram *et al.* 2015; Alam *et al.* 2012). Termite colonies are hard to locate due to their nest biology and the way they source their nutrition (Jones *et al.* 2005).

Termite control in many countries is through chemical methods such as soil treatments, baiting and dusting (Yeoh and Lee 2007). The insecticides used for termite control can be categorised into three groups: organochlorine cyclodienes (now phased out due to being hazardous to human health and environment), pyrethroids (not effective due to their repellency and short residual life in soil), and new termiticides that are considered as non-repellent with a delayed mode of action (Potter and Hillery 2003). Other chemicals recommended for termite management are chlorpyrifos, thiodan, cypermetherin, imidacloprid, fipronil, carbosulfan and triazophos (Ahmed *et al.* 2006). A new termiticide, fipronil (Termidor) is a phenyl pyrazole based chemical that inhibits the functions of the central nervous system. Fipronil also has a delayed action so that contaminated termites maintain normal behaviour over an extended period of time while transferring its lethal effects

to other colony mates through social interactions thus causing secondary mortality (Song and Hu 2006). In Fiji the only chemical available for management of AST is fipronil.

The aim of this research was to test the use of bait stations as barriers to control the infestation of termites in the sugarcane fields of Lautoka and Lovu Sector.

MATERIALS AND METHOD

Field experiments were conducted on farmers' fields infested with AST. Termite bait stations were placed in 20 fields. We used cellulose bait traps to lure the termites. Plastic bait boxes were filled with billets of sugarcane, variety Mana, (10 billets in a box) and placed on the substrate layer of soil on the boundary of the farmers' fields. The bait boxes were monitored over a 7-21 day period and termite incidence was noted. The sugarcane billet bait was changed after 21 days if the cellulose bait trap was not infested by termites. The bait boxes infested with AST were sprayed with 3 g (per box) of Termidor powder (fipronil) and monitored. Samples of termites from the bait boxes were also collected to confirm the species from all infested cellulose bait boxes. The field experiment was conducted over 12 months. Soil sampling was also carried out in the infested farms to investigate the soil physical and chemical properties.

RESULTS AND DISCUSSION

The field experiment proved successful in reducing termite populations in the farmers' fields. We saw a decline of 79% in termite incidence over the 12-month period of cellulose baiting in the Lovu Sector (initial use of 42 g of fipronil to 6 g of fipronil). In the Lautoka Sector there was a decrease of 67% incidence over the same period of cellulose baiting.

Sugarcane billets as cellulose baits were effective as attractants for *Coptotermes gestroi.* Field studies of subterranean termites typically use cellulose bait traps placed on the ground (Su and Scheffranhn 1986). After the termites foraged into the baits, application of fipronil did not deter termite activity. Fipronil is a distinctive non-repellent termiticides. This characteristic is essential because termites are not able to detect the presence of such termiticides in the baits and hence continue foraging through the soil (Yeoh and Lee 2007). Su *et al.* (1982), reported that termiticides are required to be slow acting and non-repellent because of the necrophobic behaviour demonstrated by termites, whereas quick killing of the poisoned termites may give rise to abandonment and sealing of tunnels resulting in untreated zones of healthy colony members (Su *et al.* 1982). Su (2005) also stated that termiticides need to be applied at suitable concentrations so that termites are able to return to their nest for transmission of lethal doses before it causes any effects to the contaminated individuals. Field studies have shown that fipronil has a greater impact on termite populations than organochlorine cyclodienes and pyrethroids and can provide 100% control for more than 10 years (Song and Hu 2006).

No fipronil powder was applied during June-October (Fig. 1), as these are the harvesting months for the Fijian Sugar industry. Fipronil was applied in the other months.

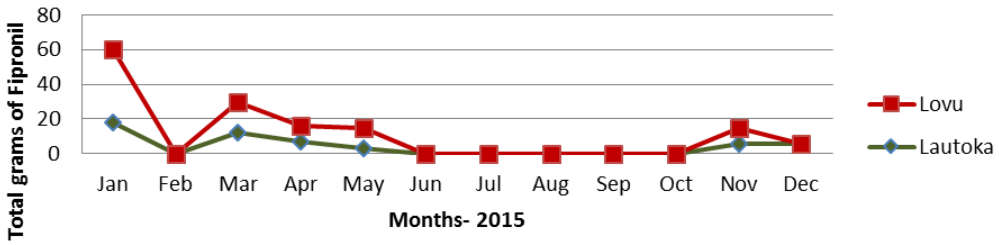

Fig. 1. Amount of fipronil applied in farms in Lautoka and Lovu Sectors.

During the monitoring of the bait boxes, we observed long legged red ants (Hymenoptera: Formicidae). According to Ram *et al.* (2015) these ants can play a significant role as biological control agents of termites.

The yield of cane of the farms infested by AST decreased by an average of 6% in 2015 compared to production of millable cane in 2014 (Fig. 2). This may be due to the long period of drought faced by the sugar industry in the year 2015 and not the impact of the termites. In 2015, only 974 mm of rain was recorded in the Lautoka District compared to an average of 1991 mm per year (average over 46 years 1970-2015; SRIF Met data 2016).

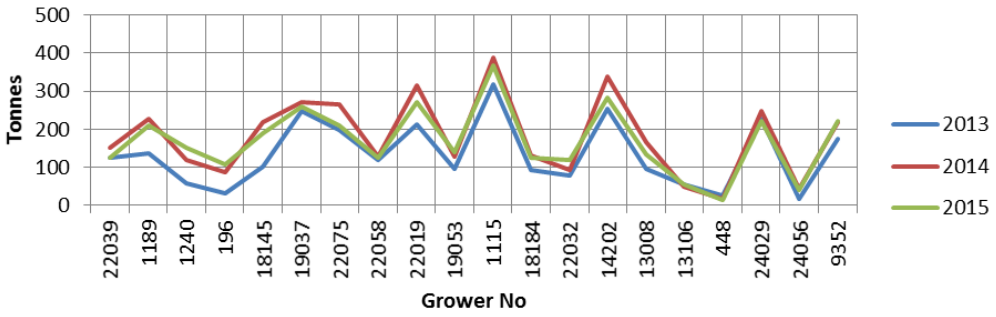

Fig. 2. Production of cane of the infested farms in 2013- 2015.

The most significant change in soil characters was in the pH of the soil. The pH of the fields sampled in this trial ranged from 4.0 to 7.0, while for the same field in 2014 (Ram *et al.* 2015) pH ranged from 3.4 to 6.9 (Fig. 3).

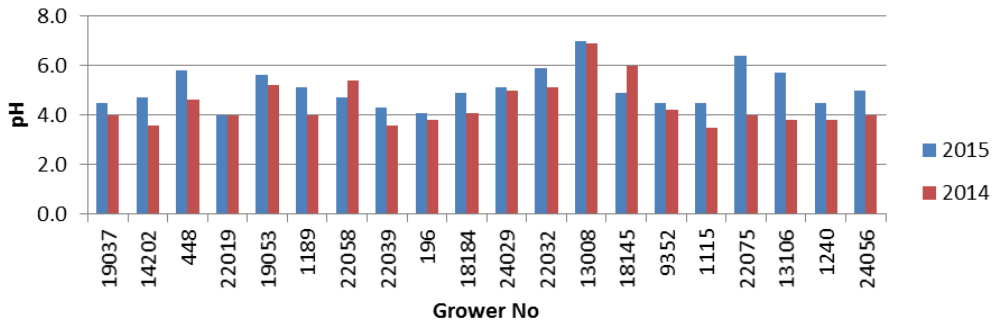

Fig. 3. Comparison of soil pH of fields in years 2014 and 2015.

CONCLUSION

The use of Fipronil powder to control the pest *Coptotermes gestroi* has proven successful. Our results indicate that cellulose bait stations can be used as barriers in farmers' fields. However, an integrated pest management for *Coptotermes gestroi* will need to be developed using the data collected from this management field experiment.

ACKNOWLEGMENT

We thank Ms Nazeea Bano, Ms Doreen Pillay and Ms Merlyn Goundar and support staff of SRIF for contributions to the Termite Project.

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Gestion d'un ravageur termite, *Coptotermes gestroi* (Isoptera) dans l'industrie sucrière des Fidji

Résumé. La canne à sucre est la production la plus importante aux Fidji. Cependant, cette culture est maintenant confrontée à l'attaque des termites asiatiques du sous-sol *Coptotermes gestroi* (AST). Après un suivi de l'incidence de ces termites et leur infestation dans trois secteurs de canne à sucre: Lautoka, Lovu et Drasa, en 2004, un essai au champ a été mis en place pour tenter de contrôler ce ravageur émergent. Les colonies de termites sont difficiles à localiser, ceci étant dû à leur biologie. Les pièges appâtés en cellulose utilisant la variété Mana ont été utilisés pour attirer les termites. Un total de 20 exploitations avec des infestations de termites ont été choisies pour tester ce piège. Les boîtes d'appâts ainsi placées ont été suivies sur une période de 7 à 20 jours et l'incidence a été notée. Le piège appâté a été changé après 21 jours si la cellulose du piège n'était pas attaquée par les termites. Des échantillons de sol ont également été prélevés dans les fermes infestées pour mieux connaître les propriétés chimiques et physiques des sols. Les boîtes appâtés infestées de termites ont été traitées avec de la poudre Termidor (Fipronil) et surveillées. L'incidence des termites a diminué de 78.6% sur une période de 12 mois dans les boîtes de cellulose munis d'un appât dans le secteur de Lovu, alors qu'il y avait une réduction de 66.7% de l'incidence dans le secteur de Lautoka. Le rendement en canne des fermes attaquées par les termites avait diminué de 6% en 2015, mais il peut y avoir aussi plusieurs autres causes. L'utilisation des postes de pièges appâtés pour contrôler *Coptotermes gestroi* s'est avéré être un succès. Cependant, une gestion intégrée de *Coptotermes gestroi* sera initié avec le prélèvement de données sur le long terme à partir des expérimentations au champ.

Mots-clés: *Coptotermes gestroi*, fipronil, pièges-appâts en cellulose, gestion des ravageurs

Manejos de los isópteros plaga, *Coptotermes gestroi*, en la industria azucarera de Fiji

Resumen. La caña de azúcar es el principal cultivo productor de azúcar en Fiji. Sin embargo, este cultivo se encuentra bajo el ataque de las termitas asiáticas subterráneas *Coptotermes gestroi* (AST). Luego de un estudio de la incidencia de las termitas y la infestación en tres localidades de caña de azúcar, Lautoka, Lovu y Drasa, en 2014, un ensayo de campo fue diseñado en un esfuerzo por controlar esta plaga emergente. Las colonias de termitas son difíciles de localizar debido a la biología de las termitas. Se utilizaron las trampas de celulosa para atraer a las termitas utilizando como cebo la variedad de caña de azúcar Mana. Las trampas se colocaron en 20 fincas infestadas con termitas. Las mismas fueron monitoreadas durante un período de 7-21 días y se observó la incidencia. Las pilas de caña

de azúcar utilizadas como cebo fueron cambiadas a los 21 días sí la trampa de cebo de celulosa no estaba infestado por las termitas. El muestreo del suelo también se llevó a cabo en las fincas infestadas para investigar las propiedades físicas y químicas del suelo. Las pilas de cebo infestadas con AST fueron monitoreadas y rociadas con polvo de Termidor (fipronil). La incidencia de las termitas se redujo en un 78,6% durante un período de 12 meses en las pilas de cebo de celulosa en Lovu, mientras que hubo una disminución de la incidencia de 66,7% en Lautoka. El rendimiento de la caña en las fincas infectadas con la plaga disminuyó en un promedio de 6,0% en 2015, pero puede haber muchas causas para esto. Se probó con éxito el uso de estaciones de cebo para controlar *Coptotermes gestroi*. Sin embargo, un manejo integrado de la plaga para *Coptotermes gestroi* se iniciará a más largo plazo con los datos colectados de los campos manejados experimentalmente.

Palabras clave: *Coptotermes gestroi*, fipronil, tampas de cebo de celulasa, manejo de plagas