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TUNNELING ABILITY OF SUBTERRANEAN TERMITE, *Psammotermes hypostoma* (DESN.) IN TREATED SOIL BY SOME INSECTICIDES GROUPS.

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ABSTRACT

The tunneling ability of termites *P. hypostoma* (Desn.), with treated particle sizes of soil resulted that; the tunneling distance and number of branching were the highest with the large soil particle size, while was less at the small particle size treated with insecticides. The fine treated soil was more toxic and termites were died quickly in the tunnels than the coarse soil. Tunneling activity and number of branching decreased by the concentration increases. Treated soil with cypermethrin showed the highest and the more toxic to prevention of tunneling and branching followed by fipronil and chlorpyrifos, respectively. On the other hand the highly density and suitable quantity of added water to soil were the principal factors in tunneling activity.
The statistics analysis resulted highly significant differences between the tested factors, (insecticides, particle sizes and concentrations), with the variable factor, (tunnel length and branches).

INTRODUCTION

Subterranean termite *P. hypostoma* represents one of the major important insects related to food kinds in the world. Termites feed mainly on cellulose; wood, papers, clothes, trees, and woody tissues of plants, buildings constructional timbers, agricultural crops, books, government records and stored products. In Egypt the considerable damage especially to rural buildings constructed with mud bricks, woodwork and furniture, causing major problems to houses and economic income. Soil treatment control methods showed failing of some chemicals applied against subterranean termite. Studies showed that termite can crossing over treated soil even with high concentration of chemicals. The present work conducted to evaluate the termite tunneling ability *P. hypostoma* (Desn.), in three particle sizes of soil treated with three insecticides groups; chlorpyrifos, fipronil and cypermethrin.

MATERIALS AND METHODS

Sandy loamy soil samples were collected from The Regional Agriculture Research Station at Ismailia Governorate. The soil samples were taken randomly from the different sites at depth of 30, 60, 90cm., where the most termite activity was carried out. Samples mixed ,homogenized for each depth, screening to three-particle sizes 850, 425 and 250μm using USA Standard Testing Sieve (ASTM. E11. Specification).

Soil samples were washed with tap water several times to get rid of organic matter and dirties, dried in open air and then sterilized in an electric oven at 105°C for 24 hours to eliminate the microorganisms' spores and vegetative stages. Samples were kept in plastic containers and placed into deep freezer for the different treatments.

To prepare a concentration of 1000ppm was diluted to 500, 250 and 125ppm by untreated soil for each insecticide, a volume of 2.08 ml of chlorpyrifos, 20.0 ml fipronil and 10.0 ml cypermethrin was dissolved in 200 ml acetone. 1kg of washed soil was spread on a clean stainless tray at 1cm height and sprayed with formulated prepared insecticide. Treated soil was shacked by electric shaker for 48 hours. Homogenized treated soil was kept at a glass jars inside deep freezer.

Collected termites were separated from El-Sebay modified trap, 1991, and kept in incubator adjusted at 27C° ±1C°. Such trap was used by El-Sebay, (1993a&b); El-Bassiouny (2001) and Ahmed (1997 & 2003).

Tested insecticides:

1- Organophosphates group was represented by chlorpyrifos: *O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate as Dursban.48 %

2-Fipronil group was represented by Fipronil: (±)-5-amino-1-(2,6-dichloro-á, á, á –trifluoro - *p*-tolyl) - 4 - trifluoromethylsulfinylpyrazole – 3 - carbonitrile as Termidor. 5%

3- Pyrethroids group: was represented by cypermethrin: (*RS*)- á -cyano-3-phenoxybenzyl (1*RS*, 3*RS*; 1*RS*, 3*SR*) – 3 - (2,2 - dichlorovinyl) - 2,2 - dimethylcyclopropanecarboxylate

Roth: (*RS*)- á -cyano-3-phenoxybenzyl (1*RS*)-*cis-trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate as Actamethrin 10%.

Experiments technique:

To study the ability of termite to overcome the treated soil and make crossing beneath treated particles, the following experiment was carried out. An apparatus designed by N. Johnson, USAD, Forest Service, USA (Jones, 1988), was adopted. The design illustrated in (Fig. ١, ٢ and ٣). It consists of double plates of transparent plastic and is attached together with 2mm distance in between, fixed in a base. At one side there is a hole 1cm in diameter which fixed with 30cm long of plastic tube attached with a plastic cup where 50gm of clean sand and a piece of cardboard (5 × 5cm). Treated soil filled the space between the double plates and moistened with 5ml of water. One hundred healthy workers of termites were liberated in a plastic cup, covered with led. Plates were installed on a wooden base specific for work. Daily inspection was carried out, length and number of tunnels branches were measured as termite ability for tunneling through treated soil. Such experiment and control was replicated five times for each treated soil particle size of all concentrations. Games (1990), Jones (1990), El-Sebay, (1993). Each treated soil was adopted in tunneling ability experiment.

The obtained data were analyzed using Proc ANOVA in SAS (SAS Institute 1988).

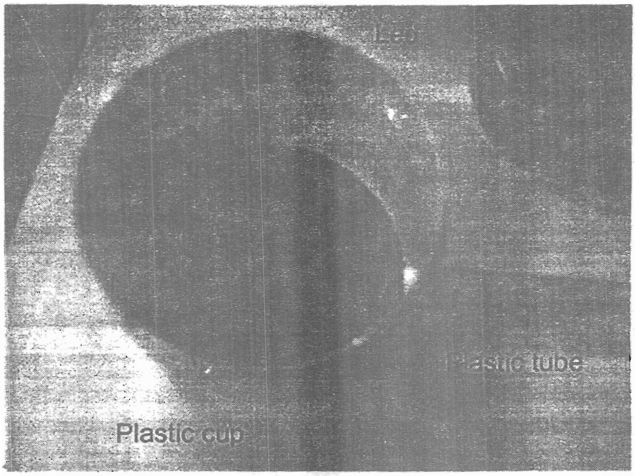

Fig. (1): Illustration of junction plastic cup and plastic tube.

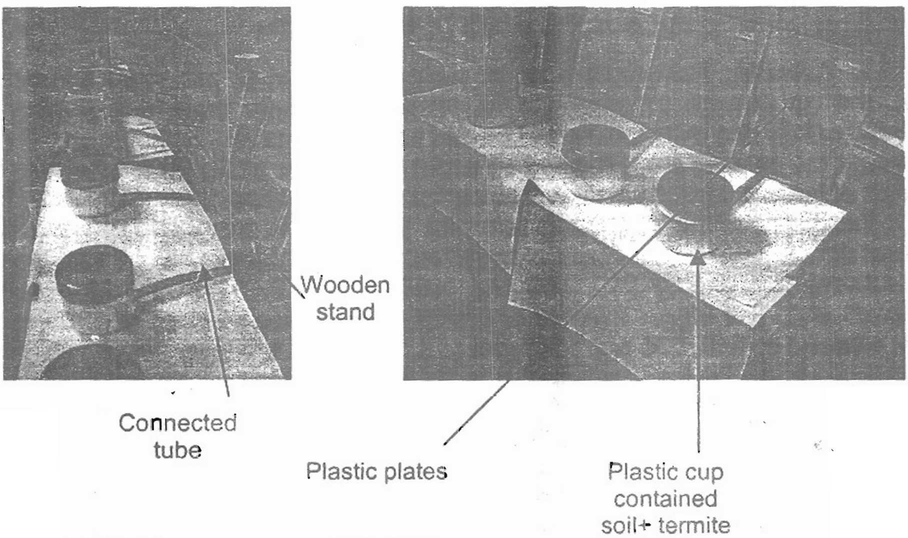

Fig. (2): Demonstrate the used materials of tunneling test.

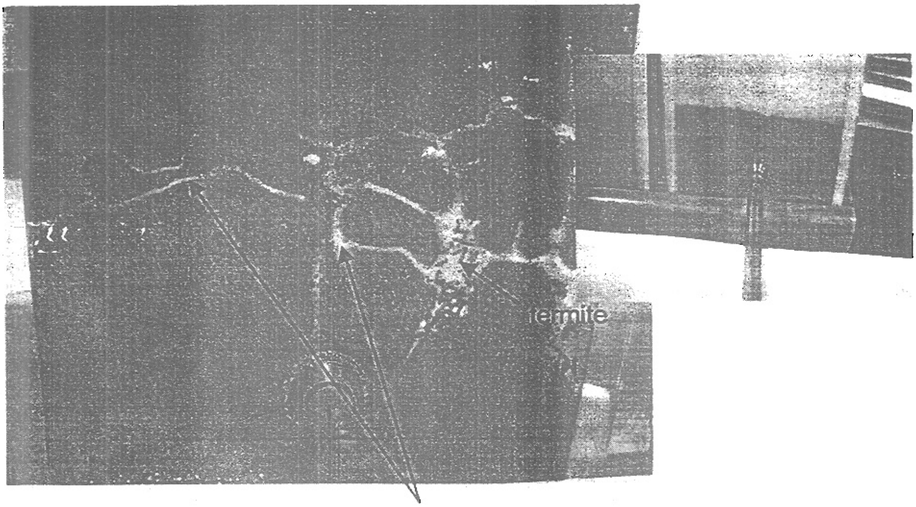

Fig. (3): Clarify of tunnels branches constructed by termites in the used plates.

RESULTS AND DISCUSSION

Tunneling ability refers to the ability of termite to penetrate treated soil and go through to construct its pathways. Tunnel branching proving termite activity and overcoming soil treated with toxicants.

Through the present study it could be assist the termite ability by number and length of tunnels constructed through treated soil as follows:

Table (1), show that at particle size 850µm, the longest constructed tunnel through treated soil with chlorpyrifos, found at concentration 125ppm (114.3mm) followed by 250, 500 and 1000ppm (83.7, 71.4, and 33.6mm, respectively). The bigger number of branches (6.4) was at dose of 125ppm and followed by 250, 500 and 1000ppm (4.6, 2.4 and 1.6, respectively).

At 425µm, the longest tunnel was 78.8mm followed by 68.2, 57.3 and 32.0mm at concentrations of 125, 250, 500 and 1000ppm, respectively. Branching number were 4.8, 2.8, 2 and 1.2 at higher concentrations.

At 250µm particle sizes, the longest tunnels found at dose of 125ppm, followed by 41.8, 5.5 and 0 at doses of 250, 500 and 1000ppm, respectively. Tunnels branching were 2, 1.4, 0.4 and 0 at 125, 250, 500 and 1000ppm, respectively.

Data in Table (2), soil application with fipronil, it is clear that, the longest tunnels was shown at soil treated with 125ppm followed by 58.4, 26 and 1mm at 250, 500 and 1000ppm in soil particle size 850µm. Branches were 3.4, 3.0, 1.2 and 0.4 at different serial concentrations.

At particle size 425µm, longest tunnel was noticed at soil treated with 125ppm, followed by 40.7, 25.5, and 0.0mm at 250, 500 and 1000ppm, respectively. Highest numbers of branches (2.6, 2.6, 1.6 and 0) were detected at concentrations of 125, 250, 500 and 1000ppm.

Table (1): Tunneling ability of *P. hypostoma* through soil treated with different concentrations of chlorpyrifos in ppm.

Rep.	Soil treated with chlorpyrifos in ppm									
	125		250		500		1000		Control	
	L	B	L	B	L	B	L	B	L	B
Particle size 850µm.										
1	95.8	5	83.7	5	74.3	3	40.3	2	122.4	11
2	112	6	90.4	6	66.8	2	35.2	1	163	12
3	108.6	7	84.7	4	70.4	2	28.7	1	155.8	9
4	107.2	6	79.5	5	69.4	3	33.4	2	170	13
5	99.5	8	80.4	3	76.2	2	30.4	2	143.4	10
Mean	114.3	6.4	83.7	4.6	71.4	2.4	33.6	1.6	150.9	11
Particle size 425µm.										
1	88	4	72.3	3	60.4	2	33	1	132.6	10
2	76	6	77.1	3	64.3	2	40.2	2	155.2	13
3	74	5	65	4	57.4	3	39.4	1	140.5	10
4	80	5	67.4	2	55	2	26.4	1	150.1	9
5	76	4	58.9	2	49.5	1	22.1	1	111.4	8
Mean	78.8	4.8	68.2	2.8	57.3	2.0	32.0	1.2	137.9	10.0
Particle size 250µm.										
1	71.2	3	53.2	1	0	0	0	0	124	9
2	63.2	2	49.1	2	0	0	0	0	134.1	10
3	55.4	1	44	1	12	1	0	0	133.4	9
4	65	2	32.1	2	15.3	1	0	0	155	11
5	57.2	2	30.4	1	0	0	0	0	124.6	8
Mean	62.4	2.0	41.8	1.4	5.5	0.4	0	0	134.2	9.4

L = Length of tunnel in mm
B = Number of tunnel branching

Table (2): Tunneling ability of *P. hypostoma* through soil treated with different concentrations of fipronil in ppm.

Rep.	Soil treated with fipronil in ppm									
	125		250		500		1000		Control	
	L	B	L	B	L	B	L	B	L	B
Particle size 850µm.										
1	75	3	62.4	3	22.4	1	0	0	135.4	10
2	77	4	55.7	4	25.7	1	0	0	136.4	10
3	69	2	58.3	2	30.1	2	3	1	140.5	9
4	80	4	55.4	3	28.4	1	2	1	154	11
5	74.3	4	60.1	3	23.3	1	0	0	139.1	10
Mean	75.1	3.4	58.4	3.0	26.0	1.2	1	0.4	141.1	10
Particle size 425µm.										
1	66.5	3	42.3	3	32.4	2	0	0	128.1	10
2	60.4	3	38.1	2	23.4	1	0	0	135.8	9
3	55.7	2	37.9	2	29.1	2	0	0	141	9
4	59.3	2	44.2	3	20.4	1	0	0	129.6	8
5	64.2	3	41.2	3	22.1	2	0	0	115.7	8
Mean	61.2	2.6	40.7	2.6	25.5	1.6	0	0	130.0	8.8
Particle size 250µm.										
1	63.4	2	44.3	3	20.4	2	0	0	122.5	9
2	60.2	3	39.4	2	16.3	1	0	0	120.5	8
3	59.8	3	29.4	2	17.3	1	0	0	130	9
4	50.3	2	30.1	1	13	1	0	0	129.4	8
5	52.7	2	25.1	1	14.5	1	0	0	125.7	8
Mean	57.3	2.4	33.7	1.8	16.3	1.2	0	0	125.6	8.4

Also, the same results were obtained at particle size 250µm. The longest tunnel (57.3mm) was found at soil treated with 125ppm and followed by 250, 500 and 1000ppm (33.7, 16.3 and 0.0mm, respectively). The highest numbers of branches (2.4, 1.8, 1.2 and 0) were found at concentrations of 125, 250, 500 and 1000ppm, respectively.

Data in table (3), presented the longest tunnel at particle size of 850µm was found at 125ppm (48.5mm), followed by 250, 500 and 1000ppm, of cypermethrin, and represented 26.2, 17.9 and 0.0mm. Branches of tunnels were, 2.2, 1.2, 1 and 0 at soil treated with 125, 250, 500 and 1000ppm.

At particle size 425µm, longest tunnel fond at soil treated with 125ppm of cypermethrin. And 29.4, 11.9 and 0.0mm at soil treated with 250, 500 and 1000ppm. Highest number of branching was 1.6mm followed by 1.4, 1.0 and 0 at the higher concentrations of treated soil.

Particle size 250µm gave the same results. At 125, 250, 500 and 1000ppm tunnels length were 26.1, 7.3, 0 and 0, respectively. At the present particle size, branches were lower, 1.4, 1.0, 0.0, 0.0 were found at 125, 250, 500 and 1000ppm.

Table (3): Tunneling ability of *P. hypostoma* through soil treated with different concentrations of cypermethrin in ppm.

Rep.	Soil treated with cypermethrin in ppm									
	125		250		500		1000		Control	
	L	B	L	B	L	B	L	B	L	B
Particle size 850µm.										
1	60.4	2	32.2	1	18.7	1	0	0	154	10
2	61.2	2	25.5	1	20.4	1	0	0	143.2	8
3	49.7	3	29.4	2	21.3	1	0	0	160.4	9
4	44.6	2	20.4	1	17.4	1	0	0	120.8	10
5	46.5	2	23.4	1	11.5	1	0	0	144.7	10
Mean	48.5	2.2	26.2	1.2	17.9	1.0	0	0	144.6	9.4
Particle size 425µm.										
1	53.2	2	29.4	1	12.4	1	0	0	130.4	10
2	43.2	2	30.2	2	16.3	1	0	0	151.2	10
3	47.9	1	32.1	2	11.4	1	0	0	136.7	9
4	39.4	1	30.1	1	10.4	1	0	0	155	9
5	34.6	2	25.1	1	9.1	1	0	0	124.3	10
Mean	43.7	1.6	29.4	1.4	11.9	1.0	0	0	139.4	9.6
Particle size 250µm.										
1	28.4	1	9.4	1	0	0	0	0	118.7	7
2	33.2	1	3.2	1	0	0	0	0	132.4	10
3	21.4	1	8.4	1	0	0	0	0	133.7	9
4	25.4	2	6.2	1	0	0	0	0	128.9	9
5	22.3	2	9.1	1	0	0	0	0	127.6	10
Mean	26.1	1.4	7.3	1.0	0	0	0	0	128.3	9.0

Generally, as shown data in Table (4), revealed that, at all particle size of tested soil the longest tunnel was at soil treated with 125ppm and decreased by the concentration increases. The highest length tunnel was

114.3mm, followed by 83.7mm in soil treated with 250ppm at the same particle size (850µm), while the least length (0.0mm) were almost at all soil treated with 1000ppm except in case of chlorpyrifos (850 and 425µm) and fipronil (850µm).

Data showed that termite can penetrate soil treated with chlorpyrifos more than fipronil and the least tunneling ability was found at all concentrations of cypermethrin. Also, branching was correlated with tunneling action, more long tunnel more branching.

On the other hand, tunneling and branching through soil with particle size of 850µm or more is prevailing and *vice versa*. Consequently, soil treated with pyrethroids showed more prevention against termite activity.

Finally, Termites tunneling ability with treated particle size of soil indicated that the tunneling and branching were the highest with the coarse treated soil, while were the least with the fine soil. So the fine treated soil was more toxic and termites were died quicker in the tunnels than the coarse soil. Tunneling activity and branching, decreased by the concentration increases. Soil treated with Pyrothroids group (cypermethrin) showed the best and the more toxic to prevention of tunneling and branching followed by Fipronil group (Fipronil) and Organophosphate group (Chlorpyrifos), respectively. The highly density and suitable quantity of water added to soil were the principal factors in tunneling activity.

The authors suggest that, the Pyrothroids group (Cypermethrin) could be the superior in the termite control of the invested wooden furniture, buildings and constructions or mixed with concrete.

The obtained results are in agreement with Galal (1982), who mentioned that the chlorpyrifos was used and succeeded to prevent tunneling activity of subterranean termites *P. hypostoma.*

Data are in agreement with Tamashiro (1989), research on *Coptotermes formosanus*, he mentioned that, chlorpyrifos forms an effective barrier in sand and clay to prevent soil penetrated for at least 5 years.

Also data are agree with the finding of Jones (1990), who showed that, the termites were constructed a greater number of tunnels of greater length at the high population density. At a high population density, *C. formosanus* may be able to bridge a termiticidal barrier, when compared among the three termiticides (Chlordane, Chlorpyrifos and Permethrin).

Data are agree with Gahlhoff (2001), Tested the ability of Subterranean termite *Reticulitermes flavipes* (Kollar) on the penetration, and data revealed that the termite penetrated only a few millimeters into 500ppm Dursban TC- treated soil at all thickness and the termites penetrating completely through 5.0 and 0.5ppm treatment.

Houseman (2003), investigated the effect of soil texture, soil moisture, and termite density on the rate of tunnel construction in *R. flavipes.* Tunneling rate and tunnel morphology were measured in laboratory arenas by simulating a thin slice of subterranean habitat. Tunneling rates were faster in arenas containing soils with higher sand concentrations. High termite densities had little effect on tunneling rates in small gallery systems. The rate of tunnel construction along edges of tunneling arenas was significantly greater than in the interior. Tunneling distance in days after the addition of water was higher than in days prior to adding water.

Laura (2005), examined the insecticides Fipronil against the Formosan subterranean termite, *Coptotermes formosanus*, (Sheraki) and Eastern subterranean termite, *Reticulitermes flavipes*, (Koller). Data indicated that the Fipronil provided an effective barrier against tested termites. Soil was penetrated to some degree at all concentrated of tested pesticide, indicated that, Fipronil showed similar toxicity for both species. Higher mortality prevented termites from penetrating the entire 5cm of treated soil.

Table (4): Tunneling ability of *P. hypostoma* through soil treated with different concentrations of three insecticides in ppm at different particle size of soil.

Chemical	Particle size in µm.	Soil treated with ppm									
		125		250		500		1000		Control	
		L	B	L	B	L	B	L	B	L	B
Chlorpyrifos	850	114.3	6.4	83.7	4.6	71.4	2.4	33.6	1.6	150.9	11.0
	425	78.8	4.8	68.2	2.8	57.3	2.0	32.0	1.2	137.9	10.0
	250	62.4	2.0	41.8	1.4	5.5	0.4	0	0	134.2	9.4
Fipronil	850	75.1	3.4	58.4	3.0	26.0	1.2	1.0	0.4	141.1	10.0
	425	61.2	2.6	40.7	2.6	25.5	1.6	0	0	130.0	8.8
	250	57.3	2.4	33.7	1.8	16.3	1.2	0	0	125.6	8.4
Cypermethrin	850	48.5	2.2	26.2	1.2	17.9	1.0	0	0	144.6	9.4
	425	43.7	1.6	29.4	1.4	11.9	1.0	0	0	139.4	9.6
	250	26.1	1.4	7.3	1.0	0	0	0	0	128.3	9.0

Statistics analysis:

Data in table (5), clarified that, the mean of treatments with chlorpyrifos, fipronil and cypermethrin, were recorded 71.467, 52.793 and 41.553 respectively, for variable L. and recorded 4.0000, 3.1600 and 2.5867 for variable B., highly significant (F. values recorded for both variables 24.85 and 16.32 respectively). In the same trend the means of particle sizes, were 66.180, 57.067 and 42.567 for variable L. and recorded 3.8533, 3.3333 and 2.5600 for variable B., the F. values recorded highly significant 15.44 and 13.68 for variable L. and B. respectively. The mean's concentrations were counted 63.044, 43.267, 25.756, 7.400 and 136.889 for 125, 250, 500, 1000ppm and control respectively, and the F. value recorded highly significant variation 163.76 for variable L., also, 2.9777, 2.2000, 1.2000, 0.3556 and 9.5111 for the concentration and the F. value recorded highly significant variation 256.53, for variables B.

Table (5): Illustration of significantly variables between the tested factors, insecticides, particle sizes and concentrations with the variables, tunnel length and branches.

Variable	The mean of treatments					F. Value 0.5%	Pr > F
	Chlorpyrifos		Fipronil	Cypermethrin			
L.	71.467		52.793	41.553		24.85**	0.0001
B.	4.0000		3.1600	2.5867		16.32**	0.0001
	The mean of particle sizes						
	850µm		425µm	250µm			
L.	66.180		57.067	42.567		15.44**	0.0001
B.	3.8533		3.3333	2.5600		13.68**	0.0001
	The mean of concentrations in ppm						
	125	250	500	1000	Control		
L.	63.044	43.267	25.756	7.400	136.889	163.76**	0.0001
B.	2.9777	2.2000	1.2000	0.3556	9.5111	256.53**	0.0001

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قدرة النمل الأبيض التحت أرضى " ساموتيرمس هيبوستوما " على حفر الأنفاق فى التربة المعاملة ببعض المبيدات

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١-قسم المبيدات - كلية الزراعة - جامعة المنصورة.

٢-قسم بحوث ناخرات الأخشاب والنمل الأبيض - معهد بحوث وقاية النباتات. الدقى. جيزة.

أثبتت التجارب أن قدرة النمل الأبيض ساموتيرمس هيبوستوما على بناء الأنفاق من حيث الطول وعدد التفرعات سجل معدلات مرتفعة مع حجم التربة الأكبر المعامل ٨٥٠ ميكرون وكانت المعدلات الأقل للنشاط البنائى مع حجم التربة الأقل المعامل ٢٥٠ ميكرون. فى نفس الوقت كان حجم التربة الأقل المعامل ٢٥٠ ميكرون الأكثر سمية والأسرع فى قتل الحشرات داخل الأنفاق من حجم التربة الأكبر المعامل ٨٥٠ ميكرون. أيضا معدلات النشاط البنائى للأنفاق كانت تضمحل وتقل معدلاتها مع زيادة تركيز المبيدات المختبرة وكان مبيد السبرمثرين الأكثر فعالية فى تثبيط النشاط البنائى للآفة تلاه مبيد الفبرونيل فى المرتبة الثانية أما مبيد الكلوربيريفوس فكان الأقل فعالية على الإطلاق عندما قورن بالبيدات المختبرة. كما لوحظ أن معدلات الرطوبة المناسبة والمضافة الى التربة مع كثافة عالية لتعداد الحشرات كانت عامل رئيسى ومحدد للنشاط البنائى للنمل الأبيض.

ومن خلال التحليل الإحصائى إتضح أن هناك فروق معنويه عالية بين المعاملات وأحجام التربة والتركيزات مع النشاط البنائى فى التربة المعاملة.