THE EFFECTIVE ROLE OF DESERT SUBTERRANEAN TERMITE *AMITERMES DESERTORUM* (DESNEUX) (ISOPTERA :TERMITIDAE) FOR CHANGING SOME SOIL PHYSICAL AND CHEMICAL CHARACTERISTICS

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ABSTRACT:

This study is concerned with subterranean termite activity *A. desertorum* as related to some changes in the physical and chemical characteristics of the tested soil at Aswan Governorate, Egypt. Infestation by this species is frequent in such region, where it attacks or infests the date palm trees, wood trees and soil field crops, as well as results in a greatly economic injury. Field observations and soil analysis showed that, foraging activity of *A. desertorum* results in various physical and chemical modifications in soil material, i.e., upward movement of fine soil particles from the subsurface dense fine textured to the surface one, which is emphasized by the relatively high contents of silt and clay fractions in soil mud tunnels and adhesive soil with P.V.C. traps (subterranean termites constrictions). Also, soil constriction materials showed more an increment in each of organic matter, total soluble salts, soluble cations & anions and low pH value than the uninfested soil material.

Key words: *Soil properties, subterranean termites, organic matter, A. desertorum, adhesive soil, adjacent soil.*

INTRODUCTION

Subterranean termite *Amitermes desertorum* (Desneux) live as colonies in more or less diffuse nests of scattered chambers in the soil. The different constructions of any termite colony such as runways, galleries, tunnels and chambers, are usually made up of fine soil fractions **(Ahmed 2003).** Subterranean termites select such fine soil particles from the subsurface soil horizons, thus may cause soil textural changes **(Lee and Wood, 1971a and Khlifa *et al.*, 1980).** Other data by **Nutting *et al.* (1973)** demonstrated that, subterranean termites could move considerable quantities of soil to the surface annually. Moreover, some species of subterranean termites are able to carry organic matter under ground and soil material above ground, thus mixing soil with organic matter **(Coaton, 1954).** Subterranean termites may also contribute to erode soil material and deposited it above ground, while consuming vegetation and litter. Furthermore, subterranean termites can be supported many physical and chemical changes in the soil material. **Brian *et al.* (1975)** reported that, capillary pore space was normally higher in termites free soil, while non capillary pore space was normally higher in termites infested soil. Such increase in the later pore size caused by termites galleries and tunnels, which may cause a decrease of soil bulk density **(Lee and Wood, 1971b).** Subterranean termite *Amitermes desertorum* is widely distributed throughout the various regions in Aswan. These subterranean termite attack date palm, living wood trees and wood debris. The objective of this study was aimed at identifying the effective role of subterranean termite *A. desertorum* for changing some properties of the soil under Aswan conditions.

MATERIALS AND METHODS:

Soil samples were collected from three regions infested with desert subterranean termite species *Amitermes desertorum* (Desneux), at Aswan Governorate, i.e., (Abou-El-Rich, Kom-Ombo and Draw region). From October 2009 – September 2010. Soil samples were taken and placed in plastic containers as follows:

1) One kilogram of soil was taken from mud tunnels of foraging workers caste.
2) One kilogram of soil was taken from adjacent soil to mud tunnels.
3) One kilogram of soil was taken from uninfested soil nearest the infested region.
4) One kilogram of soil was taken from adhesive soil to P.V.C. traps (soil translocation).

These soil samples were subjected to some soil analysis such as particle size distribution, soluble salts, soluble ions, calcium carbonate and organic matter contents.

Particle size distribution was determined using a method outlined by **Gee and Boulder (1986)**, soil texture class was obtained from the data of particle size distribution. Soil strength, commonly measured as penetration resistance which is related to soil compaction, the pocket penetrometer (El-28-670) was used to characterize the penetration resistance of the compacted soil blocks **(Klute, 1986).** Measurements and calculation of some soil chemical properties were made using the standard techniques described by **Page *et al.* (1982)**, as follows:

a) Calcium carbonate contents were determined volumetrically using a Collin's Calcimeter.
b) Soluble cations of Ca^{2+} and Mg^{2+} were determined by titration, with versine solution, while cations of Na^{+} and K^{+} were determined Photo-metrically using a Perkin Element Flame Photometer.
c) Soluble anions of CO_3^{2--}, HCO_3^{-} and Cl^{-} were determined by titration, and $SO4^{2-}$ by difference.
d) Total soluble salts, as electrical conductivity (ECe) was determined, using electrical conductivity meter.
e) Organic matter content was determined using the wet combustion method following Walkley and Black's method **(Page *et al*. 1982).**
f) Soil pH values were estimated in the standard soil paste using Beckman pH - meter.

RESULTS AND DISCUSSION

a. <u>Organic matter content:</u>

Data represented in Table (1), revealed that, the distribution of organic matter content depends on the intensive activity of *A. desertorum* for the decomposition process of organic constituents. Therefore, organic matter content tends to increase from 0.26% (uninfested soil) to 1.28, 2.15 and 2.67% for the adjacent soil, adhesive soil and mud tunnels at Abou El- Rich region, respectively. The corresponding organic matter contents were increased from

0.49% (uninfested soil) to 1.23, 2.18 and 2.56%, respectively, at Kom- Ambo region. Organic matter content tends to increase from 0.87% (uninfested soil) to 1.36, 2.23 and 2.37%, respectively, at Draw region. In this concern, **Said (1979) and El- Bassiouny (2001)** mentioned that, the organic matter content increased in soil tunnels as compared to the natural soil. **Jones (2000)** in Maliau found that, the species of subterranean termites (Rhinotermitidae) caused an increase for the organic matter in soils of the lower mountain being more suitable for soil dwelling and mountain termite as compared with the upper mountain, which has sand soils with a thick covering of peat.

b. Calcium carbonate content ($CaCO_3$):

The results presented in Table (1), showed a relatively high accumulation of calcium carbonate in the soil mud tunnels followed by adhesive and adjacent soils as compared to the uninfested one, at Abou El- Rich region. The corresponding increases in $CaCO_3$ contents were 7.42, 8.92 and 9.21% for the, adjacent soil, adhesive soil and mud tunnels soil respectively. At Kom- Ambo region, these increases were 7.61, 8.35 and 9.45% for the, adjacent soil, adhesive soil and mud tunnel soils respectively, vs. 6.31, 8.40 and 9.12% for the, adjacent soil, adhesive soil and mud tunnel soils, respectively, at Draw region. **Lee and Wood (1971 b)** mentioned that, calcium carbonate contents increased in each of tunnels, traps and infested soil as compared to the natural soil. This is mainly rendered to the continuous dissolution effect of the primary $CaCO_3$ in the initial soil under the presence of released CO_2 during organic matter decomposition, which enhances the carbonation process and the occurrence of soluble $Ca(HCO_3)_2$ by *A. desertorum* and then precipitated again as a secondary $CaCO_3$ in the soil materials of tunnels and traps as fine particales.

c. Soil PH

With respect to the soil pH value, data indicated that, its value tended to decrease from 8.11 (uninfested soil) to 7.24, 7.80 and 6.51 for the adhesive soil, adjacent soil, and mud tunnels soils, respectively, at Abou El- Rich region. The corresponding pH values were 8.20 (uninfested soil) and decreased to 7.10, 7.60 and 6.32 at Kom- Ambo region, vs. 8.19 (uninfested soil) 7.20, 7.50 and 6.14% at Draw region, respectively. Stoops (1964) mentioned that, soil pH value was relatively high in tunnels soil and traps soil as compared to the surrounding one. **Lee and Wood (1971a) in U.S.A and Badawi *et al*. (1986)** in Saudia Arabia reported that, soil pH values increased in trap soils and tunnel soils of *A. ochraceus* as compared to the uninfested one. This is probably due to the parallel increase in soluble sulfates (SO_4^{2-}) and organic materials.

d. Soluble salts

The maximum ECe value was associated with mud tunnel soils followed by the adhesive and the adjacent soils. The increases in the soluble salts (ECe values) at Abou El- Rich region reached 3.3, 2.1, 2.9 and 1.5% for mud tunnel soils, adjacent soils, adhesive soil and uninfested soil, respectively. The corresponding increase were 5.4, 2.8, 4.1 and 2.5 % at Kom Ambo region. The soluble salts (ECe values) reached 6.4, 4.3, 5.2 and 3.6 % for mud tunnel soils, adjacent soils, adhesive soil and uninfested soil at Draw region, respectively. This mainly due to their rapidly diffusion among the soil material concerning the soluble ions. **(Badawi *et al*. (1986)** mentioned that, a relative increase for salts in tunnel soils as compared to the surrounding ones.

Table (1) Organic matter, calcium carbonate, pH and total soluble salts of the different studied soil samples at the three tested regions of Aswan Governorate.

Regions	Soil samples	Organic matter %	Calcium carbonate %	Soil pH	Soluble salts (ECe) (dsm)
Abou El-Rich	a) Mud tunnels of foraging workers caste.	2.67	9.21	6.51	3.3
	b) Adjacent soil to mud tunnels.	1.28	7.42	7.80	2.1
	c) Adhesive soil to P.V.C. traps (translocation soil).	2.15	8.92	7.24	2.9
	d) Un infested soil.	0.26	5.41	8.11	1.5
Kom Ambo	a) Mud tunnels of foraging workers caste.	2.56	9.45	6.32	5.4
	b) Adjacent soil to mud tunnels.	1.23	7.61	7.60	2.8
	c) Adhesive soil to P.V.C. traps (translocation soil).	2.18	8.35	7.10	4.1
	d) Un infested soil.	0.49	6.53	8.20	2.5
Draw	a) Mud tunnels of foraging workers caste.	2.37	9.12	6.14	6.4
	b) Adjacent soil to mud tunnels.	1.36	6.31	7.20	4.3
	c) Adhesive soil to P.V.C. traps (translocation soil).	2.23	8.40	7.50	5.2
	d) Un infested soil.	0.87	5.52	8.19	3.6

e. <u>Partical size distribution:</u>

The mechanical fractions of different soil materials under investigation are given in Table (2) data obtained indicated that, a marked increase in the clay fraction was occurred for the soil materials of adjacent, adhesive and mud tunnels as compared to the uninfested one. At Abou El-Rich region, the increases in clay content for the studied soil materials, i.e., adjacent soil, adhesive soil and mud tunnel soils were 25.47, 24.62 and 35.09%, respectively. Also, the silt fraction behaves the same trend, expect of the maximum increases which was associated with the adhesive soil of P.V.C. traps. On the contrary, the reverse was true for the relatively coarse fraction (coarse and fine sand), where the corresponding decreases were 37.48, 24.60 and 26.30% for the adjacent soil, mud tunnels and adhesive soil of traps, respectively. A similar trend was observed for the studied soil mechanical fraction at both the studied regions of Kom Ambo and Daraw regions, the corresponding in clay content in adjacent soil, adhesive soil and mud tunnels soil were 26.38, 33.24 and 34.32%, respectively. Also, the corresponding decreases in coarse fraction were 32.56, 25.57 and 23.41% for the adjacent soil, mud tunnels and adhesive soil of traps, respectively. In Daraw region, the increases in clay content adjacent soil, adhesive soil and mud tunnels soil were 25.04, 27.12 and 26.75 %, respectively. On the contrary, the relatively decrease in the coarse were 38.92, 29.19 and 47.50 % for the adjacent soil, mud tunnels and adhesive soil of traps, respectively. The markedly increases of fine fractions could be interpreted on the basis of their migration or transportation by desert subterranean termite *A. desertorum* from the natural soil media towards the infested one, as well as, with more activity towards the tunnels and traps soils. This phenomenon leads to change the soil texture class from loam (uninfested and adjacent soils) to clay loam (mud tunnels soil and adhesive soil).

Table (2) Particle size distribution and soil texture of workers mud tunnels adjacent soil to mud tunnels, adhesive soil to P.V.C. traps and un infested soil at the three regions of Aswan Governorate.

Regions	Soil samples	Particle size distribution %				Soil texture class
		Sand		Silt	Clay	
		Coarse sand	Fine sand			
AbouEl-Rich	a) Mud tunnels of foraging workers caste.	7.32	17.28	40.31	35.09	Clay loam
	b) Adjacent soil to mud tunnels.	18.76	18.72	37.05	25.47	Loam
	c) Adhesive soil to P.V.C. traps (translocation soil).	10.34	15.96	45.16	28.54	Clay loam
	d) Un infested soil.	23.81	25.80	33.52	16.87	Loam
Kom Ambo	a) Mud tunnels of foraging workers caste.	6.53	19.04	40.11	34.32	Clay loam
	b) Adjacent soil to mud tunnels.	18.21	14.35	41.06	26.38	Loam
	c) Adhesive soil to P.V.C. traps (translocation soil).	11.24	12.27	43.25	33.24	Clay loam
	d) Un infested soil.	24.30	23.06	34.61	18.03	Loam
Draw	a) Mud tunnels of foraging workers caste.	7.16	22.03	44.06	26.75	Clay loam
	b) Adjacent soil to mud tunnels.	19.54	19.38	36.04	25.04	Loam
	c) Adhesive soil to P.V.C. traps (translocation soil).	15.07	11.08	46.73	27.12	Clay loam
	d) Un infested soil.	22.36	25.14	34.97	17.53	Loam

f. Soluble anions and Cations:

Data in Table (3) show that, the distribution pattern of cations was found in the descending order of Na^{+}> Ca^{2+} > Mg^{2+} > K^{+} for the uninfested and adjacent soils, while it was changed to Ca^{2+} > Na^{+} > Mg^{2+} > K^{+} for the mud tunnels soil and adhesive soil respectively.

This indicates that, a superiority for soluble Ca^{2+} for the later soil forms, with marked increases reached 85.17%, 81.92 and 84.39% for the mud tunnels soil in all studied regions. The corresponding decreases in the Na^{+} values reached 44.02, 41.65 and 43.09% for the mud tunnels soil in all three regions, respectively. Whereas, the soluble anions behaved a similar trend of Cl^{-} > $SO4^{2-}$> HCO_3^{-} for all the studied soil materials, with a pronounced increase for SO^{2-}_4 in the mud tunnels soil reached 77.50, 71.06 and 74.69% in all three 0regions, respectively. **Badawi *et al.* (1986)** mentioned that, the increase of So_4^{2-} reached 17 times in the infested soil as compared to the tunnels and traps soil.

Table (3) Soluble anions and cations of workers, mud tunnels adjacent soil to mud tunnels, adhesive soil to P.V.C. traps and un infested soil in the three regions of Aswan Governorate.

Regions	**Soil samples**	**Anions(mmolc L-)**			**Cations (mmol/L-)**			
		HCO^{3-}	CL-	$SO4^{2-}$	Ca^{2+}	Mg^{2+}	Na+	K+
Abou El-Rich	a) Mud tunnels of foraging workers caste.	3.10	79.40	77.50	85.17	28.20	44.02	2.26
	b) Adjacent soil to mud tunnels.	2.23	74.21	60.05	45.51	24.21	67.12	0.67
	c) Adhesive soil to P.V.C. traps (translocation soil).	3.91	78.01	64.54	58.42	34.51	52.47	1.83
	d) Un infested soil.	1.70	85.90	21.25	22.50	13.42	71.85	0.10
Kom Ambo	a) Mud tunnels of foraging workers caste.	3.82	80.24	71.06	81.92	26.11	41.65	3.21
	b) Adjacent soil to mud tunnels.	2.35	76.23	59.36	49.34	27.31	69.05	0.16
	c) Adhesive soil to P.V.C. traps (translocation soil).	3.58	75.06	76.18	60.08	36.82	49.52	2.46
	d) Un infested soil.	1.63	88.36	24.08	25.16	15.26	76.28	0.24
Draw	a) Mud tunnels of foraging workers caste.	3.06	79.82	74.69	84.39	29.08	43.09	3.15
	b) Adjacent soil to mud tunnels.	2.51	72.69	60.15	46.38	23.56	71.85	0.38
	c) Adhesive soil to P.V.C. traps (translocation soil).	3.49	75.52	73.26	59.96	38.65	49.22	1.16
	d) Un infested soil.	1.07	83.41	25.36	27.81	16.08	77.56	0.29

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الدور الفعال للنمل الابيض تحت الارضى من النوع
(Desneux) *Amitermes desertorum* فى تغيير بعض
الخصائص الطبيعية والكيميائية للتربه.

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تختص هذه الدراسة بنشاط حشرات النمل الابيض تحت الارضى من النـوع *Amitermes desertorum* فى أراضى محافظة أسوان وعلاقته بتغير بعض الخصائص الطبيعيه والكيميائية للتربة حيث تنتشر الاصابه بهذا النوع فى اغلب مناطق الاقليم حيث يهاجم زراعات النخيل المنتشره والاشجار الخشبية وايضا المحاصيل الحقليه الارضيه محدثا اضرار إقتصاديه خطيرة. وقد إتضح من الملاحظات الحقليه وتحليل التربه ان نشاط هذا النوع يترتب عليه بعض التغيرات فى الخواص الطبيعيه والكيميائية لمكونات التربة حيث ساهمت الحشرات خلال عملية السروح فى إنتقال وإعادة توزيع لحبيبات التربه الدقيقه (السلت والطين) وإستخدمتها فى بناء الانفاق الطينيه والتى تمثل ممرات الحركه للنمل من الطبقات السفليه للتربه الى السطحيه ومن ناحيه اخرى فقد حدث إختلاف فى تركيب ماده التربه المكونه للانفاق وكذلك التربه الملتصقه بالمصائد مما ادى الى إختلافها عن التربه المجاوره لهما ويوكد ذلك الزيادة فى محتوى التربه من الماده العضويه والاملاح الذائبه الكليه والكاتيونات والانيونات الذائبه علاوة على ميل قيم pH التربه الى الانخفاض مقارنة بمادة التربه الأصلية.