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# EFFICIENCY OF CERTAIN CHEMICAL COMPOUNDS ON THE INFESTATION OF SOME WOOD SPECIES BY SUBTERRANEAN SAND TERMITE, *PSAMMOTERMES HYBOSTOMA* DESNEUX AT FAYOUM GOVERNORATE, EGYPT

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**ABSTRACT:** *The present study was conducted at El-Hashatra village, Yousf El Sedek district, Fayoum governorate for two years of field exposure during the period from June 2011 to June 2013.Three chemicals compounds were tested against the sand termite, PSAMMOTERMES HYBOSTOMA Desn., these were Pyreban 48% at the rate 0.3% in Kerosen( by brushing),Kerosene alone (by brushing) and wood preservative,Copper Chromium Arsenates (CCA03%)by double vacuum impregnation .the sap wood Zone of five wood species were tested , these were : Poinciana regia Boj (Poinciana), Salix aegyptiaca L. (Willow), Morus sp (Mulberry) Casuarina equisetifolial (cauarina) and Populus alba (Poplar). The results showed various degrees of infestation according to wood species, chemicals used and field exposed period, these degrees were very slight, slight, moderate, severe, extremely severe attack and failure (stacks were broken in the ground). The chemicals compounds gave various protection periods for different wood species. Kerosene alone detected protection period ranged 1month (Poinciana and willow) to 3 months (Casuarina), Pyreban0.3% in Kerosene gave protection period ranged 1month (Poinciana) to 6 months(Casuarina and poplar),whereas CCA.C0.3% gave a complete protection period to all tested wood species for 2 years against the termite attack. The treatment of wood species with preservative CCA.C by vacuum and pressure was carried out by new device was designed of this purpose.*

**Key words:** *Psammotermes hybostoma*, Pyreban, kerosene, preservative CCA.C , *Poinciana regia, Salix aegyptica, Morus spp, Casuarina equistifolia* and *Populus alba*, preservation.

## INTRODUCTION

For centuries, wood has been an important primary construction material, widely used in structures. Wood is available in many forms and sizes, and is often used for railroad ties utility poles, fencing, decks and piers, bridges, highway barriers and signs, forms and scaffolding, furniture, and many decorative purposes.

Wood treatment to prevent its destruction is usually applied against decaying fungi, termites, carpenter ants, marine borers and weathering. Treating wood with the appropriate preservative agent extends its service life.

El-Sebay (1995) in Egypt studied the effect of boron against the two powder post beetles *Lyctus africanus*, and *Sinoxylon sudanicum* Lesne, on cuts of poinciana wood. Boron was applied by brushing, vacuum impregnation and dipping techniques.

Copper – chromium – arsenic (CCA) preservatives are now accepted as some of the most effective treatment for the protection of wood against fungi, insects and marine borers and are ranked along side creosote for performance in high hazard situations , with service life of 30 years or more. The chemical composition of different CCA formulations in the USA system of specification has been adopted and the AWPA define types A, B and C based on the relative amounts of active oxides (Cuo, Cro and $As_2o_5$). Type C contains: (Cuo 18.5%, $Cro_3$ 47.5%, $As_2o_5$ 34%), (Conell *et al.*, 1990), one of the most important characteristics of CCA preservative is their ability to fix in the wood and resist leaching

(Anderson *et al.,* 1991). The three components of CCA are all important in the preservative efficacy. Chromium is a bactericide, Copper is an excellent fungicide, and arsenic is effective against insects and copper-tolerant fungi.

The efficacy of CCA relies on toxicity to insects and wood decay organisms, requiring the preservative to be soluble enough to combat target organisms, but also insoluble to resist leaching ( Morrell and Rhatigan , 2000) & (Hingston *et al.,* 2001). Kim *et al.*(2008*)* used preservatives such as CCA-C, to protect radiata pine (*Pinus radiata* D. Don) wood samples from attack by two subterranean termite species, *Reticulitermes speratus* and *Coptotermes formosanus*. Lande (2008) mentioned that the most effective and widely used wood preservatives like Copper Chromium Arsenates (CCA) and creosote are banned or heavily restricted for use in many countries today, based on their human toxicity or environmental impact, Hager *et al.*, 2001. Most of the waterborne preservative treatments contained basic copper carbonate and one or more of the following additives: arsenic pentoxide, pyridine, sodium pentachlorophenate, tannin and benzoic, boric, chromic, salicylic and sorbic acids.

The aim of this work was to study the effect of subterranean sand termite *P. hybostoma* on five susceptible wood species treated with 3 compounds , ie.(pyreban, 48% in chlorpyrifos ), kerosene and the wood preservative CCA.C by vacuum and pressure for two years exposure to termite attack under natural Fayoum environmental conditions.

## MATERIAL AND METHODS:

The present work was conducted at El-Hashatra village , Yousf El- Sedek district, Fayoum governorate during June 2011. The experiment lasted for 2 years. The chosen building was known to be heavily infested with *P. hybostoma* and untreated with any termiticides. Experimental area was carefully cleaned up from any cellulose debris materials. Five wood species (*Poinciana regia*, *Salix aegyptiaca, Morus spp, Casuarina equisetifolia* and *Populus alba* ) were used, these species were preferable to termite (Mostafa *et al.* 2011) who infestation. Wood species were debarking (to increase permeation of used chemicals) separated into two zones (sap wood and heart wood).

Sap woods were cut to stakes and were dried at 105 °C for 24 hours. All tested wood stakes (120 stakes) were prepared at 50x5x3cm. Four treatments (kerosene alone, pyreban 0.3% in kerosene, the wood preservative CCA-C 3% by double vacuum pressure and control) with 6 replicates (24 stakes for each wood species) were tested against the subterranean sand termite *P. hybostoma*. Stakes were classified as following: 6 wood stakes for each wood species were treated with 0. 3% pyreban in kerosene by brushing until saturation, 6 wood stakes for each wood species were treated with kerosene alone by brushing until saturation, 6 wood stakes for each wood species were treated with CCA - C 3% by vacuum and pressure and 6 wood stakes for each wood species were left as control without any treatment. Wood treatment with CCA-C 3% by double vacuum pressure was conducted according to Barnes (1988) in the UK and Cooper *et al.* (1997), in Canada who recorded full – cell treatment cycle for both hard and softwoods with some modifications in technique were used as follow:

A new device was designed to carry out this treatment, which consists of iron a cylinder (50 ×35cm); the top cover is installed by gaskets with seven tight nails. One side of the device connects to two hoses with valves; one hose is connected with a vacuum pump and the other is connected to an air compressor and is provided with manometer for pressure measurement. The other side is provided with a heater thermostat for temperature regulation as shown in (Plate 1, A, B, C and D).

**1) Method of treatment :( Full – cell treatment cycle):**

Thirty wooden stakes (6 replicates x 5 wood species) were introduced into the cylinder at an initial vacuum (30 in Hg). The cylinder was tightly closed by means of

nails, then, the vacuum started to discharge the air from inside the cylinder until reaching 30 Hg, then, the valve is locked to stop the process of air discharging. The preservative fluid was allowed to flow inside the cylinder and was left for 30 minutes at 75ºC. The hose end was connected to a compressor which presses the air inside the cylinder (positive pressure of 10 bars) and held for 1.5 hours to increase the preservative fluid penetration. Finally, the pressure was released and the remaining preservative was drained.

**2) Post-Treatment processes (fixation):**

After treatment, all wooden stake species were wrapped in polyethylene and allowed to fixation at fixed temperature 45°C and 95% R.H. for one week. Six holes were made in area highly infested with termites. Twenty wooden stakes (5 wood species x 4 treatments) were distributed in each hole at 40 cm depth and planted vertically in the soil as shown in plate (2). Regular inspection of stakes was periodically carried out every month for six months, then after, one and two years.

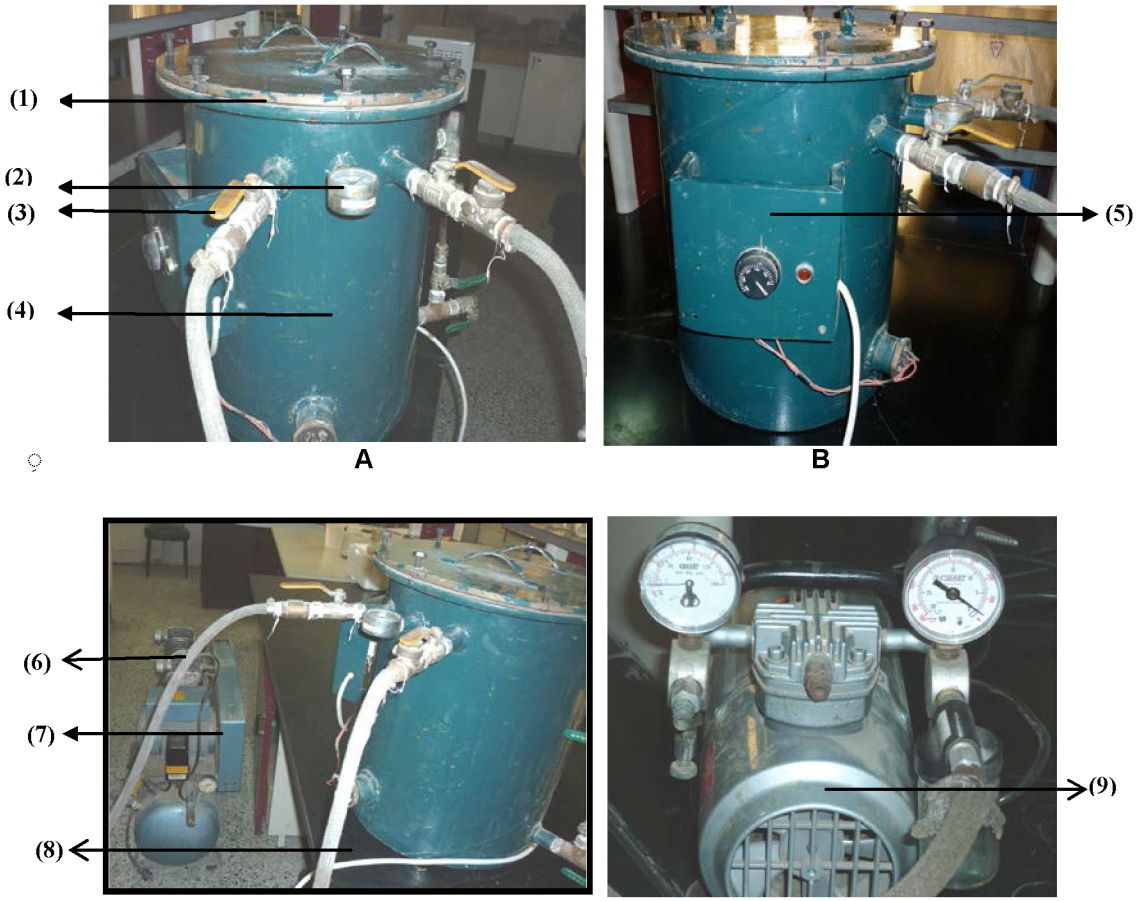


**Plate 1, The system used in the treatment of wood species by double vacuum pressure. (1) Cover is installed by gaskets (and seven nails tighten cover on device (2) Manometer to measure pressure /bar (3) Valve for closing and opening (4) Cylinder of iron (5) Heater thermostat to regulate the temperature. (6) Hose is connected with compressor for pressure (7) Compressor for pressure (8) hose is connected with pump for vacuum (9) pump for vacuum.**

**Plate (2): The distribution of wooden stakes in the hole vertically in the soil.**

The stakes were lifted from the ground to examine, then visual observations were recorded to determine degrees of infestation by *P. hybostoma* as follow:

0= no attack, 1= very slight, 2 =slight attack, 3= moderate attack, 4= severe attack, 5= extremely severe attack. The stakes were carefully re-installed in soil at the same position.

## RESULTS AND DISCUSSION

Data in Table (1) showed that the infestation varied for treated wood species with kerosene alone, pyreban and untreated. The degrees of infestation were very slight, slight, moderate, severe attack, extremely severe attack and failure (stakes break in the ground) as in showen plate 3.

After one month of field exposure, data in Table (1) showed that in all wood stakes treatments used , there were no attacks by *P. hybostoma* workers except only simple scribble in *Poinciana regia* and *Salix aegyptieca* wood stakes treated with kerosene alone by brushing, and also untreated *Morus spp* wood stakes. The initial infestation for *Poinciana regia* wood stakes treated with pyreban were recorded after 2 months of exposure to termite.

As seen in Table (1) and plate (3,1) after 3 months of field exposure to subterranean termite, the *Poinciana regia*, *Salix aegyptieca*, *Morus spp* and *Populus alba* wood stakes treated with kerosene alone, were attacked with very slight damage. While, the initial infestation for *Salix aegyptiaca* wood stakes treated with pyreban was very slight damage after 4 months of field exposure to termite attack.

Data in Table (1) showed that the initial infestation for *Morus spp* wood stakes treated with pyreban by brushing after 5 months of field exposure to termite was very slight damage(0.17). While, mean of infestation level reached moderate level (2.17and 2.5) for *Poinciana regia* and *Salix aegyptiaca* wood stakes treated with kerosene alone as shown in plate (3,3).

Also, results indicated that the initial infestation for *Populus alba* and *Casuarina equisetifolia* wood stakes treated with pyreban was observed after one year of exposure with very slight damage. While, the infestation progressed to reach severe attack (with mean 3.17) for *Salix aegyptiaca* wood stakes treated with kerosene alone and untreated as shown in plate (3, 4).

On the other hand, after one year of exposure to termite, data in Table (1) showed that all stakes for the five wood species treated with the wood preservative CCA-C 3% by vacuum impregnation have not attacked by termite workers *P. hybostoma* compared to other treatments (pyreban and kerosene alone ) as shown in plate (4).

**Table (1): Infestation degrees of 5 wood species treated with Pyreban 0.3%, wood preservative CCA-C 3% and kerosene against subterranean termite *P. hybostoma* along two years of field exposure from June 2011 to June 2013.**

| Treatments | Mean degrees of infestation at different periods of exposure | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1/7/2011 after 1 month | 1/8/2011 after 2 months | 1/9/2011 after 3 months | 10/2011 after 4 months | 11/2011 after 5 months | 12/2011 after 6 months | 6/2012 after 1 year | 6/2013 after 2 years |
| *Poinciana regia* | | | | | | | | |
| Control | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 2.00 | 1.50 | 3.83 |
| Kerosene | 0.00 | 0.67 | 1.00 | 1.50 | 2.17 | 2. 17 | 2.50 | 3.83 |
| Pyreban0.3% | 0.00 | 0.17 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 1.67 |
| CCA – C 3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Salix aegyptiaca* | | | | | | | | |
| Control | 0.00 | 0.67 | 1.00 | 1.33 | 1.83 | 1.83 | 3.17 | 5.30 |
| Kerosene | 0.00 | 0.50 | 1.00 | 1.33 | 2.50 | 2.50 | 3.17 | 4.33 |
| Pyreban0.3% | 0.00 | 0.00 | 0.00 | 0.17 | 0.33 | 0.33 | 0.67 | 1.67 |
| CCA – C 3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Morus spp* | | | | | | | | |
| Control | 0.00 | 0.17 | 0.50 | 0.83 | 0.83 | 1.00 | 1.83 | 4.00 |
| Kerosene | 0.00 | 0.00 | 0.33 | 0.67 | 0.83 | 1.00 | 1.50 | 3.80 |
| Pyreban0.3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.17 | 0.67 | 3.00 |
| CCA – C 3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Casuarina equisitifolia* | | | | | | | | |
| Control | 0.00 | 0.00 | 0.00 | 0.33 | 0.33 | 0.33 | 0.50 | 1.00 |
| Kerosene | 0.00 | 0.00 | 0.00 | 0.50 | 0.50 | 0.50 | 0.83 | 1.60 |
| Pyreban0.3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.80 |
| CCA – C 3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Populus alba* | | | | | | | | |
| Control | 0.00 | 0.00 | 0.17 | 0.17 | 0.17 | 0.17 | 0.67 | 2.17 |
| Kerosene | 0.00 | 0.00 | 0.17 | 0.17 | 0.33 | 0.33 | 0.67 | 1.50 |
| Pyreban0.3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 1.33 |
| CCA – C 3% | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Grade No | Degree of infestation |
|---|---|
| 0 | No attack or simple scribble =0 |
| 1 | 0 < Very Slight attack ≤ 1 |
| 2 | 1 < Slight attack ≤2 |
| 3 | 2 < Moderate attack ≤3 |
| 4 | 3 < Severe attack ≤4 |
| 5 | 4< Extremely severe attack ≤ 5 |
| 6 | 5 < Failure (stakes breaks in the ground and converted fully to soil) ≤ 6 |

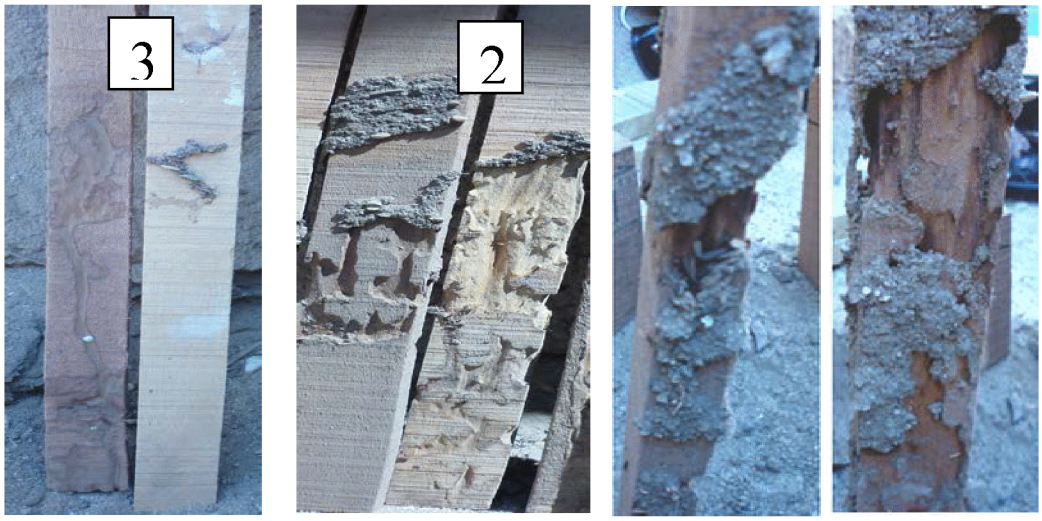



**Plate (3): The degrees of infestation**

**(1) Very slight attack in Poinciana and willow treated with kerosene. (2): Slight attack in treated willow with kerosene. (3): Moderate attack in willow treated with kerosene, there is high number of allates on the wood (4): Severe attack in willow treated with kerosene. (5): extremely severe attack in untreated willow. (6): Failure (stakes breaks in the ground in willow treated with kerosene.**

For control treatments, after two years of field exposure to termite the infestation for *Poinciana regia* and *Morus spp* wood stakes was severe damage; moderate damage for *Populus alba* wood stakes. The highest damage was failure (breaks stakes in the ground) in *Salix aegyptiaca* wood stakes, while the lowest damage was very slight for *Casuarina equisetifolia* wood stakes.

These results are in partial agreement with Mostafa *et al.* (2011)who mentioned that, both sap wood blocks of *Morus spp* and *Casuarina equisetifolia* were medium susceptible; *Poinciana regia* was susceptible, while both sap wood blocks of *Populus alba* and *Salix aegyptiaca* were very susceptible to *P. hybostoma*.

In case of Kerosene alone treatment, after two years of field exposure to termite the infestation for *Poinciana regia* and *Morus spp* wood stakes were severe and it reached extremely severe infestation for *Salix aegyptiaca* wood stakes. While, the infestation was slight in both *Casuarina equisetifolia* and *Populus alba* wood stakes treated with Kerosene.

Thus, results indicated that the efficiency of kerosene alone was low when applied on 5 wooden stakes species by brushing, where it did not give protection for these species and its effect was similar for control treatment.

Pyreban treatment results showed that, after two years of field exposure to termite the infestation reach very slight damage in case of *Casuarina equisetifolia* wood stakes; slight damage for *Poinciana regia*, *Populus alba* and *Salix aegyptiaca* wood stakes was observed, while, the infestation was moderate for *Morus spp* wood stakes treated with pyreban.

Results indicated that pyreban gave protection period ranged from 2 – 12 months against the termite attack when applied on wood stakes species by brushing. These results are in disagreement with Remadevi and Muthukrishnan (1997) who mentioned that Rubber wood stakes were treated with different concentrations of two different commercial formulations of chlorpyrifos, by either vacuum impregnation or dipping. Even at low concentrations the formulations were effective at preventing damage by termites in India when compared with untreated controls (Remadevi and Raja, 2004) who tested chlorpyrifos 1% as wood protectants in field conditions and found that control rubber wood stakes, were fully damaged within six months, while all the pressure impregnated rubber wood stakes were free of any termite attack, moreover, termite damage was observed after five years at the chlorpyrifos dip diffusion treatments.

The wood preservative CCA.C 3% by double vacuum impregnation and fixation at 45ºC & 95% R.H. for a week, gave complete protection for two years for the tested wood stakes species against the termite attack (plate 5).

These results agree partially with Abdel Nur (1980), who showed that, the brushing and dipping wood treatments in chemicals such as Creosote oil and copper chrome arsenate afforded the test timber protection for up to eight years. One of the most important characteristics of CCA preservative is their ability to fix in the wood (Anderson *et al.,* 1991).

The pressure treatment with CCA 6% on rubber wood (*Hevea brasiliensis*) unattacked by termites and the damage was visible only after six years Remadevi and Raja (2004).

A year after the woods treated by pressure with three different concentrations of CCA, showed excellent resistance to termites Encinas and Mora (2005).

Chromated copper arsenate (CCA), which had the lowest overall penetration, was more effective than either borate preservative in preventing attack; these results indicate that the efficacy of shell treatments in preventing termite attack is a function of the type of preservative Lebow *et al.* (2006).


**Plate (4):** No injury in wood species treated with CCA compared to the other treatments (pyreban & kerosene) and untreated after one year of exposure to termites attack.

**Plate (5):** No injury in wood species treated with CCA compared to the other treatments (pyreban & kerosene) and untreated after two years of exposure to termites attack.

Wood treated with CCA was effective in resisting attack termites (*Coptotermes formosanus*) using a full-cell process. The laboratory tests showed different efficiency results from the field test; retention of 4 kg/m3, gave effective protection in the laboratory but the field test required 6 kg/m3 Baeza *et al.* (2002).

The best performing of these preservatives was the four commercial formulations of copper-chromium-arsenic (CCA), which even rated well (greater than or equal to 5.8 kg/m3) to protect eucalptus sapwood at the tropical (Innisfail) site Thornton *and* Johnson (2001).

Formulation containing 2% copper-chrome-arsenic was found suitable to prevent both stain and insect attack using green (*Pinus roxburghii*) and semul (*Bombax ceiba*) timbers Jain (1998).

Data in Table (2) cleared the protection periods for treated wood species with some chemicals against sand termite *P.hybestoma*. Kerosene showed protection period ranged 1 month (Poinciana wood) to 3 months (casuarinas wood), Pyreban in Kerosene at the rate 0.3% detected that protection period to wood species varied from 1month (Poinciana wood) to 6 ≤ months whereas CCA.C gave complete protection until the end of experiment (24months).

This work detected that wood preservative CCA.C give complete protection to Poinciana , willow, mulberry, casuarinas and poplar wood against *P.hybestoma* termite for 2 years (experimental period).

**Table 2. Protection periods for treated wood species with some chemicals against *P.hybestoma***

| Tested wood | Protection period (In month) | | |
|---|---|---|---|
| | Kerosene | Pyreban + Kerosene | CCA.C |
| Pionciana | 1 | 1 | 24 |
| Willow | 1 | 3 | 24 |
| Mulberry | 2 | 4 | 24 |
| Casuarina | 3 | 6 ≤ | 24 |
| Poplar | 2 | 6 ≤ | 24 |

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# فعالية بعض المركبات الكيماوية على اصابة بعض أنواع الخشب بنمل الرمال الأبيض التحت أرضي *Psammotemmes hybostoma* Desneux بمحافظة الفيوم – مصر

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**الملخص العربي**

أجري هذ العمل في قرية الهشاترة – بمركز يوسف الصديق بمحافظة الفيوم لمدة عامين من التعريض الحقلي من يونيه ٢٠١١ حتي يونيه ٢٠١٣ حيث أختبرت فعالية كل من الكيروسين والبيريبان فى الكيروسين بمعدل ٠.٣% و حافظ الخشب CCA-C بتركيز ٣٪ بالتفريغ والضغط على الخشب العصارى لكل من البوانسيانا ، الصفصاف، التوت ،الجازورينا، الحور بنمل الرمال الأبيض التحت أرضى *P. hybostoma* وقد أظهرت النتائج درجات مختلفة من الإصابة للأخشاب المعاملة والغير معاملة تبعا الى نوع الخشب الكيماوى المستعمل وفترة التعريض الحقلى....

وقد أعطت المركبات الكيماوية فترات وقاية مختلفة.. فقد أعطى الكيروسين منفردا فترة وقاية مداها بين واحد شهر (البوانسيانا والصفصاف) إلى ثلاثة أشهر (الجازورينا) فى حين أن البيريبان فى الكيروسين بمعدل ٠.٣% أعطى فترة وقاية مابين واحد (البوانسيانا) إلى ٦ أشهر أو أكثر (الجازورينا والحور) بينما أعطى حافظ الخشب CCC-A فترة وقاية كاملة إلى جميع أنواع الخشب ضد هجوم النمل الأبيض حتى ٢ سنة (نهاية التجربة). معاملة الأنواع الخشبية بالحافظ CCC-A بالتفريغ والضغط كان يتم بواسطة جهاز جديد صمم لهذا الغرض