CHAPTER THREE

Control of armoured bush cricket, *Acanthoplus discoidalis* (Walker), (Orthoptera: Hetrodinae) by means of the carbaryl bran baited-trench method.

ABSTRACT

A technique was developed to use baited trenches for the management of armoured bush crickets (ABC), *Acanthoplus discoidalis,* in subsistence farming systems in Botswana. Field experiments were conducted to determine the most efficient trench depths as well as the effect of maize bran and insecticide bait presented inside trenches on efficacy of trenches to control crickets. Optimum trench depth was determined by evaluating cricket retention rates at depths of 200 mm, 300 mm and 500 mm. The highest number of crickets was retained at the maximum trench depth tested of 500 mm. Significantly higher numbers of crickets were retained at 300 mm than at 200 mm. The effect of maize bran inside trenches on retention rate was evaluated by placing small amounts of maize bran at 3 m intervals inside trenches. The availability of maize bran alone inside trenches reduced the effectiveness of trenches. If small amounts of carbaryl/maize bran bait (2.5g a. i. kg^{-1}) are placed inside the trench, the trapped crickets ingest bait and later die. Adding moistened carbaryl bran bait increased ABC mortality significantly for all trench depths tested. This effect was most dramatic for the 300 mm (intermediate) trench depth, where cricket retention after 24 hours improved from 55 % to 93 %. The trapped crickets subsequently died. The baited trench was equally effective against male and female ABC. Behavioural observations suggest that trapped crickets struggle vigorously to escape from the trench for up to three hours. The 0.3 % carbaryl bran baited trench method provided an economical technique for use by small scale, resource poor farmers to control ABC with reduced costs and impact on the environment.

Key words: *Acanthoplus discoidalis*, baited-trench, Botswana, carbaryl 85 WP bait.

INTRODUCTION

Armoured bush crickets (ABC), *Acanthoplus discoidalis* (Walker), belong to the order Orthoptera, family Tettigoniidae, subfamily Hetrodinae. Members of this subfamily are endemic to Africa (Rentz 1978, 1979; Skaife 1979; De Villiers 1989). ABC are agricultural pests occurring in low - altitude areas (400 - 800 m) of Southern Africa, where there is annual summer rainfall up to 700 mm with a long distinctly, hot, growing season (Leuschner 1990; Mbata 1992). ABC are omnivorous insects that feed on a variety of plants and damage crops including maize, sorghum and pearl millet as well as cowpeas and sunflower. In addition, ABC are opportunistic scavengers, consuming carrion and even cannibalising their own species.

Application of insecticides has been the main method used to control ABC. However, resource-poor farmers in Botswana, as elsewhere, have little income to spend on insecticides, which are perceived as expensive and hazardous (Matsaert *et al.* 2000). This has prompted a search for more affordable and simpler implemented strategies to control the ABC.

ABC typically invade crop fields from the surrounding shrubs at around the time of cereal panicle emergence. Since crickets enter farmers' fields at a predictable time (when panicles become available) and at predictable locations (field margins bordering the scrub), the opportunity exists for farmers to prepare control in advance. Trenching at field boundaries is one cultural method, which, with prior preparation, could be used to limit the number of ABC that invade crops. Some success using trenches against ABC was reported by Musonda & Leuschner (1990) and Minja (2000) in Zambia. These authors indicated that trenching held promise as a control method. Trenches were used in the past during locust control operations to control hopper bands in subsistence farmers' fields (Jack 1934). Hoppers collected in these trenches were readily destroyed, but the trenches required attention to keep in repair so that trapped hoppers could not escape (De Groot 1995). A few farmers in Botswana are reported to dig ditches around their fields to trap ABC that cross field margins to invade crop fields (Matsaert *et al.* 2000). Trapped ABC may die from cannibalism or drowning if there is rain (Matsaert *et al.* 2000).

The effectiveness of trenching, as currently practiced for control of ABC, has potential for improvement. The optimal depth and methods for killing of the trapped ABC have not been previously evaluated. The principal purpose of the present study was hence to determine the optimum trench depth required and to determine the retention time. The effects of carbaryl bran bait application on cricket survival in trenches were also studied.

MATERIALS AND METHODS

Determination of effective trench depth

Three trench depths, 200, 300 and 500 mm, were evaluated in this study. Vertical-sided 300 mm wide trenches were manually excavated in a sorghum field with uniform soil type (Figs. 3.1 & 3.2).

Trenches at these different depths were constructed using a pick and a spade around the perimeters of three plots of 4 m x 3 m, providing a trial plot of 12 m^2 in each case, on which crickets were subsequently to be released. These plots were cleared of any crop residues or other material that could be consumed by ABC. The trenches were constructed adjacent to fields of flowering sorghum, separated by a buffer distance of 75 cm to prevent ABC from climbing out using overhanging leaves or stems. This close proximity to sorghum provided an attractive potential food source that induced the crickets to approach and fall into the trenches in an attempt to invade the sorghum fields.

The effect of including maize bran alone and carbaryl bran bait inside the trench was also investigated. Three treatments were compared: 1) trench only, 2) maize bran alone and 3) carbaryl bran bait mix. Carbaryl bran bait was mixed with bran at 2.5 g a. i. kg^{-1} of bran to prepare a 0.3 % bran bait for treatment 3. In treatments 2 and 3, the maize bran and the bait respectively, were applied in 4 g heaps every 3 m at the bottom of the trench.

A total of 36 adult crickets (1:1 sex ratio) were used in each of five replicates for each trench depth. Prior to release, the insects were starved inside plastic baskets for six hours in the laboratory to ensure that hungry crickets were used. They were then released on the trial plots by turning the plastic baskets upside down and allowing the crickets to crawl out. The ABC density in the release area was three insects per square metre, a cricket density normally observed under field conditions during an outbreak. The experiment was replicated three times.

The number of trapped crickets and the number of crickets still on the plot were recorded for each trench depth 24 hours after the release of the insects. A preliminary observation in this study showed that 24 hours post release, trapped crickets had completely stopped struggling to escape from the trench.

Trapping success of the baited trench over time

A study was conducted to determine the ABC escape rate from the 300 mm deep baited-trench over a 24 hours period. Carbaryl 85 WP was mixed with maize bran at 2.5 g a. i. kg^{-1} of bran to prepare a 0.3 % carbaryl bran bait to be placed in the trench. A total of 108 (1:1 sex ratio) crickets were released in the trench in three groups (replicates) of 36. The numbers of crickets, which successfully climbed out of the trench, were recorded at three hours intervals over a 24 hours period. Escape rates were similarly monitored during the night and the day over 12 hours period. The sexes of crickets that remained trapped in the trench were also recorded.

Statistical methods

Analysis of variance was carried out on retention rates at different trench depths using GLM procedure of SAS. Difference in retention for different times of the day and between cricket sexes were determined using t-tests.

RESULTS

Determination of effective trench depth

Significant differences in ABC retention rates were observed when comparing the numbers of crickets retained after 24 hours in the three trench depths (Fig. 3.3: F value = 69.24, df =2, Pr > = 0.001). The 500 mm trench gave the highest retention level followed by the 300 mm trench depth and then the 200 mm depth.

When maize bran was added to trenches, the trend of increased cricket retention with trench depth was still observed, but retention rates were significantly lower than when no food was provided (Fig. 3.4). The crickets settled to feed on the maize bran and subsequently climbed out.

When carbaryl baits were deployed inside trenches, ABC retention rates increased significantly for all three trench depths tested (Fig. 3.5). Similar, high retention rates (> 90 %) were observed in the 300 mm and 500 mm baited trenches. ABC retention rates did not differ significantly between these two depths, but both provided significantly better retention over 24 hours than the 200 mm deep baited trench. The improvement in cricket retention with the addition of carbaryl bran bait was particularly marked in the 300 mm deep trench, with retention after 24 hours rising from 55 % to 93 % (Fig. 3.5). The trapped crickets subsequently died as a result of feeding on the carbaryl bran bait. The statistical summary of the effect of carbaryl bran bait or no bait on trenching is shown in Table 3.1.

Trapping success of the baited trench over time

Observations from the study on ABC escape rates from baited trenches indicated that ABC make vigorous attempts to climb out of the trench close to the point of entry during the first three hours after falling in. The escape rate is greatly reduced after this time because crickets then walked along the trench and fed on the bait (Fig. 3.6). No crickets escaped after nine hours, indicating exhaustion or death.

Similar numbers of male and female crickets were trapped and retained in the baited trench at night (45 % male: 55 % female) and during the day (50:50). No difference was detected in a t-test comparing the numbers of males and females trapped in the 300 mm trench (df. =1, $t = 0.1629$, $P > 0.05$). Baited-trenches were effective in retaining crickets and the escape rate decreased between 0 – 6 hours and then levels off (Fig. 3.6).

DISCUSSION

Trenches without insecticide

Trench-based methods for control of ABC depend on the interception and retention of invading ABC at the field perimeter. The present study set out to establish the most effective trench depth and then also tested the effect of bait application in trenches on cricket retention. Of the methods tested here, the 300 mm deep baited trench provided the most practical method (in terms of ABC retention and labour input) for control of ABC. Construction of trenches deeper than the 300 mm require a substantial increase in labour, which many farmers would find a disincentive. Although a retention rate of 55 % after 24 hours was obtained with the 300 mm deep trench alone, further studies showed that by placing small quantities of insecticide bait in the trench increased the retention rate to

93 %.

The finding that an unbaited 500 mm deep trench had a 78 % cricket retention rate over 24 hours is also an important finding, since some farmers in Botswana are unwilling to use any pesticides but may be prepared to dig deeper trenches to protect their crops. The reduction in cricket retention rate when food was provided in unbaited trenches may be explained by that when crickets have access to edible material, they may benefit from feeding and escape from the trench. Therefore, if farmers deploy unbaited trenches, they should be maintained and cleared of any potential food to reduce cricket escaping. Since the ABC is omnivorous, any edible material such as plant material, dead crickets, roots and leaves inside the trench or hanging closely above the trench should be removed when the trench is in use.

Reduced escape rates of ABC with time is an indication that if trenches are properly constructed and maintained fewer crickets will cross into the crops. Most crickets will remain in the trench and seeing dead ABC in the trench is likely to boost farmer motivation during control campaigns. In fact, the LUBILOSA grasshopper control project in Sahelian West Africa found that evidence of dead grasshoppers in treated areas was of much greater interest to farmers than reduction in overall grasshopper numbers baited with insecticide (Stonehouse *et al*. 1997).

Trenches with insecticide

The results of these on-station trials suggest that the baited trench method is potentially an effective strategy for resource poor farmers to use in the control of ABC, offering substantial environmental and economic benefits compared to other application. The crop itself remains untreated and natural enemies of ABC and other pests are conserved. The impact of this control method on non-targets is evaluated in Chapter 6. The overall amount of pesticides used in ABC control by the baited trench method is clearly much less than would be used in conventional cover spraying or widespread baiting, making it more cost-efficient. Calculations made based on cost of carbaryl 85 WP (Karbaspray®) (US $ 0.08 per gram of a.i. in Botswana), have shown that the carbaryl baited trench method would cost US $ 17.92/ha, whereas full cover baiting will cost US $ 72.00/ha and full cover spraying US $ 84.00/ha. Costs are only based on the cost of the insecticide and exclude trench construction and application costs. Control by baited-trench will thus cost 75 % less than full cover baiting and 79 % less than full cover spraying. Labour costs are, however, likely to be significant if trenches are extensive. The prospects for integrating this method with other cultural, biological and chemical control methods against ABC appear good.

Farmers should be motivated to utilize baited-trenches where possible because of the difficulties in trying to control ABC by other methods. Wohlleber *et al.* (1996) reported poor efficacy in surface baiting of ABC because crickets would just by-pass the bait and head for the crops. Baited-trench methods provide crickets with no other food choice other than the bait once they are trapped inside the trenches. Because of the investment in labour and time involved, the strategic deployment of trenches in locations where they will have the greatest impact is critical to success. Farmers therefore need to scout for high nymphal densities in December and January, and then construct trenches around their fields at the end of the ploughing period, set by the Botswana government at January 31st in the southern part of Botswana and February 14th in the northern part of the country. Insecticide baits should be placed inside trenches only when the first invading ABC are noticed.

The main constraint on farmer up-take of the technique would appear to be shortage of labour to construct the trenches. In addressing the high labour demands required in constructing trenches, preliminary studies have been conducted to develop a mechanical trench digger suitable for use by resource poor farmers.

REFERENCES

BASHIR, E.A., BINEY, H., ISLAM, S.S. & PATHAK, V. K. 1991. Extensive national surveys for the detection, identification and assessment of major pests and diseases of cereal and horticultural crops. UNDP/FAO-Plant protection project (BOT/88/04). Technical Report No.5. Gaborone, Botswana. 44 pp.

DE GROOT, A.A. 1995. The functioning and sustainability of village crop protection brigades in Niger. *Journal of Pest Management* **41:** 243 - 248.

DE VILLIERS, W.M. 1989. Suborder Ensifera. In: Insects of Southern Africa. Scholtz, C.H. & Holm, E. (Editors). Butterworths, Durban, South Africa. pp. 80 – 86.

INGRAM, W.R., IRVING, N.S. & ROOME, R.E. 1973. A handbook on control of agricultural pests in Botswana. Printed by government printer, Gaborone, Botswana. 129 pp.

JACK, R.W. 1934. The destruction and control of locust hoppers. Bulletin No. 938. Issued by authority of the minister of agriculture. Salisbury, Rhodesia.

LEUSCHNER, K. 1990. Insect Pests of Sorghum Panicles in Eastern and Southern Africa. Pages 49 – 56 In: Panicle insects pests of sorghum and pearl millet: Proceedings of an International Consultative Workshop, 4 – 7 October, 1993, ICRISAT Sahel Center, Niamey, Niger (Nwanze, K. F., and Youm, 0. (Eds.) Patancheru 502324, Andhra Pradesh, India: International Crop Research Institute for the Semi Arid Tropics.

MANTHE, C.S. 2000. Cereal insect pests (sorghum, maize and millet). In: Field crops reference handbook in Botswana. pp. 34 - 37. Manthe-Tsuaneng and G.S. Maphanyane (editors). Gaborone, Botswana. 56 pp.

MATSAERT, H., MOSUPI, P.O.P., MVIHA, P.J.V., GREEN, S.V. & MINJA, E.M. 2000. Survey of farmers' indigenous knowledge and control practices against armoured bush cricket (Setotojane) in Central and Francistown agricultural regions of Botswana, April 2000. Department of Agricultural Research, Gaborone, Botswana, 21 pp.

MBATA, K. J. 1992. The biology and host plant specificity of *Acanthoplus speiseri* Brancsik (Orthoptera: Tettigoniidae: Hetrodinae), a pest of grain crops. *Journal of Entomological Society of Southern Africa* **55**: 99 - 106.

MINJA, E.M. 2000. Management of armoured bush cricket in Namibia and Zambia: Farmers' methods. In: Management of sorghum and pearl millet pests in SADC region. ICRISAT. Minja, E.M. & Van den Berg, J. (editors). Matopos research station, Zimbabwe.

MUSONDA, E. M. & LEUSCHNER, K. 1990. Biology and Control of the armoured cricket. pp. 230 – 243. In: Proceeding of the sixth regional workshop on sorghum and millets for Southern Africa. *18 - 22,* Sep *1989,* Bulawayo, Zimbabwe. P.O. Box *776,* Bulawayo, Zimbabwe: SADC/ICRISAT Sorghum and Millet Improvement Program.

POWER, J. H. 1958. On the biology of *Acanthoplus bechuanas* Per. (Orthoptera: Tettigoniidae). *Journal of the Entomological Society of Southern Africa* **21**:1 61 - 168.

RENTZ, D.C.F. 1978. Orthoptera. In: Biology and ecology of Southern Africa. Ed. L.A. Werger. Vol. 2. Junk W. Dr. Publishers, The Hague, pp. 733 - 746.

RENTZ, D.C.F. 1979. Comments on the classification of the Orthopteran family, Tettigoniidae, with a key to the subfamilies and description of two new subfamilies. *Australian Journal of Zoology* **27**: 991 - 1043.

SKAIFE, S.H. 1979. *African Insect Life.* 2nd Edn. Longmans and Green Company, London.

STONEHOUSE, J.M., GBONGBOUI, C., de GROOT, A., LOMER, C., LY, S., MAIGA, I. and TIJANI. 1997. Grasshopper control in the Sahel: Farmer perceptions and participation. *Crop Protection* **16**(8): 733-741.

WOHLLEBER, B. 1996. First Results of Research on the armoured ground cricket *(Acanthoplus discoidalis)* on Pearl Millet in Namibia: Population dynamics, Biology and Control. pp 163 -172 In: Drought tolerant crops of Southern Africa: Proceedings of the SADC/ICRISAT Regional and Pearl Millet Workshop, 25 – 29 July 1994, Gaborone, Botswana (Eds. Leuschner K. and Manthe, C. S).

WOHLLEBER, B. 2000. Research on armoured bush cricket (*Acanthoplus discoidalis*) management on pearl millet in Namibia. . pp. 63-81. In: Minja, E.M. and Van den Berg (eds.): Proceedings of the workshop on management of sorghum and pearl millet pests in the SADC region, 10-13 February 1998, Matopos Research Station, Zimbabwe: ICRISAT.

WOHLLEBER, B., SCHMUTTERER, H., LEUSCHNER, K. & EKANDJO, S.T. 1996. Armoured bush cricket (*Acanthoplus discoidalis*) - population dynamics, biology and control on pearl millet. MAWRD Pest Control Workshop, Windhoek, Sept 1996.

1:0.7

Fig 3. 1. Manual trench construction in progress.

1:0.56

Fig 3.2. ABC trapped in a 300 mm deep trench 24 hours post their release.

Table 3.1 Summary of GLM procedure for transformed data, for trench with food or bait

Source	df	Type SS	Mean squares	F value	P > F
Trench depth	2	4.74	2.34	69.24	0.0001
Treatment [food: No food: Bait]	2	1.64	0.82	23.97	0.0001
Interaction					
Trench size * Food type	4	0.084	0.021	0.62	0.6532

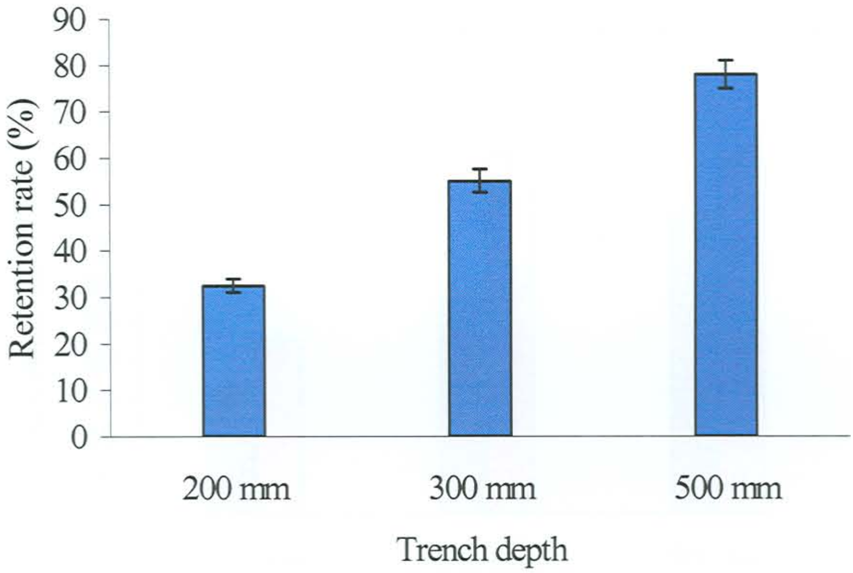

Fig. 3.3. The effect of trench depth on retention rate over 24 hours of trenches for trapping armoured bush crickets. Bars represent standard error (SE). All trenches were 300 mm wide.

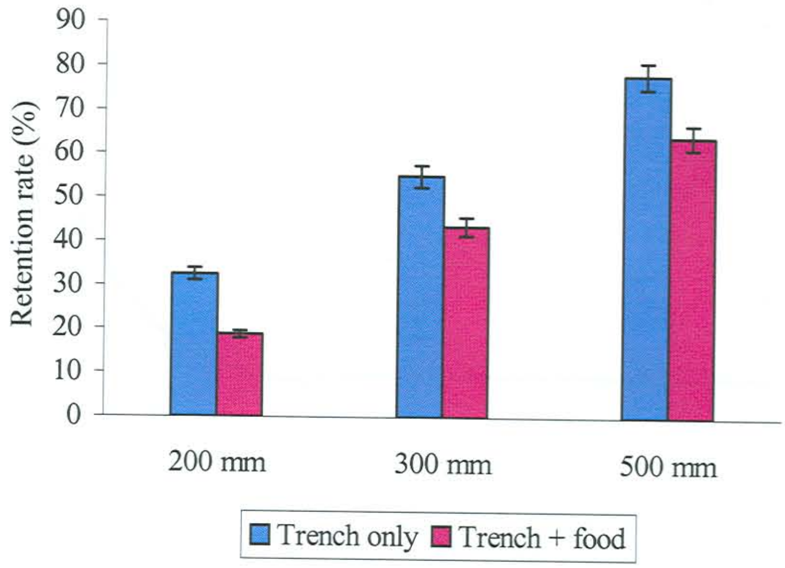

Fig. 3.4. The effect of food material on retention rates of different trench depths for trapping of armoured bush crickets. Bars represent standard error (SE).

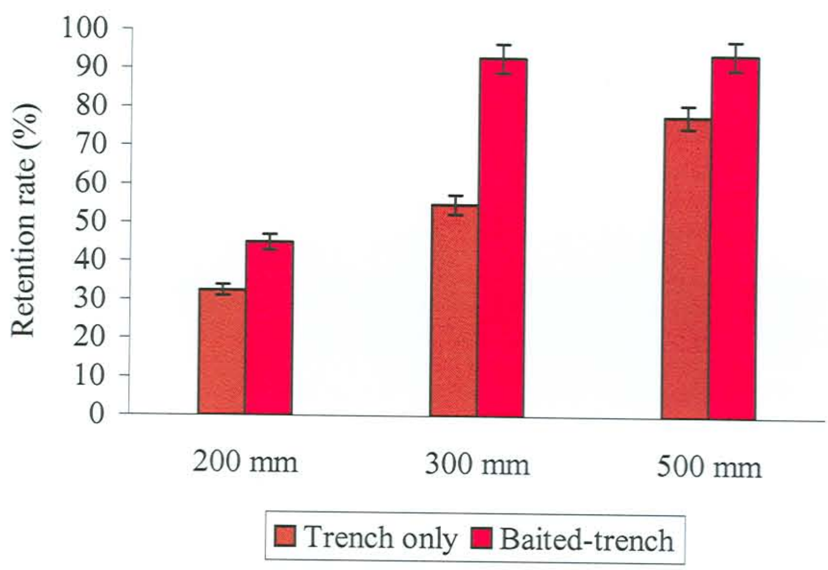

Fig. 3.5. The effect of different trench depths with or without carbaryl bait for trapping of armoured bush crickets. Bars represent standard error (SE).

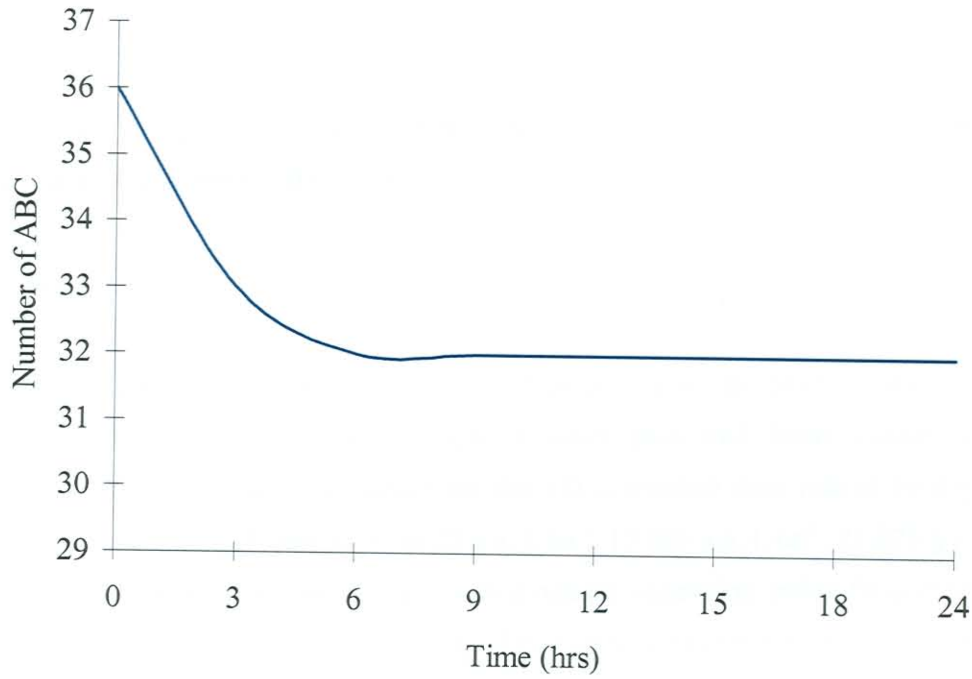

Fig. 3.6. Escape rate of armoured bush cricket from a 300 mm un-baited trench over a 24 hours period.