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Evaluation of the Exterra Baiting System for the Management of *Microcerotermes diversus* in Baghdad Date Palm Orchards

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Abstract
Microcerotermes diversus (Silvestri) is a termite species responsible for the destruction of date palm orchards in Baghdad, Iraq. The trees are left unhealthy with low yields. This experiment was conducted to evaluate and determine the effectiveness of Exterra Baiting System comprising an insect growth regulator-chlorfluazuron in controlling termites under local field conditions. The study area comprised a date palm orchard at Abu Ghraib District containing 163 palms aged between 15-22 years old whereby all infested trees were installed with baiting stations which were monitored every 21-30 days within a period of 48 weeks checking on severity of infestation, termite activity as well as recovery of palms. In the first six weeks there was no change in levels of infestation but starting from ninth week up to thirty fifth week when finally all the palms(100%)recovered different degrees declining trends were observed. McNemar's test showed a highly significant difference, ($\chi^2 = 158.0$, df = 1, $p < 0.0001$), between the infestation status before and after treatment with an absolute risk reduction of 96.93%. This result supports that Exterra is significantly effective in killing termite colonies within one growing season. The baiting method attains by eliminating colonies which ensure safe-and long-lasting alternative compared to reinfestation traditional insecticide applications! Termite management strategy potential implementation emphasized study Iraq similar environments Date Palm incorporating Exterra Baiting System.
Keywords: Microcerotermes diversus, Exter

Introduction

Termites are known for their wood feeding habits. They become a big menace to agriculture due to their hunger, which can only be satisfied by consuming cellulose materials of economic plants and infrastructural elements supporting these activities. (Rust & Su, 2012) In the warm climates of the world they are regarded as the principal structural pest with an annual repair bill in excess of $40 billion,(Su, 2019) Baghdad's situation is reflective of this global problem wherein its date palm orchards that form a substantial part of its economy is under constant threat from this pest whereby infestation in most cases go undetected at earlier stages due to development o subterranean mud tubes on fronds feeding on tissues before visible symptoms appear making it more susceptible secondary pests an diseases besides general weakening . Because o f its importance different researchers have tried various management options building n successful ones implemented elsewhere globally. One of the systems is the Exterra Baiting System. This is a new method which depends on termite behavior while foraging to detect their colonies at an early stage and prevent colony development (Chouvenc & Su, 2017). The present study is the first attempt to evaluate the effectiveness of such a unique system under Baghdad's specific environmental conditions aimed at filling a large knowledge gap besides providing practical field-oriented solutions. The system uses chlorfluazuron as an insect growth regulator (IGR) for controlling and eliminating pest colonies. Three monitoring stations per tree shall be installed in date palm orchards forming triangles around each tree. This includes external trunk stations which are to target active infestations together with soil stations at 3-5 m as a preventive installation in young plantations. The objective of this study was to test the effectiveness of the Exterra system in protection Baghdad's date palm orchards from Microcerotermes diversus.

Materials and Methods

Exterra Baiting System of Ensystex, Australia was used for detection and control management of termite colonies (Su, 2019). The system has two types of stations:

1. In-ground stations are partially buried in the soil around the palm tree bole to allow termite entry from the soil. The stations contain wooden inserts and if infestation is detected during subsequent inspections, then the bait is placed.
2. Above-ground stations are installed directly on the trunk of the infested palm trees where termite workers have been observed. (Chouvenc & Su, 2017).

The stations were equipped with cellulose-based bait; insect growth regulator(IGr) chlorfluazuron chitin synthesis inhibitor is applied-as explained by Huang et al.,2020 and Yeoh & Lee,2007 inability to complete molting gradually collapses the whole colony because no new nymphs can develop into adults-this method totally eliminates colonies together with queens disrupting colony structure without dependence on massive amounts of conventional pesticides(Rust&Su,2012).

Station placement

Stations were established on March 29, 2024, for all infested palms to ensure uniform experimental conditions. One station per infested palm tree made a total of 158 stations in 158 palms. The stations were installed above the areas with termite workers on trunks at visible feeding sites using two-inch screws for firm attachment. A layer of clay was applied around the perimeter of each station to seal gaps between the station and trunk.

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Bait Placement

Right after the installation, a standard quantity of cellulose bait treated with chlorfluazuron was placed in each station. This will make sure that the workers get fed quickly because it has been observed that Exterra above-ground stations become active immediately upon installation due to their direct access to workers.

Infestation Severity Assessment

Infestation severity was assessed based on field criteria which included:

a) Bait consumption at the time of periodic checks
b) Number of workers inside the feeding stations
c) Presence or absence of mud tunnels on the trunks
d) Degree of erosion in wood tissues by feeding
e) General condition of the tree in vigor and productivity of fruits.

The apparent damage, in three classes as low, medium, and high, rated infestation severity within visible extent,

Periodic Monitoring

The monitoring was conducted at an interval of 21 to 30 days throughout the experimental period and included:

a) recording consumption of bait at each station.
b) assessment of level(lows, medium, high).
c) counting a number of worker termites in the colony,
d) observation for dead individuals inside stations if any,
e) replenishing bait in case it was partially or completely consumed and
f) recording changes in infested trees regarding improved growth and reduced symptoms of diseases.

Continuation until Recovery

The treatment continued up to the time when there was no more activity in the installed stations. A palm was considered recovered when termites were no longer detected in the station installed on it.

Results

Before Exterra baiting, 158 out of 163 palms were infested by Microcerotermes diversus (Silvestri) 96.93% (95%CI: 93.02-98.68%), and five were not infested (3.07%). The severity of infestation can be judged by the quantity of bait consumed during the period of treatment which is directly related to the number of workers found in the stations.

Infestation Progress During the Experimental Period

For the first six weeks,158 trees remained infested and five others uninfested. Only at certain stations was there a marked decline in the number of termite workers being recorded. From week nine, June 2024, for the first time since monitoring began ,the number of infested trees declined to 122 while 41 more trees were healthy .The numbers continued declining/increasing respectively until by week 45(April19,2025) all 163 trees were healthy thus fully eliminating the infestation Monitoring of the stations continued up to end study period48weeks with no new infestations recorded after week35.

Table 1. Weekly progress of infested and healthy date palms following the application of the Exterra Baiting System.

Week	*Number of Infested Trees*	*Number of Healthy Trees*	*Cumulative Recovery (%)*
1	158	5	0%
6	158	5	0%
9	122	41	5.5%
15	93	70	32.5%
28	12	151	63.2%
35	0	163	100%
48	0	163	100%

McNemar's test showed a highly significant difference between the condition of palm trees before and after intervention ($\chi^2 = 158.0$, df =1, $p < 0.0001$). The absolute risk reduction (ARR) was 96.93% which means that the baiting system was highly effective in eliminating infestation during the monitoring period.

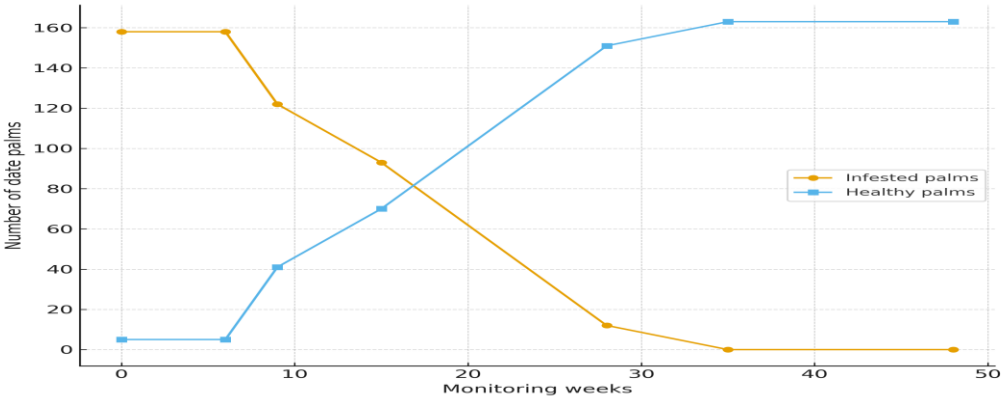

Figure 1. Trend of termite infestation decline, and recovery of date palms treated with the Exterra Baiting System in Baghdad orchards.

Discussion

The results obtained ensure to prove Exterra as a highly effective system in the control of termite infestation within one growing season in date palm orchards. All trees recovered fully by week 35,100% recovery (Figure 4). Infestation persistence at weeks twelve can be attributed to the time taken for bait discovery and consumption and transfer among colony members-horizontally; besides this is another factor related physiologically with the active ingredient whose action delays on chitin synthesis inhibition mode of action disrupts molting process nymphal stages into adults development collapsing finally the whole colony such delayed yet progressive response happens characteristic type based biological control systems against social insects(Su,2019 ;BioOne ,2024) .A gradual consistent decrease was noticed after this initial latency period up healthy increasing number tree. This trend shows the efficient spread of toxicant among termite colonies and supports the concept

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of colony suppression capacity at a baiting system, instead of only apparent individual reduction (Umar & Majid 2020; Chouvenc & Su 2015). Compared to conventional termite control methods such as soil drenches or trunk injection and surface spraying, several other advantages can be noted regarding the Exterra baiting system. One major advantage is that it conserves date palm productivity without any chemical contamination within plant tissues since foraging workers are attracted to fixed bait stations rather than feeding on structural parts of palms (Su & Scheffrahn 2016). The environmental safety aspect involves reducing pesticide exposure in soil and groundwater plus non-target organisms all over areas covered by pesticides where termites exist(Yeoh&Lee2007). The system also enables long-term population suppression because new colonies cannot be quickly formed since reproductive are killed before they can successfully disperse and start a new colony. An interesting observation that needs further study is that when termite queens consume the bait, it seems to result in the laying of non-viable eggs without proper chorionic development-eggs which will not produce larvae or brood for renewal of the colony. Another practical advantage with Exterra is that sometimes within one day after installing stations, termites have been detected thus giving an opportunity for early intervention as well as good monitoring on dynamics of infestation. This finding agrees with other reports where usually a gradual decrease over time was observed in levels/extent(s)of infestations by using any termite baiting system. (2020) reported that a period of between six and nine months may be needed for total colony elimination, depending on the degree of infestation as well as other environmental factors. Generally, these results prove that strategically within integrated pest management (IPM) programs for Date palm orchards in Iraq and similar agro-ecological regions, the Exterra baiting system is effective. This will ensure minimal dependence on chemical pesticides while ensuring sustainability long-term protection of Palm productivity.

Conclusion

The results prove the Exterra baiting system to be one of the most effective and reliable approaches for controlling termite infestations in date palm orchards. All trees recovered within a single season, thus reflecting that the system kills colonies of termites rather than offering temporary suppression of visible individuals. The delay observed during the first few weeks is attributable to its biological mode of action whereby sufficient time has to elapse both for transferal among members within a colony as well as inhibition on chitin synthesis so that normal development processes can take place. Bait dissemination efficiency throughout Termite Colony Progressive Reduction Levels Infestation And Corresponding Increase Healthy Trees Compared With Conventional Chemical Control Methods This Exterra System Provides Significant Advantages Including Protection Palm Tissues From Chemical Contamination Enhanced Environmental Safety Long Term Suppression Of Termite Populations At The Colony Level Elimination. The system supports the detection of termite activity at its initial stages, hence timely interventions and enhanced monitoring within integrated pest management programs. Generally speaking, an alternative sustainable environmentally sound approach comparable to direct chemical treatments for termite control in date palm orchards is discussed herein through the Exterra baiting system. Its environmental conditions under Iraq's condition as well as other similar arid & semi-arid regions can be considered a strategy where conventional insecticides are used less while ensuring strong protection of palm productivity.

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