Minufiya J. Agric. Res. Vol. 33 No.1: 211 - 230 (2008)

ENZYME ACTIVITIES IN COMPOSTED SOIL TREATED WITH NEMATICIDES

M.A. El-Howeity[1], M.M. El-Shinnawi[2] and S.A. Abdel-Gawad[3]
1) Environmental Studies & Research Institute, Minufiya University, Sadat City, Egypt.
2) Dept. Soil Sci., Fac. Agric., Minufiya University, Shibin Elkom, Egypt.
3) Dept.Agric. Microbiology, Soils, Water and Environment Res. Inst., ARC,Giza, Egypt.

(Received: Dec., 16 , 2007)

ABSTRACT: ***In a laboratory trial, the influence of nematicides on biochemical processes in a silty clay loam soil (pH 7.3) amended with compost was examined. The nematicides carbofuran, oxamyl and cadusafas were used at levels of 0, recommended dose and 3- fold of the recommended dose. The soil was firstly enriched with a compost at rates of 0, 1 and 2%, moistened constantly to 60 % of its water–holding capacity and incubated at 30 oC. Activities of microbial enzymes, namely, dehydrogenase, nitrogenase, phosphatase (acid and alkaline phosphatases) and urease had been determined intermittently during a 45 – day course of the study.***

The results denoted that, application of the nematicides at the recommended doses stimulated the enzyme activities in the soil, except nitrogenase, but the highest doses of the nematicides were inhibitory. Carbofuran was the most depressive, followed descendingly by oxamyl and cadusafas.

Addition of compost at the rate of 1 % increased all of the microbial enzymes tested in the soil. Doubling the compost rate to 2% was of a highly stimulative effect on dehydrogenase, phosphatases (acid and alkaline) and urease activities in the soil, but conversely on the nitrogenase activity. Incorporation of compost reduced the inhibitory action of the nematicides on the enzyme activities determined in the silty clay loam soil under consideration.

Key words: ***Nematicides, Compost, Soil enzymes, Dehydrogenase, Nitrogenase, Phosphatase, Urease.***

INTRODUCTION

Soil microorganisms are agents involved in the biogeochemical cycles in nature. They are mainly responsible for soil fertility and hence crop productivity, via their role in the transformations of nutritional elements. Activities of these microorganisms are influenced by several environmental factors and cultivation operations. Studies on soils exposed to tropical or temperate climates under different cultivation systems showed that bacterial

activities are correlated with content of organic matter (Appiah and Thomas, 1982). By being heterotrophic microorganisms, they depend on an organic carbon source for growth and activity and this source may be provided by the addition of organic matter to the soil, in this manner, the incorporation of green manure increased dehydrogenase, phosphatase and urease activities, as well as microbial biomass (Bolton et al., 1985). Despite, microorganisms make up to 1-3% of the total amount of organic component in the soil, they act directly and indirectly on the availability of plant nutrients (Mc Gill et al., 1986). For the mineralization of an organic substrate to occur, both the synthesis and the activity of a specific enzyme or enzyme complex are needed, and these processes may be linked to the presence of countless factors directly implicated in the mechanism of synthesis and secretion (Martens et al., 1992).

The extensive use of pesticides during the last fifty years had led to their becoming ubiquitous pollutants in soils, crops, groundwater, and human and animal tissues. The main categories of compounds used as pesticides are as follows, insecticides, fungicides, herbicides and nematicides. Levanon (1993) studying the biodegradation of pesticides, found that , the mineralization of alkyl-sise chains of alachlor and alkyl- amino-side chains of atraizne was found to be mainly due to fungal activity, but the mineralization of carbofuran and malathion was mainly due to bacterial activity. Singh and Singh (2005) examined the impacts of diazinon and lindane treatments on dehydrogenase and alkaline phosphomonoesterase enzyme activities. Diazinon seed treatment had no significant effect on dehydrogenase and alkaline phosphomonoesterase enzyme activities. In diazinon soil treatment, there were a significant increase in dehydrogenase and decrease in alkaline phosphomonoesterase activities. Gundi et al.(2007) studying the interaction of insecticides monocrotophos and quinalphos (organophosphates), and cypermethrin (pyrethroid) on microbial activities in soil, found that individual application of the three insecticides at 5, 10 and 25 µg g^{-1} to the soil distinctly enhanced the activities of cellulase and amylase. At lower levels, 5 and 10 µg g^{-1}, the insecticides in combination interacted additively or synergistically toward both enzymes. But, both combinations at the highest level of 25 µg g^{-1} exhibited an antagonistic interaction, with a reduction in enzyme activities. Bending et al.(2007) found that, three fungicides, i.e. azoxystrobin, tebuconazal and chlorothalonil significantly reduced dehydrogenase activity to varying extents in the low organic matter but not in the high organic matter content in soil.

Nematicides are important category of pesticides, they are directly introduced onto the soil to control the faunal nematode pests (Manahan,

1991). El-Howeity (1997) found that, adding furdan and nemacur to different arid soils slightly inhibited the dehydrogenase activity, the magnitude of their action varied depending on the nature of each of the compound and the soil, as well as on moisture content. Increasing the moisture content of soil decreased the severity of the applied nematicides. Megharaj et al.(1999)studied the effects of fenamiphos on native algal populations and enzymatic activities in soil. They found that, nearly 80% of added fenamiphos disappeared in unautoclaved soil during 20-day incubation. In autoclaved soil incubated under similar conditions the recovery of fenamiphos was about 91%. That indicated the involvement of microorganisms in degradation of the compound. Fenamiphos in genral was not toxic to the soil algal community and soil enzymes dehydrogenase, phosphatase and B-glucosidase. Therefore fenamiphos at field application rates might not endanger the non-target microorganisms and their activities in soil.

The present work aimed at studying the influence of some nematicides, usually applied in the Egyptian agriculture, namely, carbofuran, oxamyl and cadusafas, on the activities of major microbial enzymes, that contribute to the availability of plant nutrients in soil, i.e. dehydrogenase, phosphatase, nitrogenase and urease in an arid arable soil amended with compost.

MATERIALS AND METHODS

Soil

Samples of a soil were collected from the upper layer (0-20 cm)from agricultural area (Giza, Egypt) , air-dried and ground to pass a 2-mm sieve. Routine analyses of this soil were carried out following the methods described by Page et al.(1982). Data obtained are presented in Table (1 a & b). The soil was silty clay loam, poor in organic matter and having a neutral pH.

Table (1) Analytical data of the experimental soil.

a. Physical Properties

$CaCO_3$ (%)	Organic matter (%)	Particle size distribution (%)				Textural class
		Coarse Sand	Fine Sand	Silt	Clay	
5.20	0.36	12.0	45.6	13.1	29.3	Silty clay loam

b. Chemical Properties

pH^*	EC^{**} (dSm^{-1})	Soluble cations (meq/L)				Soluble anions (meq/L)			
		Ca^{++}	Mg^{++}	K^+	Na^+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
7.3	2.40	7.02	10.66	0.41	6.00	-	2.60	7.84	13.65

* In the 1: 2.5 soil / water suspension . ** Electrical conductivity in 1: 5 soil / water extract (w/v).

Compost

Compost was mixed with the soil at the rates of 0,1 & 2 %(w/w). Chemical analysis of the compost used is presented in Table (2) . The methods followed were according to Page et al.(1982).

Table (2). Characteristics of the compost applied.

pH (1:2.5)	E.C (dSm^{-1})	$O.C^*$ (%)	$O.M^{**}$ (%)	Total N (%)	C/N Ratio	Total P (%)	Total K (%)
7.6	1.11	35.00	59.34	1.45	24.09	1.80	1.70

* O.C.= Organic carbon . ** O.M.= Organic matter.

Nematicides

Three nematicides, usually applied in the Egyptian agriculture are tested in the present study, namely, carbofuran, oxamyl and cadusafas. Detail data on such agrochemicals are shown in Table (3), quoted from Tolmin (2006).

Experimental Technique

Sub samples of 200 g sifted air dry soil were weighed. Finely pulverized compost was added to each sub sample, at rates of 0, 1 and 2% and entirely mixed, then placed in plastic pots (having dimensions of 15 cm height and 10 cm diameter). The nematicides concerned were introduced (as colloidal solutions) onto the potted soil at 0, the recommended dose, and 3 – fold (times) of the recommended dose (Table3). All treatments were moistened with deionized water to 60% of the water- holding capacity of the soil and kept constant along 45- day experimental course , by compensating the evaporation losses every three days (by weighing the pots). Each treatment was replicated 15 times , i.e., three for the assay of each of dehydrogenase, nitrogenase , acid phosphatase, alkaline phosphatase, and urease activities in the soil. The pots were left at the ambient laboratory temperature (27- 30 °C) along the experimental duration.

Assay of Enzyme Activities

Activities of the enzymes under study were determined according to the following methods:

- **Dehydrogenase: colourimetrically, for the 2,3,5- triphenyl formazan (TPF) produced from the reduction of 2,3,5- triphenyl tetrazolium chloride (TTC), using acetone for extraction…..(Casida *et al.,*1964).**
- **Nitrogenase: by means of gas liquid chromatograph for ethylene produced from the reduction of acetylene….(Hardy *et al.,* 1973).**
- **Phosphatases: colourimetrically, using modified universal buffer (MUB) at pH 6.5 for acid phosphatase and pH 11 for alkaline phosphatase… (Tabatabai,1982).**
- **Urease: colourimetrically, for the residual urea by P-dimethyl- aminobenza-ldehyde solution…. (Porter,1965).**

RESULTS AND DISCUSSION

Dehydrogenase Activity (DA)

Dehydrogenase activity (DA) is frequently used as a measurement of the overall microbial activity in a soil. Changes in DA during incubation of the different treatments are presented in Table (4). Results showed that, DA increased in the soil with time reaching a maximum (56 µg TPF/ g dry soil/ day) for the control treatment after15 days of incubation, thereafter gradually decreased.

Addition of compost at both rates (1 and 2%) increased DA in the soil, such increases, respectively, reached 50.70 and 128.60 % above the control (unamended), as a result of stimulating the proliferation of soil biomass. Dehydrogenases catalyze the electron transfer yielding the energy required for the anabolic processes of various microorganisms inhabiting the soil. Through such reactions, the energy source, or electron donor, is converted to a simpler form that could be utilized by other organisms (plants and microbes). Hence, such enzymes are not only responsible for oxidation-reduction processes, but are also involved in the recycling of elements in soil for the benefit of both macro- and microflora (Burns,1985). Organic materials serve as the nutritional supply and energy source for the major part of microbial population in soil, e,g. heterotrophs. Lima *et al*.(1996); El-Howeity (1997); El-Shinnawi *et al.* (1997); Crecchio *et al.*(2004) and Lee *et al.* (2004), pointed out that the addition of sewage sludge, dried blood and peat moss or compost as a source of organic matter increased DA in soils. In a recent study, Melero *et al.* (2007) found that, addition of two mature composts (vegetal and animal composted wastes) at a rate of 30 t ha^{-1} over 4 years had led to increases in quantity of total organic carbon, improvement of soil chemical and biological status, quality of humic acids, and increased microbial biomass and dehydrogenase activity in soils.

Incorporation of nematicides, in general, at the recommended doses increased the activity of DA, with the exception of carbofuran which showed lower values of the enzyme activity in soil. On the other hand, addition of the nematicides at 3 times of the recommended doses inhibited the DA in soil, the decreases reached 47.40, 41.78 and 34.74 %, as compared with the untreated soil, for carbofuran, oxamyl and cadusafas, respectively. These results are in harmony with those of Miterer *et al.* (1981); Ross and Speir (1984); Abou-El-Naga (1989); El-Howeity (1997) and Abou-Zeid (2001) who reported that application of benomyl, oxamyl, fenamiphos, temic, carbofuran and nemacur inhibited DA in soils. The harmful effect might be due to the chemical structure of nematicides and/ or the dose applied.

Table (4) Activity of dehydrogenase in the composted soil treated with nematicides (µ g TPF / g dry soil).

Treatments		Incubation Time (days) 0	7	15	30	45	Mean	Difference from Control(%)
Control(no additives)		37	48	56	42	30	42.60	00.00
Compost	1%	39	58	78	89	57	64.20	+50.70
	2%	42	97	123	131	94	97.40	+128.60
Nematicides (1R)*	Carbofuran	36	42	34	23	17	30.40	- 28.63
	Oxamyl	38	51	61	52	38	48	+ 12.14
	Cadusafos	37	42	59	43	35	43.20	+ 1.40
Nematicides (3R)*	Carbofuran	34	29	22	16	11	22.40	-47.40
	Oxamyl	36	31	24	19	14	24.80	-41.78
	Cadusafos	36	41	25	20	17	27.80	-34.74
Compost(1%) + Nematicides(1R)	Carbofuran	38	53	66	57	39	50.60	+18.77
	Oxamyl	38	58	78	63	44	56.20	+31.92
	Cadusafos	41	66	83	69	51	62.00	+45.53
Compost(1%) + Nematicides(3R)	Carbofuran	35	41	48	32	26	36.40	-14.55
	Oxamyl	37	49	57	45	33	44.20	+3.75
	Cadusafos	37	53	64	49	39	48.40	+13.60
Compost(2%) + Nematicides(1R)	Carbofuran	37	61	71	63	41	54.60	+28.16
	Oxamyl	38	65	76	68	51	59.60	+39.90
	Cadusafos	40	65	89	73	54	64.20	+50.70
Compost (2%) + Nematicides(3R)	Carbofuran	36	47	54	44	35	43.20	+1.40
	Oxamyl	37	48	58	45	35	44.60	+4.69
	Cadusafos	39	54	61	47	36	47.40	+11.26

* (1R) = Single recommended dose, (3R) = Triple recommended dose.

Introduction of compost (at 1%) together with the nematicides lowered the depressive action of the nematicides, when the effect of the nematicides was improved to record 17.88, 31.90 and 45.50 % above the control for carbofuran, oxamyl and cadusafas, respectively at their lower doses. Higher rate of compost (2%) had more promotive role in such concern, at either dose of the nematicides applied (Table 4).

These results are in harmony with those found by El-Shinnawi *et al.* (1997) who mentioned that, magnitude of the action of nematicides varied relating to

the nature of each of the compound and the soil, as well as to the moisture content. Composition and molecular structure of the nematicide, as a synthetic organic material, control the degree of its toxicity and biodegradability, since such substance might be utilized as a source of organic carbon and energy by some tolerant or less susceptible chemooganotrophic microbial agents. Earlier works by Garcia and Hernandez (1996) and Lima *et al.* (1996) revealed that the addition of bromacil (pesticide) alone decreased DA , while incorporation of organic matter mixed with bromacil increased the activity of such enzyme.

Nitrogenase Activity (NA)

The enzyme nitrogenase catalyzes the reactions leading to bring the gaseous N_{2}- available for both soil microorganisms and growing plants by diazotrophic agents. Results presented in Table (5) demonstrated the effect of nematicides added to the soil enriched with compost on acetylene reduction activity, by the concerned microbial population. Results showed that, nitrogenase activity NA increased in the soil with time reaching a maximum (4.4 µl C_2H_4/ g^{-1} /hr^{-1}) for the control treatment on the 15th day of incubation, thereafter gradually decreased. The other treatments had obvious encouraging effects on the activity of free- living diazotrophic microbial population in the soil. Addition of compost at the rate of 1% increased the NA (to 6.5 µl C_2H_4/ g^{-1} /hr^{-1}) on the 15th day, corresponding to 42.50 % above the control. However, the higher rate of compost (2%) reduced the NA in soil , due to the appreciable combined nitrogen content of the compost used (see Table 2), which inhibited the function of nitrogenase within the microbial cells. These results coincided with those obtained by El-Shinnawi and Frankenberger(1988) who found that, application of manures generally depressed the nitrogenase activity in soils.

Incorporation of nematicides at both doses, generally, suppressed the activity of nitrogenase enzyme in the soil. It was observed that carbofuran had the most depressive effect, and followed descendingly by oxamyl and cadusafas. Extents of decreases, as compared with the control, reached 20.62, 7.50 and 14.37% with the recommended doses and 35.00, 16.80 and 25.00% with the higher doses of carbofuran, oxamyl and cadusafas, respectively.

Table (5) Activity of nitrogenase in the composted soil treated with nematicides (µ l C_2H_4 g^{-1} dry soil hr^{-1}).

Treatments		Incubation Time (days)					Mean	Difference from Control(%)
		0	7	15	30	45		
Control(no additives)		2.7	3.8	4.4	3.1	2.0	3.2	00.00
Compost	1%	3.0	4.7	6.5	4.9	3.7	4.56	+42.50
	2%	2.7	3.5	3.9	2.7	1.7	2.90	-9.37
Nematicides (1R)*	Carbofuran	2.5	3.1	3.7	2.0	1.4	2.54	-20.62
	Oxamyl	2.6	3.7	4.1	2.5	1.9	2.96	- 7.50
	Cadusafos	2.5	3.4	4.0	2.2	1.6	2.74	-14.37
Nematicides (3R)*	Carbofuran	2.1	2.8	3.4	1.3	0.8	2.08	-35.00
	Oxamyl	2.4	3.3	3.9	2.1	1.6	2.66	-16.87
	Cadusafos	2.4	3.1	3.6	1.8	1.1	2.40	-25.00
Compost(1%) + Nematicides(1R)	Carbofuran	2.5	3.2	4.3	3.1	2.4	3.10	-3.12
	Oxamyl	2.7	4.1	5.2	3.7	2.8	3.70	+15.62
	Cadusafos	2.5	3.8	4.7	3.5	2.5	3.40	+6.25
Compost(1%) + Nematicides(3R)	Carbofuran	2.2	3.1	3.3	2.0	1.1	2.34	-26.87
	Oxamyl	2.5	3.6	4.0	2.7	1.5	2.86	-10.62
	Cadusafos	2.4	3.3	3.8	2.3	1.4	2.64	-17.50
Compost(2%) + Nematicides(1R)	Carbofuran	2.5	3.1	4.0	2.3	1.5	2.68	-16.25
	Oxamyl	2.7	3.6	4.3	2.8	2.1	3.10	-3.12
	Cadusafos	2.7	3.5	4.2	2.5	1.8	2.94	-8.12
Compost (2%) + Nematicides(3R)	Carbofuran	2.4	3.0	3.3	1.8	1.0	2.30	-28.12
	Oxamyl	2.5	3.7	4.1	2.8	1.7	2.96	-7.50
	Cadusafos	2.5	3.5	3.9	2.6	1.5	2.80	-12.50

* (1R) = Single recommended dose, (3R) = Triple recommended dose.

Presence of 1% compost in the soil reduced the nematicide harmful effects only with oxamyl and cadusafas, but not with carbofuran. However, raising the rate of compost applied augmented the passive action on the NA in soil treated with the assigned nematicides at either dose added. Such results confirm those obtained by Salem and Subramonian (1988), and Abou-Zeid(2001),who reported that adding nematicides or high organic matter to soil led to decreases in nitrogenase activity .

Phosphatase Activity (PA)

Phosphatases are the biocatalysts that involved in the liberation of mineral phosphorus from its organic sources for the use of growing plants.

A. Acid Phosphatase: Data presented in Table (6) showed the periodical changes in the activity of acid PA in soil under the experimental treatments. Results declared that such enzyme increased in the control soil after 7 days when reached 252 µg P g^{-1} dry soil hr^{-1}. The addition of compost enhanced the enzyme activity, to show means of 34.50 and 44.20 % above the control with adding 1 and 2% compost, respectively. The maximum values obtained throughout were 354 and 380 µg P g^{-1} dry soil hr^{-1} after 15 days of incubation, thereafter began to decrease gradually.

Increases in the acid PA in soil upon using such organic amendments encouraged the microbial community, thus more active dephosphorelation by the chemoorganotrophs, in presence of organic carbon and energy sources for their proliferation, had taken place. Garcia and Hernandez (1996) ; Lima, et al.(1996); Crecchio, et al.(2004)and Melero, et al.(2007)observed that application of sewage sludge and compost increased phosphatase enzyme activity in soils.

It was noticed that, addition of the nematicides at the recommended doses resulted in slight decreases in the acid PA with carbofuran, but increases with oxamyl and cadusafas reaching 0.78 and 3.74 %, respectively. However, incorporation of the nematicides at the higher doses lowered the enzyme activity by 3.40, 3.92 and 3.22 % referring to the control, with carbofuran, oxamyl and cadusafas, respectively. It was obvious that the nematicides at the lower doses could be degradable, as they might represent sources of carbon and energy for the responsible microbial agents. The higher doses of nematicides were, in turn, detrimental. Zaghloul, et al.(2003) noted that inoculation of soil with *Azospirillum baselines* combined with insecticides application accelerated the degrading rate and transformation of both carbofuran and temic especially when the mixture of two strains were used.

Table (6) Activity of acid phosphatase in the composted soil treated with nematicides (µ g P g^{-1} dry soil hr^{-1}).

Treatments		Incubation Time (days)					Mean	Difference from Control(%)
		0	7	15	30	45		
Control(no additives)		216	252	245	228	206	229.40	00.00
Compost	1%	224	322	354	339	304	308.60	+34.50
	2%	229	343	380	372	330	330.80	+44.20
Nematicides (1R)*	Carbofuran	216	246	244	224	215	229.00	-0.17
	Oxamyl	216	248	241	234	217	231.20	+0.78
	Cadusafos	216	255	246	234	221	238.00	3.74
Nematicides (3R)*	Carbofuran	210	241	234	217	206	221.60	-3.40
	Oxamyl	210	239	236	216	201	220.40	-3.92
	Cadusafos	211	243	236	217	203	222.00	-3.22
Compost(1%) + Nematicides(1R)	Carbofuran	219	297	342	321	289	293.60	+27.98
	Oxamyl	221	320	360	324	314	307.80	+34.17
	Cadusafos	219	335	368	354	311	317.40	+38.36
Compost(1%) + Nematicides(3R)	Carbofuran	213	251	268	240	228	240.00	+4.62
	Oxamyl	214	271	289	262	242	255.60	+11.42
	Cadusafos	216	283	301	286	263	269.80	+17.61
Compost(2%) + Nematicides(1R)	Carbofuran	222	301	334	302	280	287.80	+25.45
	Oxamyl	220	326	347	313	316	304.20	+32.60
	Cadusafos	220	350	371	337	316	318.80	+39.97
Compost (2%) + Nematicides(3R)	Carbofuran	216	239	262	231	231	235.80	+2.78
	Oxamyl	219	277	299	269	256	264.00	+15.08
	Cadusafos	219	383	321	309	271	300.60	+31.03

* (1R) = Single recommended dose, (3R) = Triple recommended dose.

Regarding the effect of the introduced nematicides combined with compost, results of Table (6) denoted stimulations of the acid PA throughout. Rates of increases were 27.98, 34.17 and 38.36 % compared to the control with 1% compost and 4.6, 11.4 and 17.6 % with 2% compost for carbofuran, oxamyl and cadusafas, respectively. Ross and Speir (1985) and Kole and Raghu (1990) who mentioned that, addition of oxamyl or carbofuran did not affect phosphatase activity. Lima et al.(1996); Abou-Zeid(2001); Crecchio et al.

(2004); Lee et al.(2004) and Melero et al.(2007)demonstrated that, using organic matter increased phosphatase activity in soils.

B. Alkaline Phosphatase: Data presented in Table (7) indicated that, the same trend of actions of the experimental treatments, previously noticed for the acid phosphatase, was also observed for the alkaline phosphatase. Addition of compost at both rates (1 and 2%) increased the alkaline PA in soil up to 24.00 and 40.46% above the control, respectively. The nematicide carbofuran, at the lower dose, caused slight decreases in such enzyme activity, i.e., 0.94 % below the control, but oxamyl and cadusafos led to increases reached up to 3.14 and 2.93%, in order. The higher doses of all nematicides used decreased the alkaline PA in soil to reach 4.12, 3.09 and 2.80 % below the control, for carbofuran, oxamyl and cadusafas, respectively. These results confirm the findings of earlier workers, i.e. Quilt et al.(1979),Ross and Speir (1984)and Abou-Zeid(2001) who pointed out that, the addition of low doses of pesticides did not affect phosphatase activity but adding high doses of pesticides reduced the microbial phosphatase activities in soil.

As a result of the nematicides application in presence of compost, the harmful effect of such agrochemicals was not only diminished but also some increases occurred for the alkaline PA. Extent of enhancement depended on the rate of compost added, as well as on dose and kind of the nematicide used.

Noteworthy that, the highest value of such enzyme activity was recorded on the 30th day of incubation , reaching 8.70, 29.66 and 30.00 % above the control with the lower doses of nematicides at 1% compost, and 1.23 , 14.90 and 17.68% with the higher doses at the same rate of compost for carbofuran, oxamyl and cadusafas , respectively.

Addition of the higher rate of compost (2%) with the lower doses of nematicides gave increases of 11.82, 27.83 & 28.93% and with the higher doses3.00, 20.72 & 22.01 % for the same mentioned order of the tested nematicides. This is logically attributed to the role of organic matter in restricting the passive action of nematicides, on one hand, and its role as nutrient and energy source for the micrbiota in soil .This result agree with those obtained by Garcie and Hernandez (1996); Lima et al. (1996) and Lee et al.(2004) who reported that addition of organic matter reduced the toxicity of pesticides in soil.

Table (7) Activity of alkaline phosphatase in the composted soil treated with nematicides (μ g P g^{-1} dry soil hr^{-1}).

Treatments		Incubation Time (days)					Mean	Difference from Control(%)
		0	7	15	30	45		
Control(no additives)		185	210	199	187	173	190.80	00.00
Compost	1%	189	240	296	227	231	236.60	+24.00
	2%	196	270	316	293	265	268.00	+40.46
Nematicides (1R)*	Carbofuran	183	199	198	190	175	189.00	-0.94
	Oxamyl	184	213	215	189	183	196.80	+3.14
	Cadusafos	182	214	205	193	188	196.40	+2.93
Nematicides (3R)*	Carbofuran	182	189	190	183	170	182.92	-4.12
	Oxamyl	177	201	197	178	171	184.90	-3.09
	Cadusafos	180	201	193	183	170	185.40	-2.80
Compost(1%) + Nematicides(1R)	Carbofuran	186	220	222	211	200	207.40	+8.70
	Oxamyl	185	245	285	275	247	247.40	+29.66
	Cadusafos	183	245	285	279	248	248.60	+30.00
Compost(1%) + Nematicides(3R)	Carbofuran	183	199	202	192	188	193.16	+1.23
	Oxamyl	184	224	249	229	209	219.24	+14.90
	Cadusafos	181	231	273	227	209	224.54	+17.68
Compost(2%) + Nematicides(1R)	Carbofuran	186	216	235	230	199	213.36	+11.82
	Oxamyl	188	251	264	285	232	243.90	+27.83
	Cadusafos	188	257	292	263	230	246.00	+28.93
Compost (2%) + Nematicides(3R)	Carbofuran	183	203	210	195	190	196.54	+3.00
	Oxamyl	184	229	262	251	224	230.34	+20.72
	Cadusafos	181	245	286	230	224	232.80	+22.01

* (1R) = Single recommended dose, (3R) = Triple recommended dose.

Urease Activity (UA)

It is known that urea is used as a chemical organic nitrogenous fertilizer. It requires an enzymatic hydrolysis to make its nitrogen content available to plant. Urease enzyme is the bio catalyst responsible for such process in soil.

Results presented in Table (8) exhibited the effect of nematicides added to the soil in presence or absence of compost on urease activity UA. In the control treatment, without nematicides, UA slightly increased by addition of compost, at both rates, to reach 44.19 and 78.02 % above the control without organic amendment, at 1 and 2 %, respectively. These results are in harmony with those of Doraisomy and Ajukunna(1993); Garcia and Hernandez(1996) and Crecchio et al.(2004) who found that, addition of cowdung , cowdung

slurry , sewage sludge and municipal soild waste increased urease activity up to 15.4% . Also, Nayak et al.(2007) found that, long-term application of compost increased microbial biomass and urease activity in soil.

Table (8) Activity of urease in the composted soil treated with nematicides ($\mu gNH^{+}{}_{4}$-N g^{-1} dry soil day^{-1}).

Treatments		Incubation Time (days)					Mean	Difference from Control(%)
		0	7	15	30	45		
Control(no additives)		24.5	25.7	25.9	23.5	22.8	24.48	00.00
Compost	1%	26.7	38.5	38.8	37.0	35.5	35.30	+44.19
	2%	26.8	48.5	49.1	48.0	45.5	43.58	+78.02
Nematicides (1R)*	Carbofuran	24.2	27.5	28.6	24.0	22.5	25.36	+3.59
	Oxamyl	23.3	27.0	32.5	30.5	23.3	27.32	+11.60
	Cadusafas	24.4	25.7	25.8	25.1	23.8	24.69	+1.96
Nematicides (3R)*	Carbofuran	20.8	23.7	24.1	22.8	21.7	22.62	-7.59
	Oxamyl	22.8	26.5	24.6	23.1	22.1	23.82	-2.69
	Cadusafas	22.3	24.6	24.2	21.1	20.7	22.58	-7.76
Compost(1%) + Nematicides(1R)	Carbofuran	24.4	36.2	36.5	36.0	33.7	33.36	+36.27
	Oxamyl	25.1	42.5	43.4	42.3	27.1	36.08	+47.38
	Cadusafas	24.9	35.6	36.2	34.0	30.0	32.14	+31.29
Compost(1%) + Nematicides(3R)	Carbofuran	23.2	30.3	31.8	29.0	27.7	28.30	+15.60
	Oxamyl	23.3	32.5	32.8	30.3	25.1	28.78	+17.56
	Cadusafas	22.1	28.1	28.3	27.5	25.5	26.30	+7.43
Compost(2%) + Nematicides(1R)	Carbofuran	24.9	41.8	41.0	38.3	36.4	36.48	+49.01
	Oxamyl	24.7	45.1	46.9	43.5	36.3	39.30	+60.53
	Cadusafas	26.6	40.5	38.8	38.7	35.9	36.10	+47.46
Compost (2%) + Nematicides(3R)	Carbofuran	24.1	33.7	36.5	35.3	32.1	32.34	+32.10
	Oxamyl	24.7	37.1	36.2	35.0	33.2	33.24	+35.78
	Cadusafas	23.7	33.0	33.4	32.1	30.5	30.54	+24.75

*** (1R) = Single recommended dose, (3R) = Triple recommended dose.**

Incorporation of the nematicides at the recommended doses improved the UA in soil to surpass the control by 3.59, 11.60 &1.96% for carbofuran , oxamyl and cadusafas , but elevating the doses suppressed the UA, to reach

7.59, 2.69 and 7.76 % below the control with carbofuran , oxamyl and cadusafas, respectively. These findings are in harmony with those of Beltagy(2000)and Moussa (2004) who revealed that cadusafas and aldicarb had significantly decreased urease activity in soils as compared with control.

Addition of the nematicides in presence of 1% compost increased the UA to 36.27, 47.38 & 31. 29 %, at their lower doses, and to 15.60, 17.56 &7.43 % at the higher doses of carbofuran, oxamyl and cadusafas, respectively. Application of 2% compost promoted the UA in soil to reach 49.01, 60.53& 47.46 % at the lower doses of nematicides and to 32.10, 35.78 & 24.75 % at the higher doses for carbofuran, oxamyl and cadusafas, respectively. Those increases in the UA are due to the effect of compost on alleviating the deleterious action of nematicides and promoting microbial processes in the soil. Garia and Hernandez (1996) showed that urease activity increased with addition of bromacil (a pesticide) and combined addition of sewage sludge and bromacil also led to increase such enzyme activity.

Soil enzymes are bioorganic catalysts produced by microbial population, in order to depolymerize the organic macromolecules to their primeraly building blocks (monomers and elements). Many factors influence the activities of these enzymes in their environment, i.e. soil conditions and cultivation practices. Nematicides, because of their direct application onto the soil, have a special interest on enzyme action. The present work, as well as, that of other workers confirmed that kind of nematicide ,i.e. structural formula, molecular composition and weight and used dose contribute to the particular action of such compound on the non-target microorganisms. Presence and amount of organic matter in soil , as a sole source of carbon and energy for the majority of microflora , inhabiting the soil (chemoorganonotrophs) play an outstanding role in restricting the effect of such detrimental pesticide compounds , via encouraging the proliferation and tolerance of the microbiota. A probable interaction among the metabolites of organic materials and the applied nematicides might be also involved in diminishing the deleterious effect of the agrochemical applied. Noteworthy that, some pesticides, under certain circumstances, could be stimulating to some or more microorganisms . Our present study declared the effect of three popular nematicides used in the Egyptian agriculture, on the activity of major soil enzymes, qualitatively and quantitatively. Such enzymes are directly and indirectly, responsible, to a large extent, for soil fertility and its productivity.

REFERENCES

Abo El-Naga, S.A. (1989). Influence of some nematicides on microbial processes in faba bean planted soil. Proc. Third –World Conference on Environmental and Health Hazards of Pesticides : 319-330.

Abou-Zeid,M.Y.(2001). Biochemical investigation on a symbiotic nitrogen – fixing bacteria as a biofertilizer. Ph.D., Fac.Agric.,Cairo Univ., Egypt.

Appiah, M.R. and R.L. Thomas (1982). Inositol phosphate and organic phosphorus contents and phosphatase activity of some Canadian and Ghanaian soils. Can.J.Soil, 62:31-38.

Beltagy, M.M.H.(2000). Side effect of certain pesticides on earthworms in soil.M.Sc.Thesis., Fac.Agric.,Minufiya Univ., Egypt.

Bending G.D.,M.S.Rodriguez-Cruz and S.D.Lincoln(2007). Fungicide impacts on microbial communities in soils with contrasting management histories. Chemosphere , 69(1):82-88.

Bolton, Jr.,H.Elliott, L.F. Papendick and D.F.Bezdicek(1985). Soil microbial biomass and selected soil enzyme activities :effect of fertilization and cropping practices. Soil Biol. Biochem., 17:297- 302.

Burns, R.G. (1985). Enzyme activity in soil : location and a possible role in microbial ecology . Soil Biol.Biochem., 14:423- 427.

Casida,L.E., D.A.Kiein and T. Santoro (1964). Soil dehydrogenase activity. Soil Sci., 89:371-376

Crecchio ,C.,M.Curci, D.R.Pizzigallo, P.Ricciut and P.Ruggiero(2004). Effects of municipal soild waste compost amendments on soil enzyme activities and bacterial gentic diversity. Soil Biol. Bioch., 36:1595-1603.

Doraisomy, P. and K. Ajukunna (1993). Effect of carbofuran on urease activity of certain organic matter amended soil. Madras,Agric.J., 5:296-297.

El-Howeity, M.A. (1997). Ecological studies on soil microorganisms .M.Sc. Thesis, Fac. Agric., Minufiya Univ., Egypt.

El-Shinnawi,M.M.and W.F.Frankenberger(1988). Salt inhibition of free living diazotroph population density and nitrogenase activity in soil. Soil Sci.,146:176-184.

El-Shinnawi, M.M., S.A. Aboel-Naga and M.A. El-Howeity (1997). Nitrogen dynamics and dehydrogenase activity in soils treated with nematicides at varying moisture contents. Minufiya J. Agric.Res., 22 (2):613-638.

Garcia,C. and T. Hernandez(1996). Effect of bromacil and sewage sludge addition on soil enzymatic activity . Soil Sci.Plant Nutr.,42(1):191-194.

Gundi V.,B.Viswanath, M.S.Chandra, V.N.Kumar and B.R. Reddy (2007). Activities of cellulase and amylase in soils as influenced by insecticide interactions. Ecotoxicology and Environmental Safety, (Article in press).

Hardy, R.F., R.C. Burns and R.D.Holsten (1973). Applications of the acetylene –ethylene assay for measurement of nitrogen fixation . Soil Biol. Biochem., 5:47-81.

Kole, S.P. and K.Raghu (1990). Effect of carbofuran on soil phosphatase and aryl sulfatase activities .J.Env.Biolo.,111:1-5.

Lee, J.J., Ro-D.Park, Y.W. Kim, J.H. Shim, D.H.Chae, Y.S. Rim, B.K. Sohn, T.H. Kim and K.Y. Kim (2004). Effect of food waste compost on microbial population, soil enzyme activity and lettuce growth. Bioresource Technology,93:21-28.

Levanon, D. (1993). Roles of fungi and bacteria in the mineralization of pesticides atrazine, alachlor, malathion and carbofuran in soil. Soil Bio. Bioch., 25(8):1097-1105.

Lima J.A., E. Nahas and A.C. Gomes (1996). Microbial populations and activities in sewage sludge and phosphate fertilizer –amended soil. Appl. Soil Ecol., 4:75-82.

Manahan, S.E. (1991). Environmental Chemistry (5th ed.) Dewis Pub., Chelsea, Michigan, USA.

Martens,D.A., J.B.Johanson and W.T.Frankenberger Jr.(1992). Production and persistence of soil enzymes with repeated addition of organic residues . Soil Sci., 153:53-61.

McGill, W.B., K.R. Cannon , J.A. Robertson and F.D. Cook (1986). Dynamics of soil microbial biomass and water-soluble organic C in Breton L after 50 years of cropping to two rotations. Can. J.Soil Sci., 66:1-6.

Megharaj, M., I. Singleton, R. Kookana and R. Naidu (1999). Persistence and effects of fenamiphos on native algal populations and enzymatic activities in soil. Soil Biol. Bioch., 31(11): 1549-1553.

Melero S., E. Madejon, J.C. Ruiz and J.F. Herencia (2007). Chemical and biochemical properties of a clay soil under dry land agriculture system as affected by organic fertilization. European J. Agron., 26:327-334.

Miterer,M.,H.Bayer and F.Schinner(1981). The influence of fungicides on microbial activity in soil .Z.Pflanzenern. Bodenkd.,144:463-471.

Moussa, A.M.A.(2004). Biological and environmental studies on certain pesticide formulation. Ph.D.Thesis,Fac.Agric.,Alex. Univ., Egypt.

Nayak,R., Y.J. Babu and T.K. Adhya (2007). Long-term application of compost influences microbial biomass and enzyme activities in a tropical aeria endoaquept planted to rice under flooded condition. Soil Biol. Biochem, (article in press).

Page,A.L. , R.H. Miller and D.R. Keeney (1982). Methods of Soil Analysis. Part 2, 2 nd ed. Amer.Soc.Agron. , Inc.,Mad.,Wisc., USA.

Porter, L.K. (1965). Enzymes. In C.A.Black et al.(ed.) Methods of Soil Analysis, Part 2, Amer. Soc. Agron., Inc. Mad., Wisc., USA.

Quilt, P., E. Grossbard and S.J.L. Wright (1979). Effects of the herbicide barban and its commercial formulation carbine on soil microorganisms. J. Appl. Bacteriol., 36:431-442.

Ross,D.J. and T.W. Speir (1984). Influence of field application of oxamyl and fenamiphos on biochemical activities of soil under pasture . N. Z. J. Sci., 27:247-254.

Ross,D.J. and T.W. Speir (1985). Changes in biochemical activities of soil incubated with the nimaticides oxamyl and fenamiphos. Soil Biol. Biochem., 17:123-125.

Salam, M.A. and S. Subramonian (1988). Nitrogenase activity of the rhizosphere treated with granular insecticides, urea and zinc. Indian J.Microbiol., 28(3); 243-246.

Singh J. and D.K. Singh (2005). Dehydrogenase and phosphomonoesterase activities in groundnut (*Arachis hypogaaea*) field after diazinon, imidacloprid and lindane treatments. Chemosphere, 60(1):32-42.

Tabatabai, M.A.(1982). Soil enzymes. InA.L.Page et al.(ed.)Methods of Soil Analysis, Part 2. Amer. Soc. Agron., Inc., Mad., Wisc.,USA.

Tolmin, C. (2006). The Pesticide Mannual. 14 th ed. Amer. Soc. Agron. Madison, Wisc., USA.

Zaghloul, R.R., E.A. Hanafy, A.G. Rahal and Lobna A. Moussa (2003). Bioremediation of the polluted soil with carbamate pesticides by *streptomyces violaceusniger* or/ and *Azospirillum brasilense*. Proc.11th Conf. of Microbiol.,Cairo, Egypt:12-14.

الأنشطة الإنزيمية في الأرض المسمدة عضويا والمعاملة بمبيدات نيماتودية

محمد أحمد الحويطى[١] – ماهر مراد الشناوى[٢] – شبل عبدالله عبد الجواد[٣]

١) معهد الدراسات والبحوث البيئية– جامعة المنوفية

٢) كلية الزراعة– جامعة المنوفية

٣) معهد الاراضى و المياه و البيئة – مركز البحوث الزراعية.

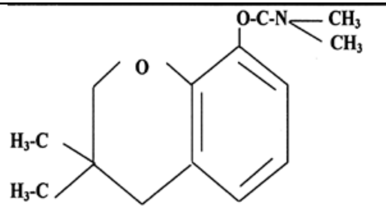
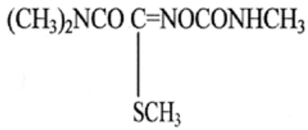
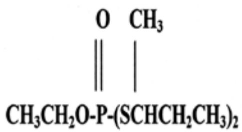
الملخص العربى

تم في تجربة معملية دراسة أثر ثلاثة مبيدات نيماتودية على الأنشطة الإنزيمية الميكروبية في أرض (سلتية لومية طينية ذات pH 7.3) في وجود أو عدم وجود سماد الكومبوست, حيث تمت إضافة المبيدات النيماتودية" الكربوفيوران و الاوكساميل والكادوسافاس" بثلاث مستويات هى : بدون إضافة ,المعدل الموصى به , وثلاثة أمثال المعدل الموصى به لكل منهم ، وتم تسميد الأرض بالكومبوست بمعدلات هى: بدون إضافة ، ١% و٢% . كما ضبط مستوى الرطوبة عند ٦٠% من السعة المائية الكلية للأرض طوال زمن التجربة (٤٥ يوم) ، وتم التحضين على درجة حرارة ٣٠ مئوية . وكانت الأنشطة الإنزيمية التى تم تقديرها هى لكل من: الديهيدروجينيز والنيتروجينيز والفوسفاتيز(الحامضى والقلوى),واليورييز وذلك على فترات خلال زمن التجربة.

وأظهرت الدراسة بوضوح أن إضافة المبيدات بالمعدل الموصى به لم تسبب أى تأثير سلبى بل على العكس قد أدت إلى تنشيط عمل هذة الإنزيمات , فيما عدا انزيم النيتروجينيزالذى انخفض نشاطة بصفة عامة .وكان للجرعات العالية من تلك المبيدات النيماتودية تأثيرا مثبطا لجميع الإنزيمات محل الدراسة . وكان هذا التأثير المثبط أكثر وضوحا مع مبيد الكربوفيوران , والذى تلاه تنازليا الاوكساميل والكادوسافاس.

وأدت إضافة الكومبوست بمعدل١% إلى زيادة جميع الأنشطة الإنزيمية المختبرة , والتى تحسنت مع مضاعفة الإضافة العضوية إلى ٢%,بينما لم يستجب إنزيم النيتروجينيز لهذه الاضافة.وكان للكومبوست تأثيرات مشجعة للأنشطة الإنزيمية فى معاملات المبيدات النيماتودية بصفة عامة , فيما عدا النيتروجينيز الذى تميز بسلبية الاستجابة لجميع معاملات الدراسة.

Table (3): Pertinent data on the nematicides used (quoted from Tolmin, 2006).

Common name	Trade name	Imperical Formula (chemical composition)	Molecular Structure	Physical form	Recommend dose /feddan*	Active Ingredient	Nutrient contents (%)
Carbofuran	Furdan	2, 3- dihydro-2, 2- dimethyl benzofuran- 7- methyl carbamate		Granules grey	10kg	10%	C 11.77 N 7.00
Oxamyl	Vydate	Methyl 2- (dimethyamino)-N- [(methylamino) carbony] oxyj-2- = oxoethanim- idothioate		Colourless crystals, with a garlic-like odour	2 L	240 g/L	C 38.36 N 19.20
Cadosafos	Rugby	O-ethyl 5,5-bis (1- methyl-propyl) phosphorodithioate		Colourless to yellow , liquid	600ml	200 g/L	C 44.40 P 11.48

*** Feddan = 4200 m^2**

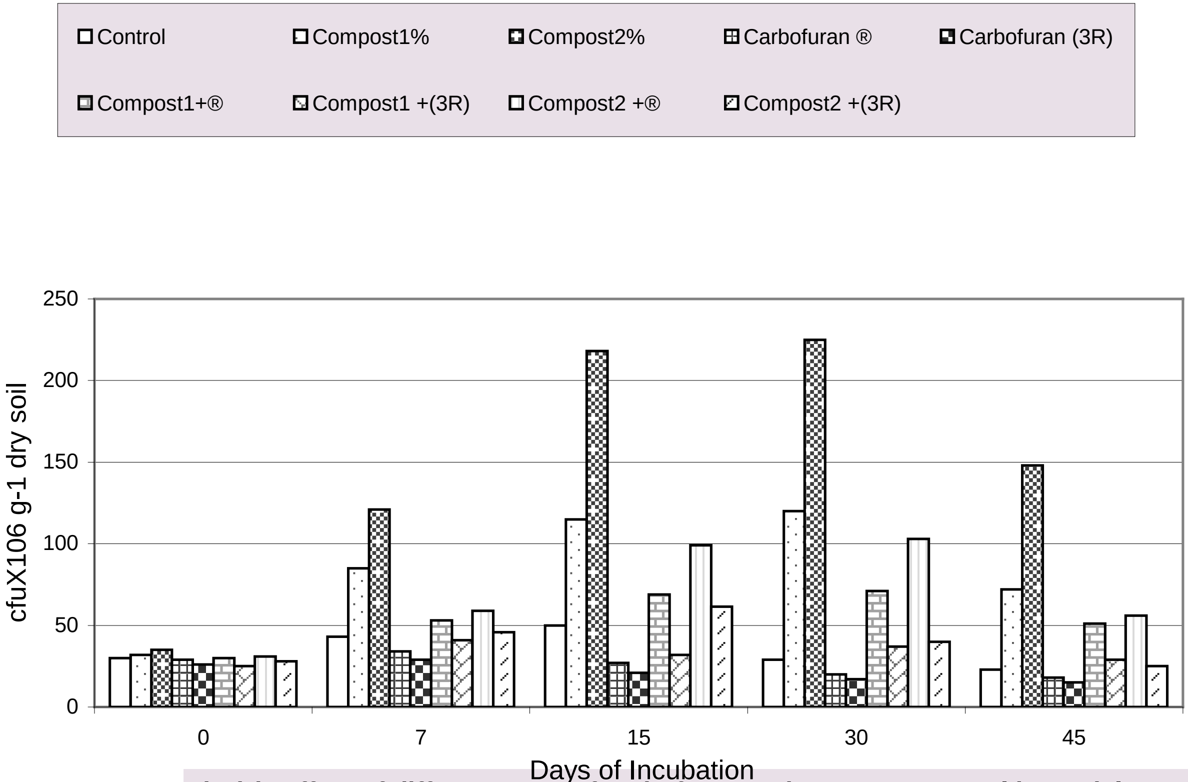


Fig.(1): Effect of different rates of carbofuran and compost on total bacterial count in soil

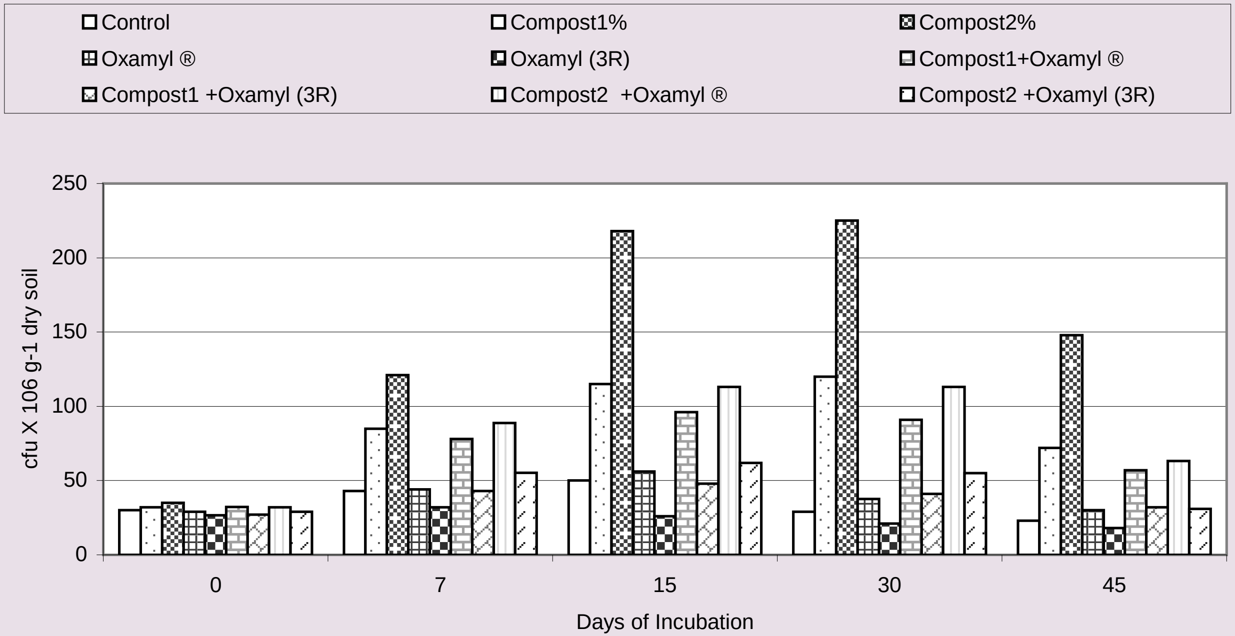


Fig.(2): Effect of different of rate of oxamyl and compost on total bacterial count in soil.

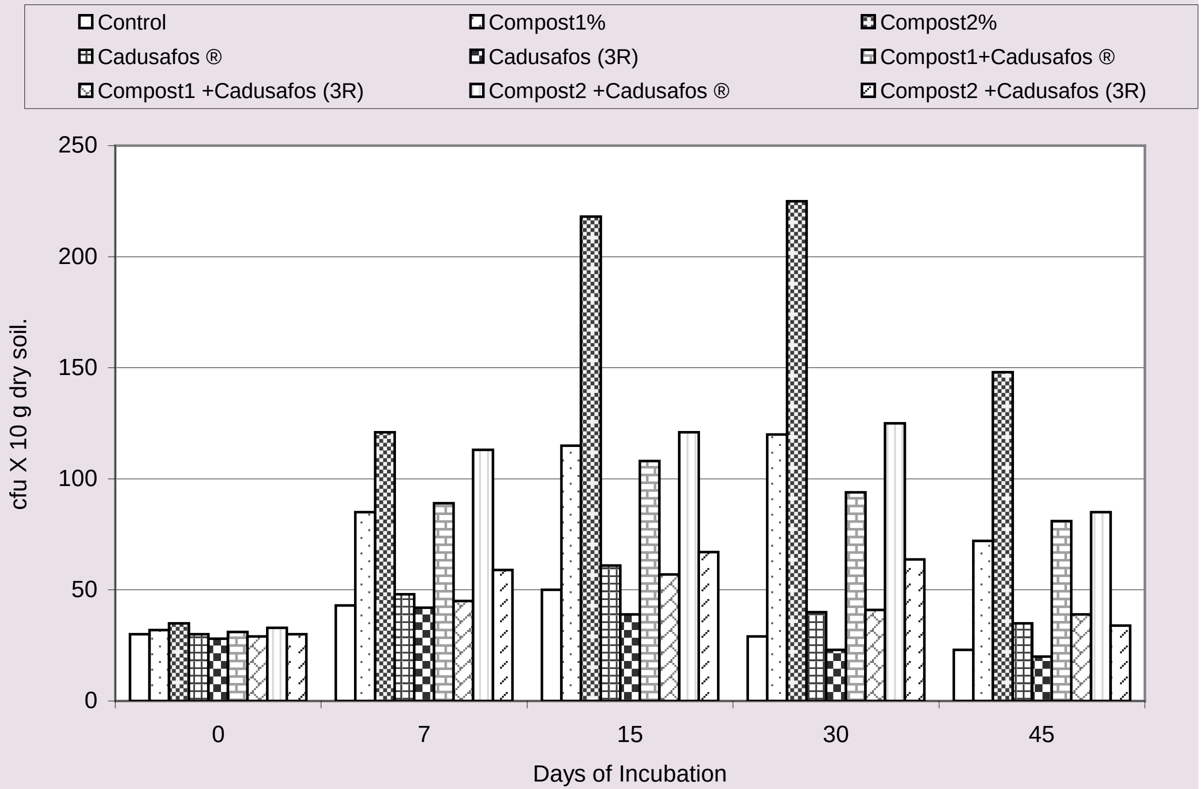


Fig.(3):Effect of different rates ofcadusafos and compost on total bacterial count in soil.

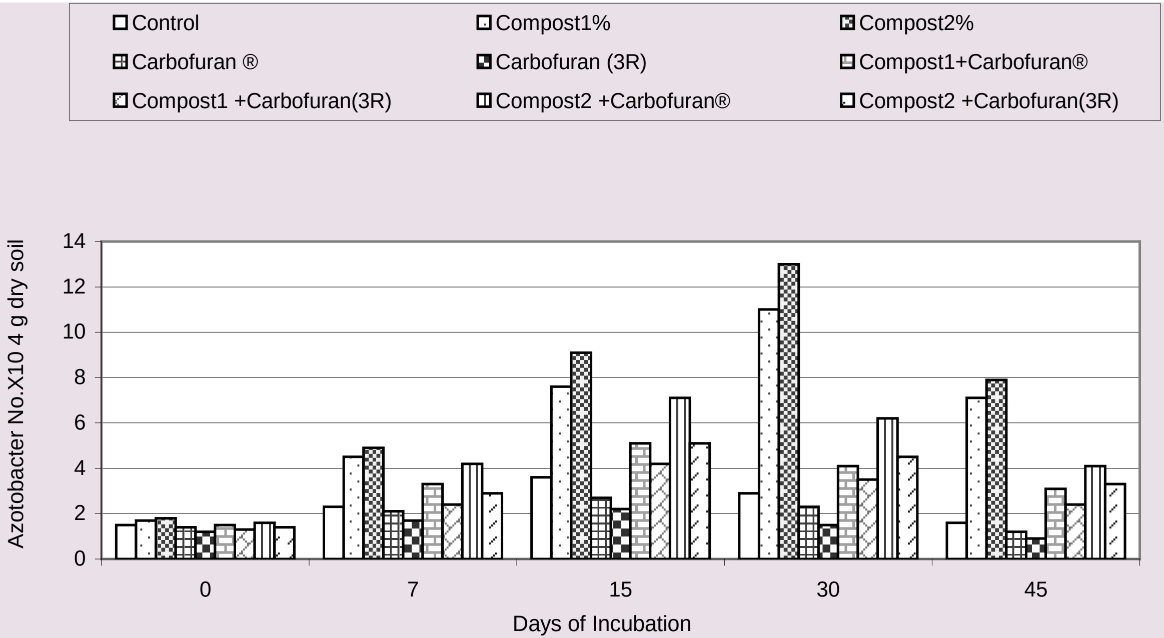


Fig.(4) Effect of different rates of carbofuran and compost on Azotobacter count in soil.

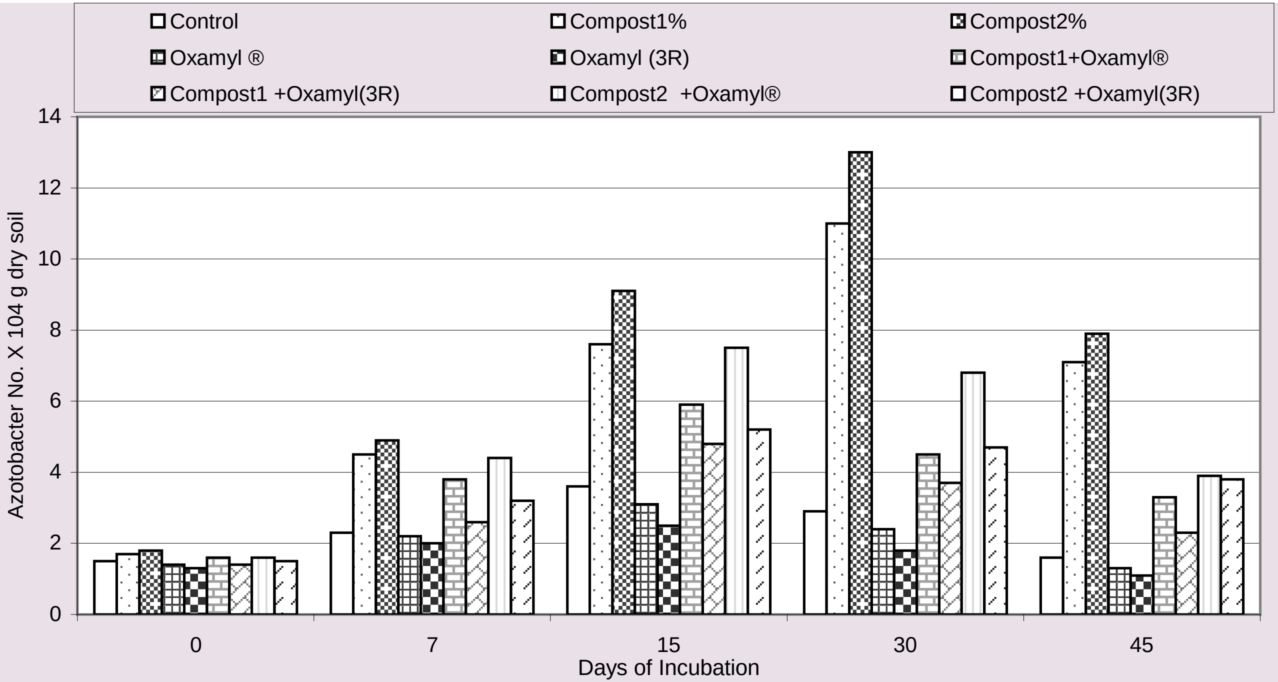


Fig.(5):Effect of different rates of oxamyl and compost on Azotobacter count in soil.

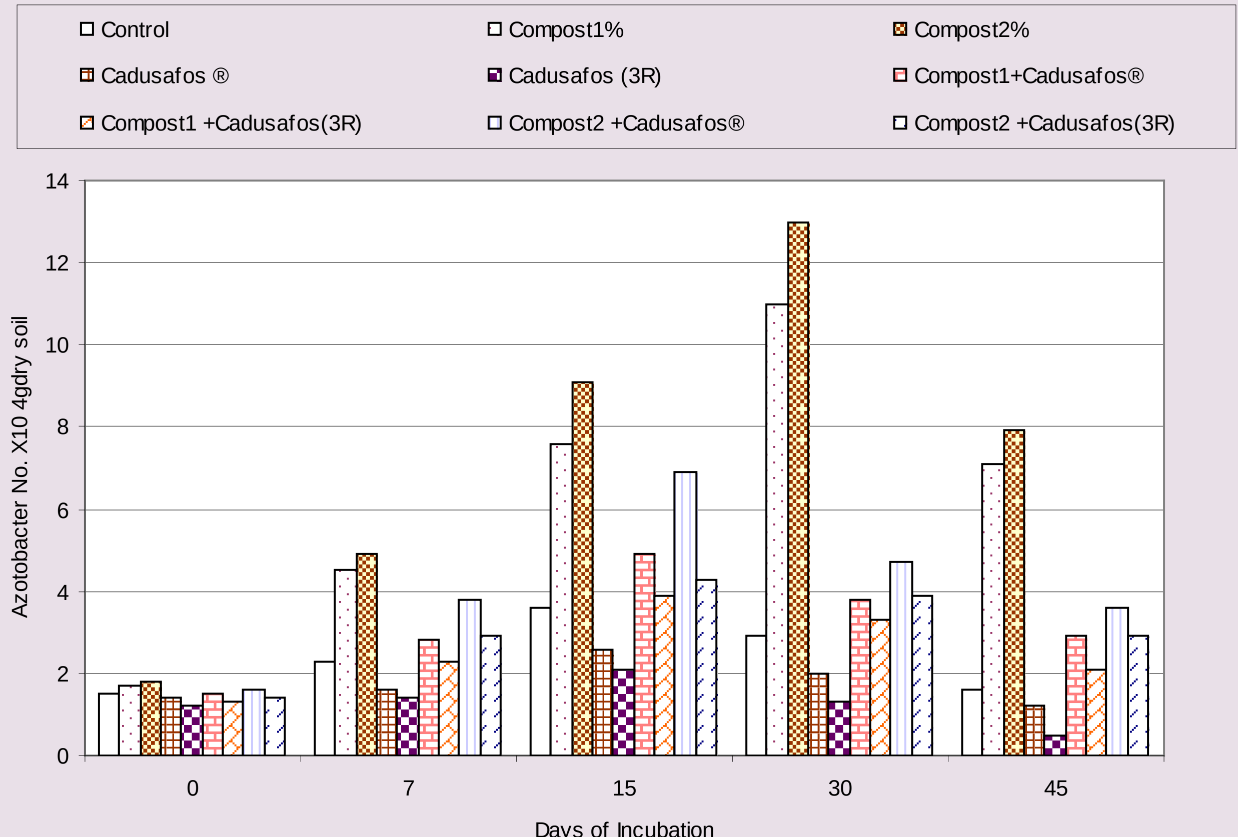


Fig.(6): Effect of different rates of cadusafos and compost on Azotobacter count in soil.

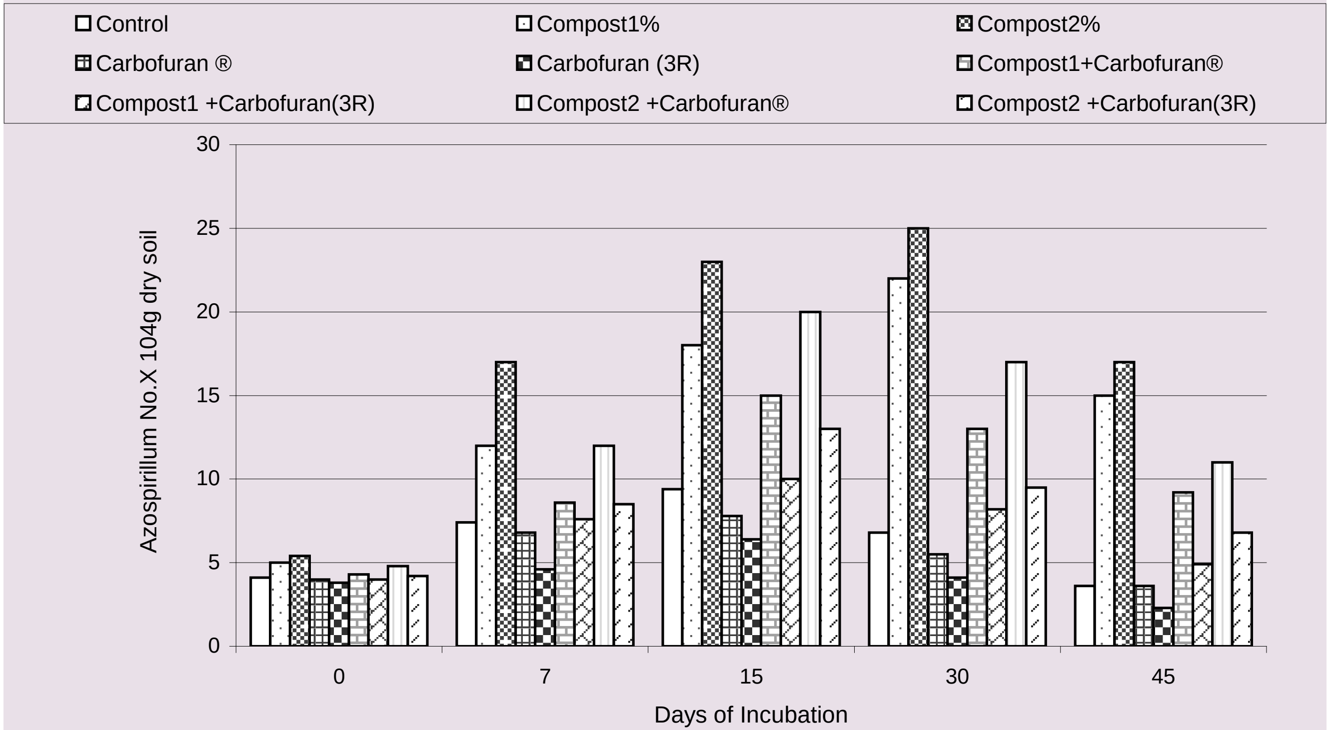


Fig.(7):Effect of different rates of carbofuran and compost on Azospirillum count in soil.

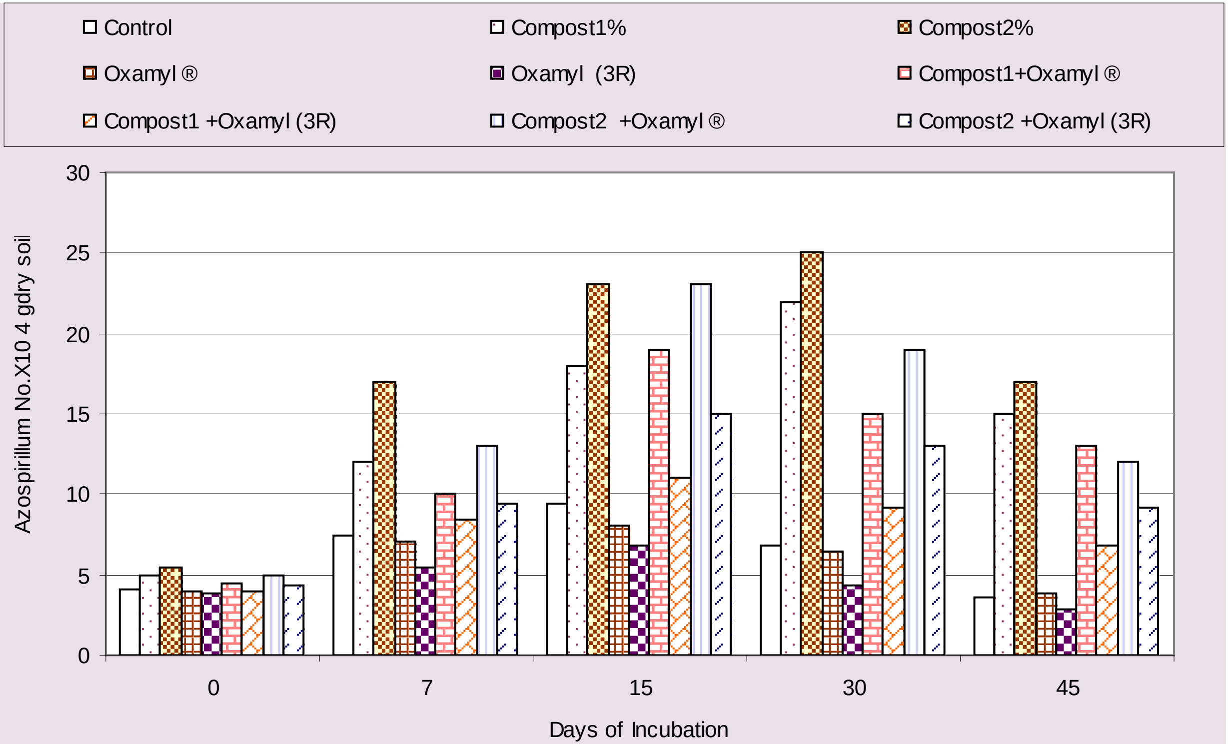


Fig.(8):Effect of different rates of oxamyl and compost on Azospirillum count in soil.

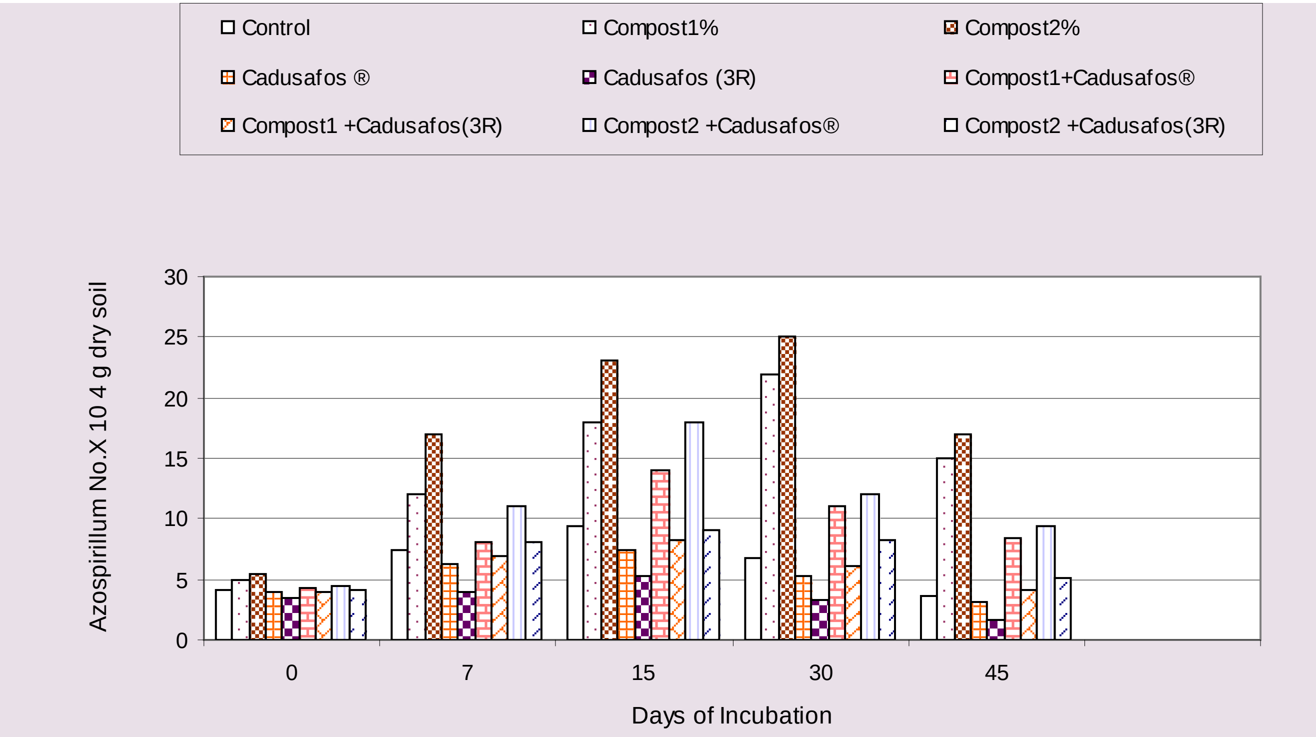


Fig.(9): Effect of different rates of cadusafos and compost on Azospirillum count in soil.

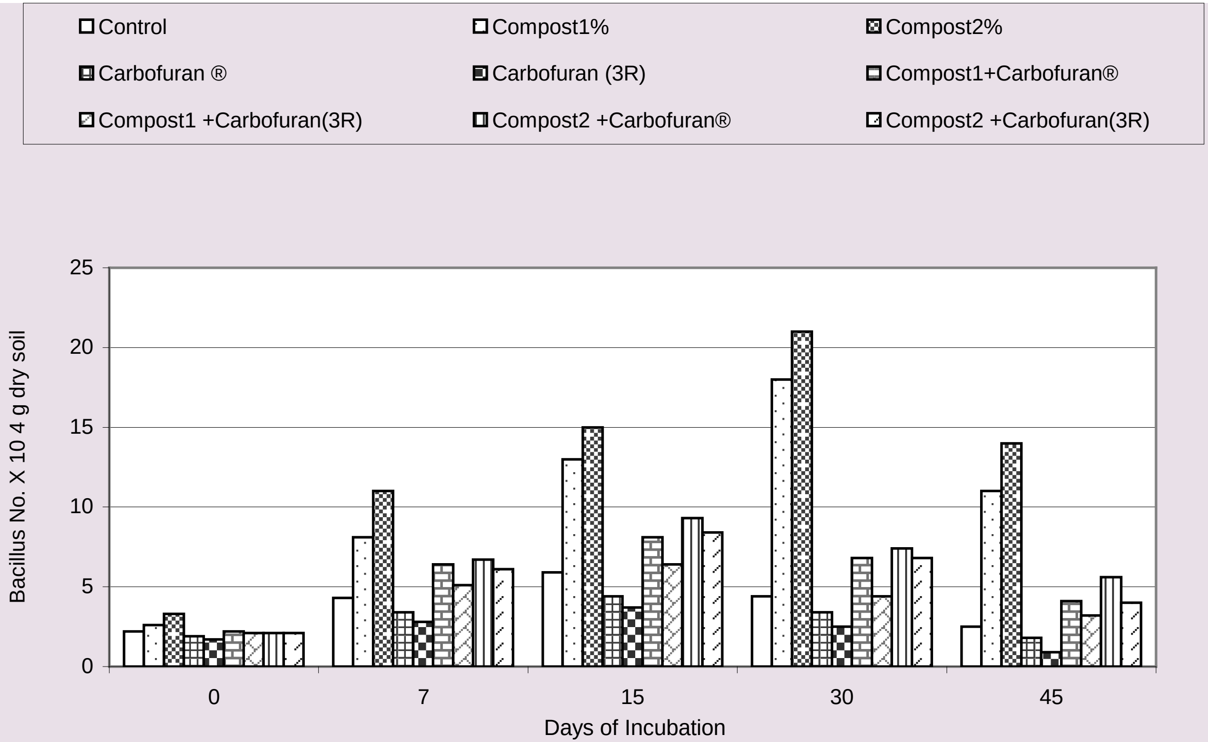


Fig.(10):Effect of different rates of carbofuran and compost on bacillus count in soil.

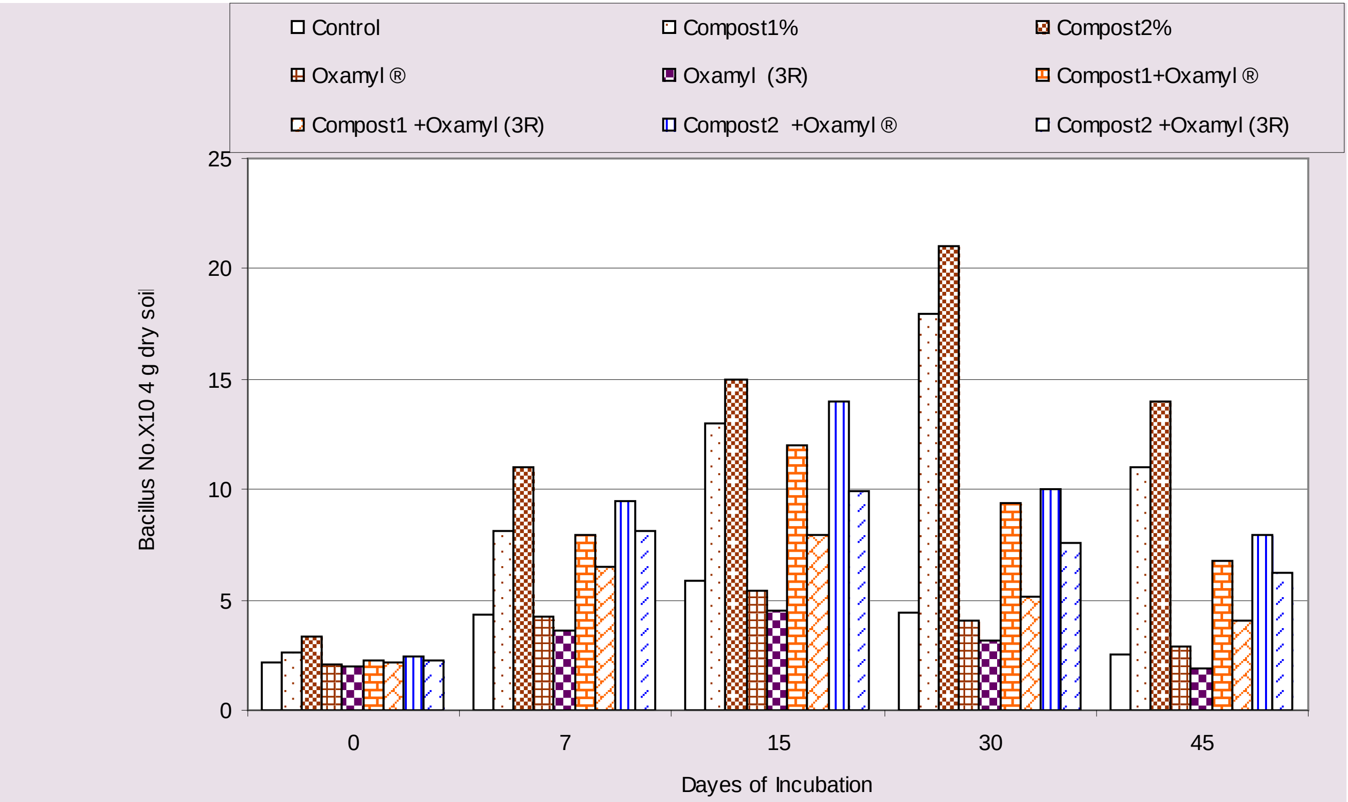


Fig .(11):Effect of different rates of oxamyl and compost on bacillus count in soil.

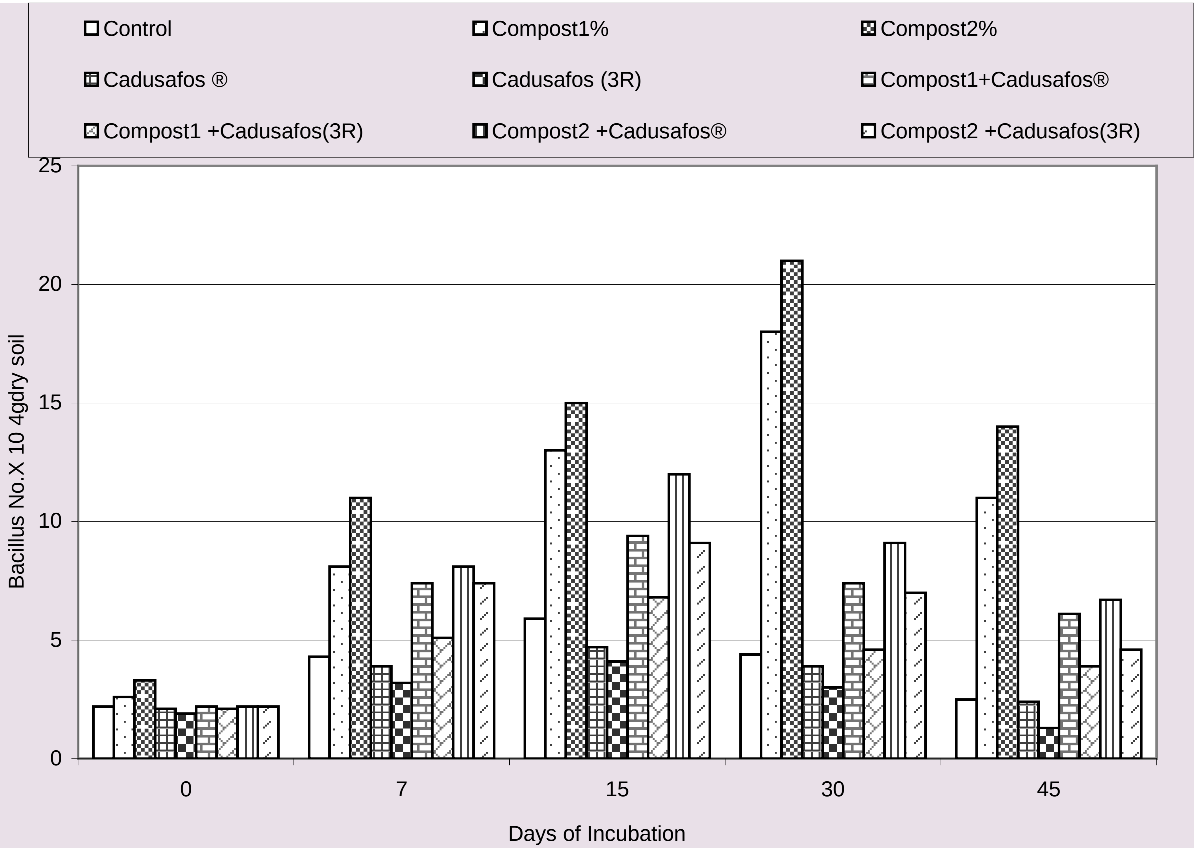


Fig.(12):Effect of different rates of cadusafos and compost on bacillus count in soil.