4- RESULTS AND DISCUSSION

4.1. Mineralization of PNP in the rhizosphere

The present investigation deals with the potential role of some plants to facilitate the microbial degradation of chemical contaminants in soil. It is important to select the proper plants which are able to minimize the toxicity of the chemical contamination under various conditions. Therefore, this study was conducted to investigate the potential effect of 2 different plants, corn as a cereal plant and soybean as leguminous plant in mineralization p-nitro phenol "PNP " in 2 different types of soils i.e. clay loam and silty loam soil . Results of analyses of the soils used are presented in Table 2.

Some characteristics of the investigated soils

Soils type	pH	Organic matter percent	Moisture percent
Clay loam	6.99	7.198	2.36
Silty loam	6.63	7.10	1.76

4.1.1. Mineralization of PNP in the presence of corn plant in clay loam soil.

The soil under investigation was treated with PNP at a concentration of 1ppm . The mineralization of PNP was estimated by measuring the evolution of ($^{14}CO_2$) from the radiolabelled PNP added to the surface of the soil.

The obtained data showen in Table (4) and Fig (4) revealed that, PNP mineralization percent in the presence of corn plant resulted in an increase in its mineralization in the first 2 days, 4.16% of PNP was mineralized after one day in soil cultivated with corn plant compared with 2.35% in uncultivated soil .

Table (4): Mineralization of para-nitrophenol in the presence of corn plant in clay loam soil.

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1136	1943	1520	1533	2.35	2772	2391	2965	2709	4.16
2	5223	5148	5045	5138	7.9	10509	6158	8210	8292	12.75
3	16507	13927	13216	14550	22.38	15731	12184	14175	14030	21.85
4	23354	25235	23290	23959	36.86	21663	17680	17308	18883	29.05
5	27803	31399	28584	29262	45.01	24161	20018	21156	21178	32.58
6	29466	33378	31632	31492	48.44	25259	21588	22792	23213	35.71
7	30425	34747	31587	32253	49.62	26549	23140	23758	24482	37.66
8	31319	35548	33498	33455	51.46	27563	23941	24943	25482	39.2
9	32115	36141	33542	33932	52.2	28200	25233	30879	28104	43.23
10	32691	36540	34612	34614	53.25	28705	30432	33693	30943	47.6

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant

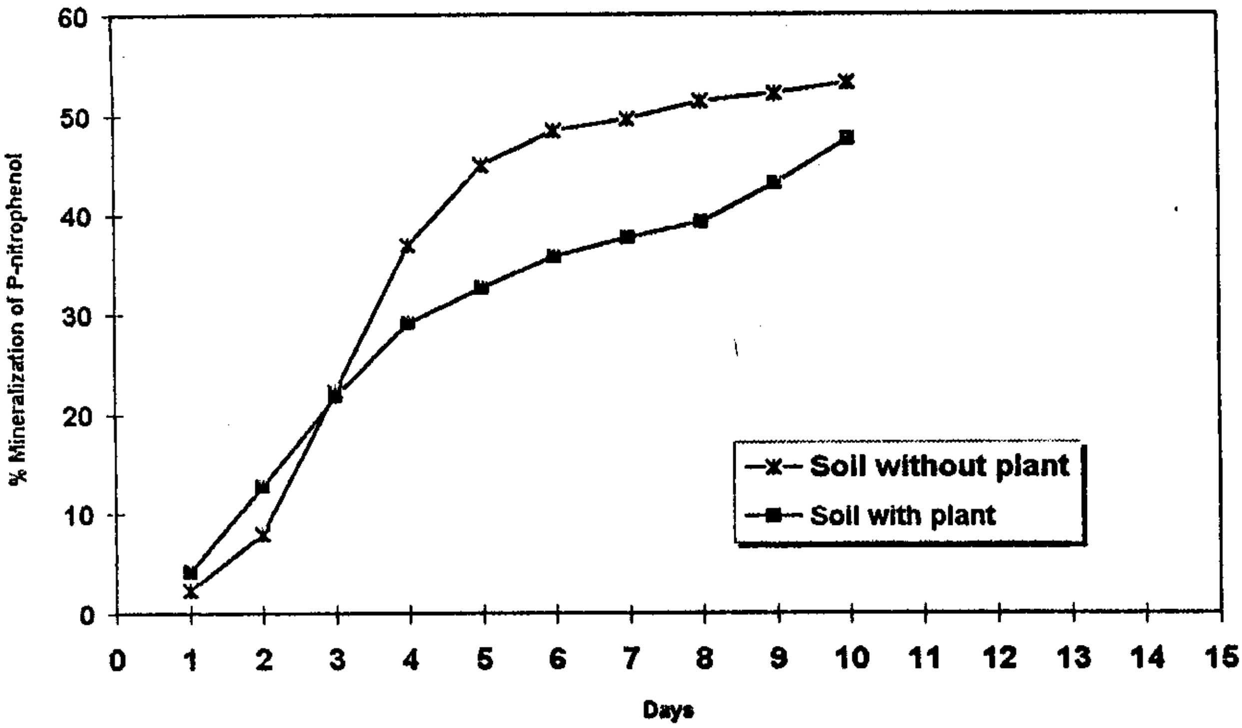


Figure (4) Mineralization of P- nitrophenol in the presence of corn plant in clay loam soil .

After 2 days, the mineralization was increased to 12.75% in the soil cultivated with corn plant compared with 7.9% in the soil without corn plant. This indicated that clay loam soil used in this study contain indigenous microorganisms community that was able to mineralize PNP. However, after 3 days, the extent of mineralization was decreased in soil with corn plant compared with soil without plant, and this trend was observed up to end of the experiment. However, statistical analysis of data showed that mineralization of PNP in the soil cultivated with corn plant did not differ significantly from that in the uncultivated soil. After ten days of the addition of PNP, soil released 53.25% of the radiolabelled PNP as $^{14}CO_2$, whears 47.6% was released in soil with corn plant.

4.1.2. Mineralization of PNP in the presence of soybean plant in clay loam soil.

The samples of clay loam soil were treated with the same concentrations of PNP whose mineralization was measured in soil with and without soybean plant.

The results in Table (5) and in Fig (5) showed that in soil cultivated with soybean plant , 7.18% of PNP was released after 2 days compared with 12.42% of PNP released in soil without plant. The mineralization was rapid, after 10 days, 46.47% of PNP was released in soil cultivated with soybean plant compared with 57.66% in soil without plant. There was non significant difference between the results in both treatments.

From the 2 previous experiments , it could be noticed that neither cultivated soil with corn or soybean plants has a non significant effect on the PNP mineralization in

Table (5): Mineralization of P-nitrophenol in the presence of soybean plant in clay loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
2	9112	5547	8162	7607	12.42	4470	4075	4654	4399	7.18
3	23370	18209	24490	22023	35.95	12989	11814	13749	12850	20.98
4	28391	27836	30335	28854	47.11	22079	20054	23457	21863	35.69
5	30959	31471	32477	31635	51.65	25420	23563	26785	25256	41.23
7	32957	33872	34093	33640	54.92	27384	25763	28609	27252	44.49
8	33786	34790	34784	34453	56.25	28056	26394	29259	27903	45.55
10	34698	35758	35505	35320	57.66	28650	26970	29779	28466	46.47
12	34972	35960	35790	35574	58.08	28908	27259	30048	28738	46.92
14	35759	36686	36359	36268	59.21	29474	27799	30660	29311	47.85
15	36108	37019	36732	36619	59.79	29744	28109	30936	29596	48.32

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant

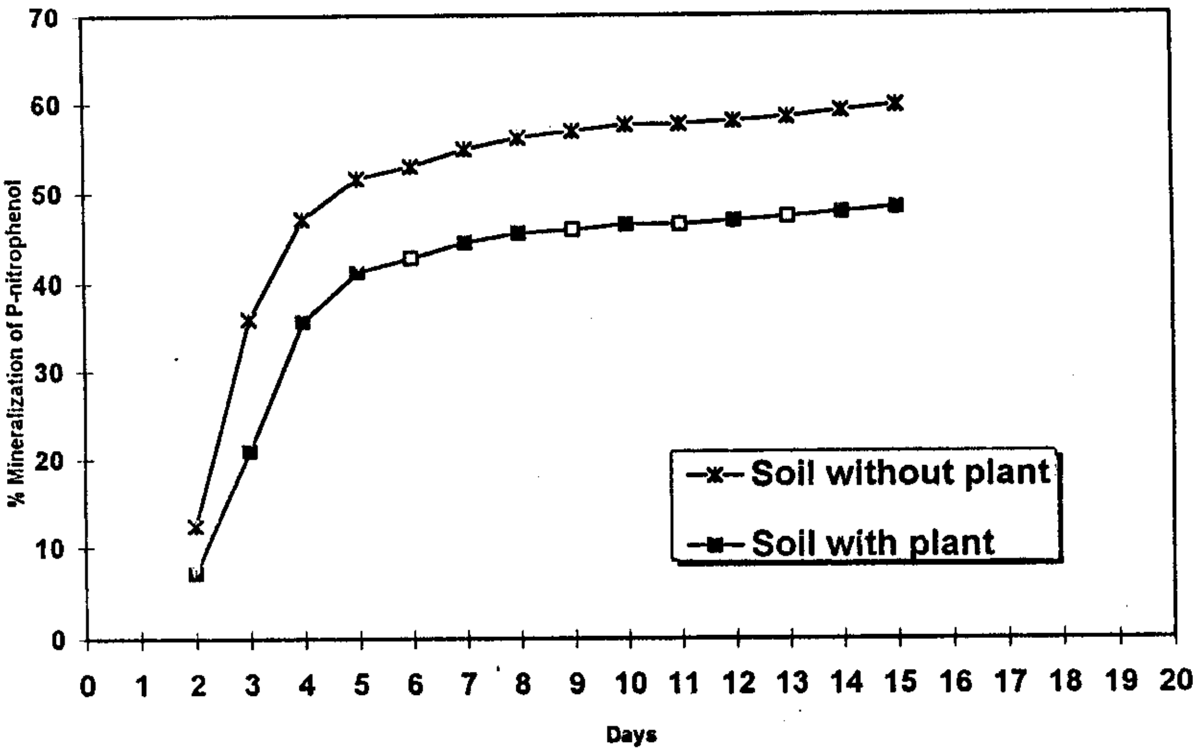


Figure (5) Mineralization of P-nitrophenol in the presence of soybean plant in soil .

clay loam soil. This implies that the mineralization of PNP in soil cultivated with plant may be limited by the characterists of soil, chemical and plant interactions.Such a finding could be explained by Shann and Boyle (1994), They showed that the presence of plant affect the bioavailability of soil pollutant, either by fixation of the pollutant to surface of roots or uptake by the plant. The same authors added that the adsorption of a chemical contaminant on the cell wall of the root system may decrease its bioavailability to the soil microorganisms for biodegradation process.

On the other hand, Reddy and Sethunathan (1994) reported that PNP was mineralized more rapidly in the presence of rice plant than in unplanted soil under non flooded and flooded conditions.

4.1.3. Mineralization of PNP in the presence of corn plant in silty loam soil

$^{14}CO_2$ released from (14c) PNP applied to the surface of silty loam soil was measured and compared with that released in the presence of corn plant

The results in Table (6) and Fig(6) showed that the mineralization of PNP was 2.07% in silty loam soil , after one day, This indicate that this type of soil contain a sufficient number of microorganisms able to partially mineralize PNP. At the end of the experiment, Table (6): Mineralization of P- nitrophenol in the presence of corn plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1120	1370	1550	1346	2.07	1440	1235	1133	1269	1.95
2	4340	4479	5670	4829	7.43	4475	3519	3758	3917	6.02
3	11449	11693	12009	11717	18.02	11863	10171	9108	10380	15.97
4	17549	17898	17392	17613	27.09	18282	15494	15491	16422	25.26
5	21852	22560	21999	22137	34.05	22504	19159	18681	20114	30.94
6	23782	24215	23601	23866	36.71	24423	21031	19923	21792	33.52
7	24734	25127	24435	24765	38.1	25300	21943	20699	22647	34.84
8	25626	26013	25337	25658	39.47	26122	22557	21428	23369	35.95
9	26403	26707	25850	26320	40.49	26750	23247	21975	23990	36.9
10	26796	27034	26069	26633	40.97	27089	23623	22286	24332	37.43

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant

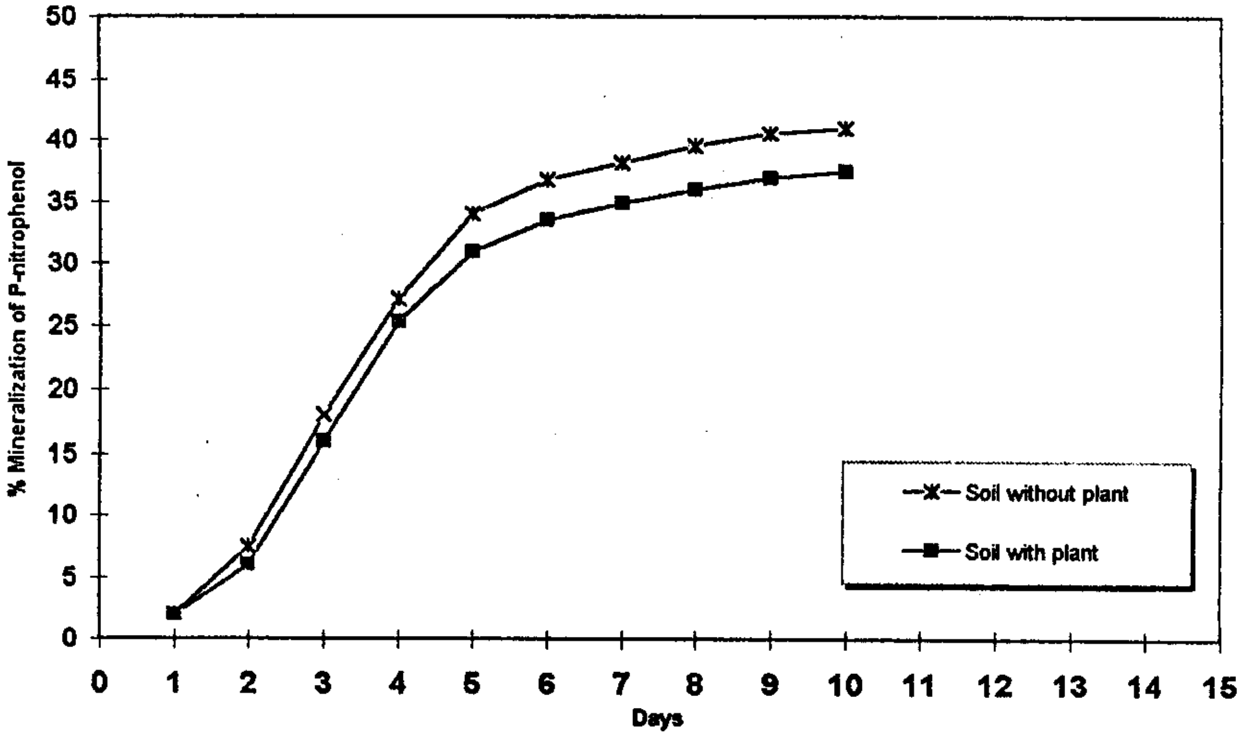


Figure (6): Mineralization of P-nitrophenol in the presence of corn plant in silty loam soil .

about 37.43% of the added PNP was released as $^{14}CO_2$ in soil cultivated with corn plant compared with 40.97% in uncultivated soil

Comparing PNP mineralization in the clay loam soil with that in silty loam soil, Table (4) and Table(6) , it was observed that, the mineralization of PNP in the presence of corn plant is slightly higher in the clay loam soil than that in the silty loam soil. At the end of these two experiment, 41.11% of PNP was mineralized in the presence of corn plant whears 37.43% only of the same compound was mineralized in silty loam soil in the presence of the same plant.This finding may indicate that the clay loam soil provide more favourable conditions for the activity of microorganisms responsible for PNP mineralization.

4.1.4. Mineralization of PNP in the presence of soybean plant in silty loam soil.

Mineralization of PNP was studied in the silty loam soil with and without the rhizosphere of soybean plant.

In Table (7) and Fig (7) PNP mineralization was about the same in rhizosphere and non rhizosphere soil. The variation in PNP mineralization were statistically non significant between both treatments.

Comparing the formentioned results with that in tables (4) and table (5), it was reveals a slightly increase in the extent of PNP mineralization in the presence of soybean plant than that in the presence of corn plant in the same type of soil. After 10 days, 43.50% of PNP was released in the rhizosphere of soybean plant

Table (7): Mineralization of P-nitrophenol in the presence of soybean plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1203	1541	1511	1418	2.18	1184	1438	1542	1388	2.13
2	4245	5726	4711	4894	7.52	4202	4193	4264	4219	6.49
3	11419	13228	13729	12792	19.68	14099	13150	12216	13155	20.23
4	17390	16543	17512	17148	26.38	17444	16351	16250	16681	25.66
5	20031	21389	21654	21024	32.34	21391	21264	19269	20641	31.75
6	23550	23751	21332	22877	35.19	24276	24674	23804	24251	37.3
7	24001	24283	23910	24064	37.02	24112	24985	24263	24453	37.62
8	25998	25264	26227	25829	39.73	25880	25913	25117	25636	39.44
9	26736	27897	27200	27277	41.96	26665	27117	27649	27143	41.75
10	27605	28824	28397	28275	43.5	27215	28786	28200	28067	43.18

R1, R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant

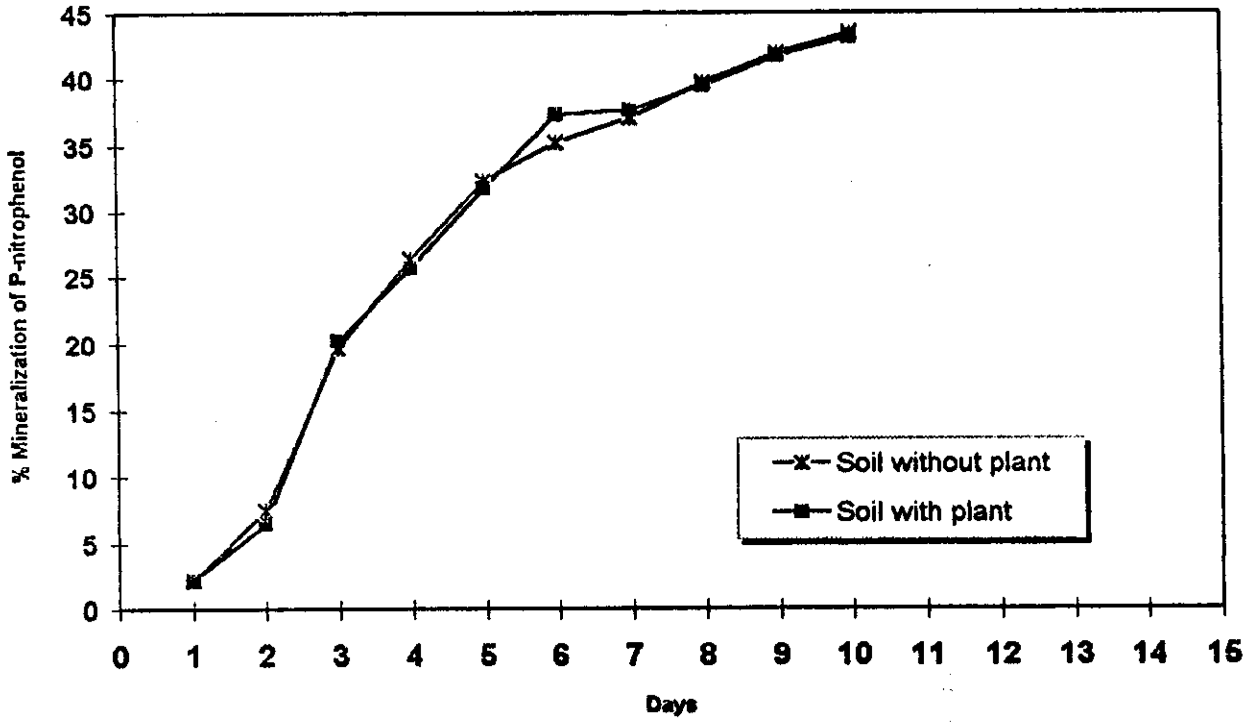


Figure (7) **Mineralization of Para nitrophenol in the presence of soybean plant in silty loam soil .**

whears only 37.42% of PNP was released in the rhizosphere of corn plant. In addition, mineralization of PNP in clay loam soil was 57.66% after 10 days whears 43.50% of PNP was mineralization in silty loam soil under the same conditions. This means that a difference in PNP mineralization between clay and silty loam soil under the same conditions was pointed out. Such results may be attributed to the presence of organic constituents in the clay loam soil that may facilitate the degradation of PNP or clay loam soil may contain a sufficient number of PNP biodegraders than that in silty loam soil.

Knaebel and Vestal (1994) studied the effect of two different types of soils on the mineralization of several chemicals in the rhizosphere of corn and soybean plants and found that there was an interaction between the organic matter in soils and the applied chemical compounds.

4.1.5. Mineralization of PNP in the presence of corn root exudates in clay loam soil.

Mineralization of PNP at a concentration of 1ppm was estimated in soil irrigated with a natural root exudates excreted by corn plants compared with soil irrigated with a nutrient soln. as a control treatment.

The obtained data in table (8) and Fig (8) showed that there was a higher significant difference between mineralization of PNP in the soil irrigated with corn root exudates and soil that irrigated with a nutrient soln. After one day of adding PNP to the clay loam soil under investigation, the first soil released 4.31% of the total

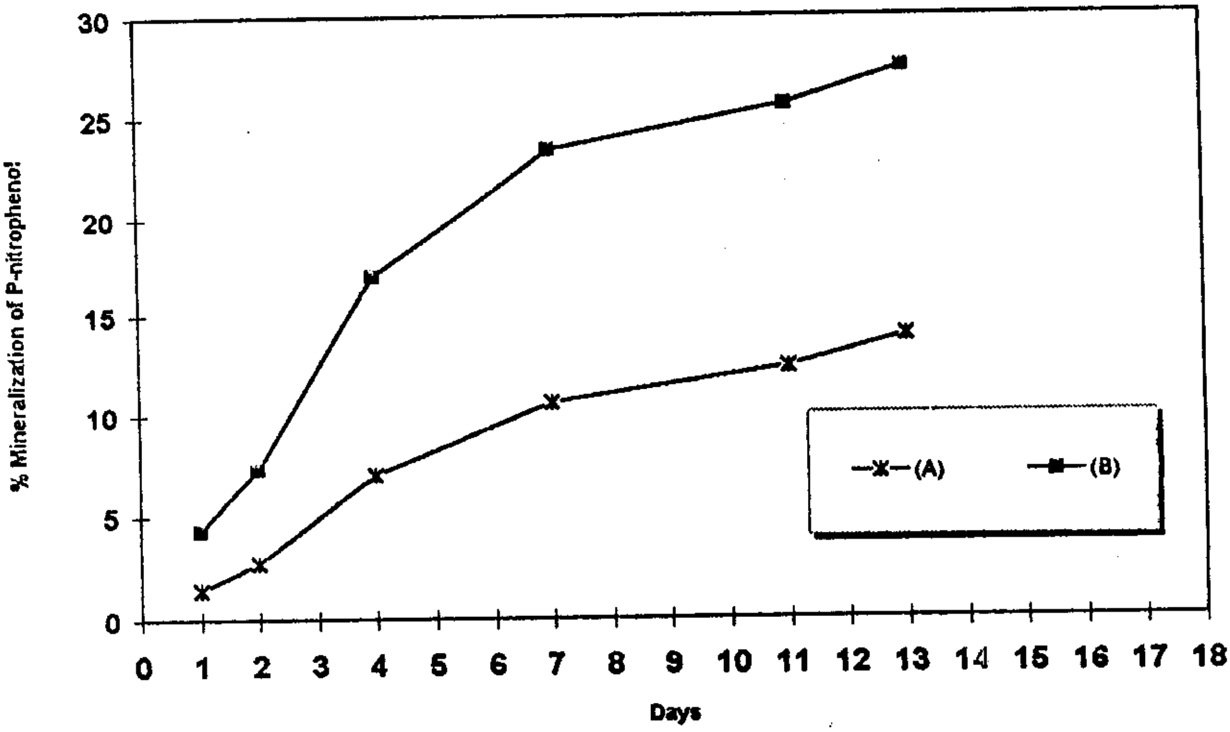
Table (8): Mineralization of P-nitrophenol in the presence of corn root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln.					Soil irrigated with corn root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	786	781	782	783	1.45	2321	2375	2300	2332	4.31
2	1415	1511	1472	1466	2.71	4025	3926	3990	3980	7.37
4	4048	3492	3842	3794	7.02	9572	8911	8975	9152	16.94
7	6730	5123	5326	5726	10.6	13302	12251	12345	12632	23.39
11	7944	5782	6262	6662	12.33	14522	13383	13521	13808	25.57
13	8982	6470	7012	7488	13.86	15677	14451	14352	14826	27.45

R1, R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Highly significant



(A)Soil Irrigatad with nutrient soln .

(B) Soil irrigated with corn root exudates .

Figure (8): Mineralization of P- nitrophenol in the presence of corn root exudates in clay loam soil .

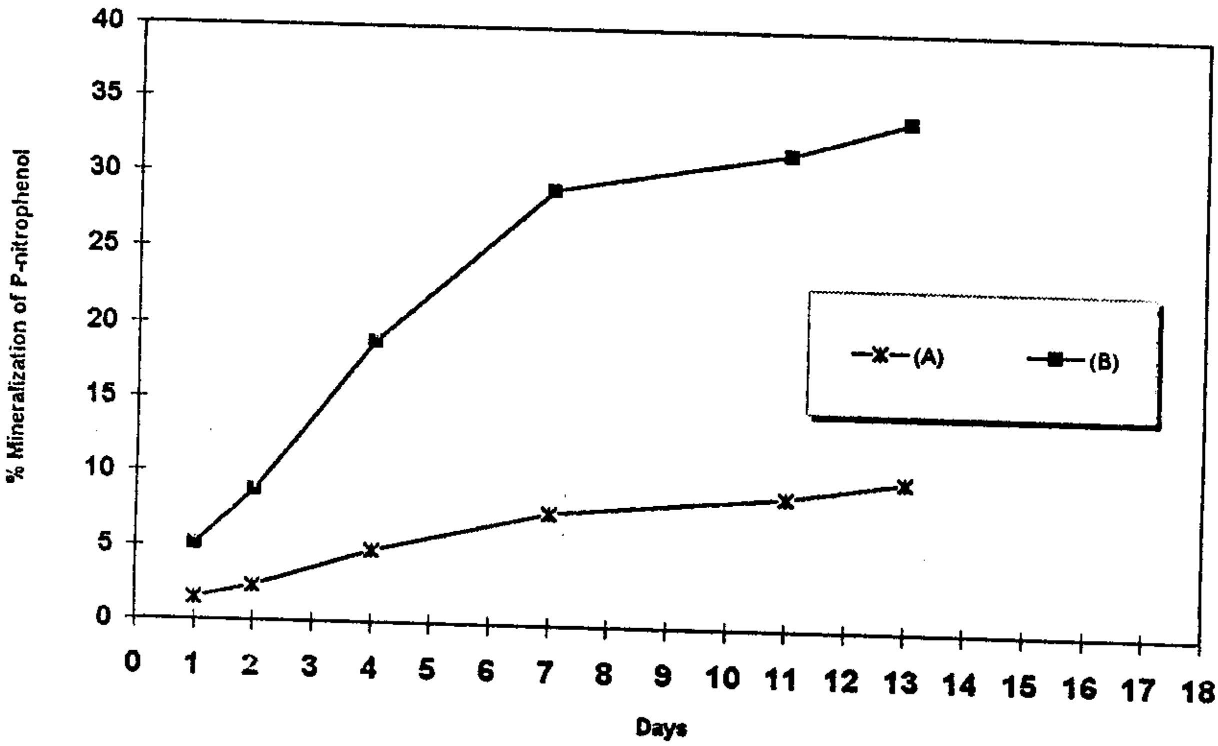
Table (9):Mineralization of P-nitrophenol in the presence of soybean root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln .					Soil irrigated with soybean root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	811	826	792	809	1.49	2966	2595	2703	2754	5.1
2	1239	1315	1289	1281	2.37	4993	4670	4630	4764	8.82
4	2602	2570	2641	2604	4.82	10773	9876	10021	10223	18.93
7	4128	3956	4171	4085	7.56	16502	15016	15553	15690	29.05
11	4844	4728	4790	4787	8.86	17997	16388	16924	17103	31.67
13	5529	5375	5403	5435	10.06	19350	17612	18237	18399	34.07

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Highly significant



(A) Soil Irrigatad with nutrient soln .

(B) Soil irrigated with soybean root exudates .

Figure (9): Mineralization of P-nitrophenol in the presence of soybean root exudates in clay loam soil .

4.1.7. Mineralization of PNP in the presence of synthetic root exudates in clay loam soil.

The behavior of microorganisms in soil is influenced by the presence of nutrients, and thus, the composition of soil microorganisms is regulated by these nutrients. The nutrients may be easily utilized by biodegraders of contaminants in soil.

In this experiment, PNP mineralization was increased by the addition of synthetic root exudates compared with that in soil irrigated with deionized water as shown in Table (10) and Fig (10). After 6 days, soil irrigated with synthetic root exudates released 22.79% of its PNP whears soil irrigated with deionized water released 6.64% only. The increase in PNP mineralization was observed until the end of the experiment. After 12 days, soil supplemented with synthetic root exudates evolved 28.22% of $^{14}CO_2$ as a result of mineralization of PNP, compared with 11.40% released in soil irrigated with deionized water. The variation in PNP mineralization between the two treatments i.e. soil irrigated with synthetic root exudates and that irrigated with deionized water were highly significantly different.

Similar response was obtained by Rubin and Alexander (1983). They found that the addition of inorganic nutrients, arginine, or yeast extract enhanced the rate of phenol mineralization in fresh water. Also, Sethunathan et. al. (1989) found that the addition of yeast extract accelerated the degradation of methyl parathion.

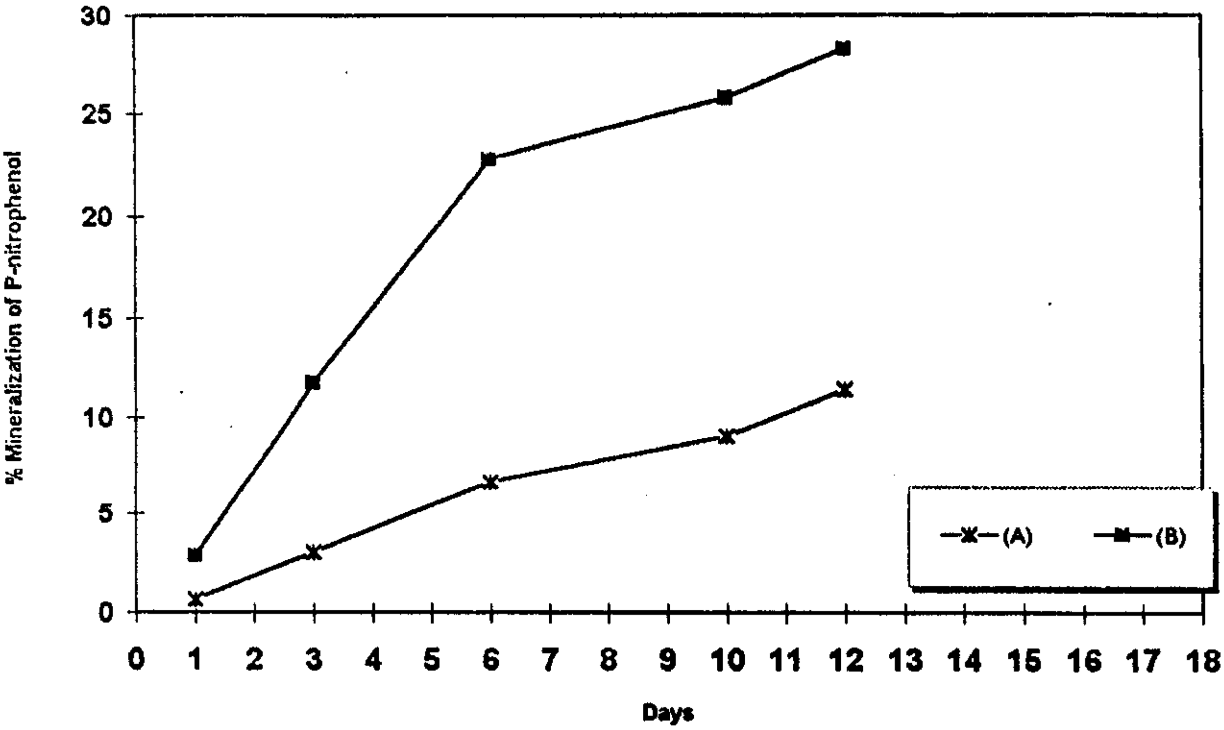
Table (10): Mineralization of P-nitrophenol in the presence of synthetic root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln.					Soil irrigated with synthetic root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	362	360	363	361	0.66	1498	1620	1484	1534	2.84
3	1649	1542	1642	1611	2.98	6540	6242	6216	6332	11.72
6	3764	3454	3551	3589	6.64	13317	12113	11500	12310	22.79
10	5102	4744	4841	4895	9.06	15031	13665	13090	13928	25.79
12	6429	5971	6068	6156	11.4	16351	14969	14402	15240	28.22

R1, R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Highly significant



(A) Soil irrigated with Deionized Distilled water .
(B) Soil irrigated with Synthetic root exudates.

Figure (10)Mineralization of P-nitrophenol in the presence of synthetic root exudates in clay loam soil .

4.2. Mineralization of 2,4-D in the rhizosphere.

Researches on microbial degradation of organic compounds in the rhizosphere focuse mainly on agricultural chemicals such as herbicides and insecticides. A number of investigators have described herbicides degradation in the rhizosphere of a variety of plant species , Anderson et. al. (1993).

In this study, a range of experiments were carried out under different conditions, using two different plants and two types of soils to investigate some of the hypotheses previously reported on the possibility of enhancing the degradation of 2,4-dichlorophenoxy acetic acid "2,4-D " in the rhizosphere .

4.2.1. Mineralization of 2,4-D in the presence of corn plant in clay loam soil.

The mineralization was monitored over different periods as an evolution of $^{14}CO_2$ released due to the mineralization of 2,4-D

The results in Table (11) and Fig (11) indicated that 2,4-D was mineralized slowly. The rate and extent of mineralization in the first 4 days in both treatments was almost the same.Howevere, later on the extent of 2,4-D mineralization in soil with corn plant was higher than that in soil without corn plant. At the end of the

Table (11):Mineralization of 2,4-D in the presence of corn plant in clay loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	460	405	438	434	0.66	290	327	432	349	0.53
2	753	590	668	670	1.02	665	661	723	683	1.04
3	967	1272	1113	1117	1.7	1128	1121	1316	1188	1.81
4	1213	1726	1513	1484	2.27	1499	1616	1671	1595	2.44
5	1452	2205	1835	1830	2.8	1661	2004	2585	2083	3.18
6	1952	2495	2255	2234	3.41	3088	2306	3122	2838	4.34
7	2473	2784	2655	2637	4.03	3352	2841	4796	3663	5.6
8	2997	3140	3045	3060	4.68	3646	4793	5382	4607	7.04
9	3452	3584	3575	3537	5.41	3720	5987	6014	5240	8.01
10	3922	4061	4048	4010	6.13	3803	6594	7072	5823	8.9
11	4549	4693	4678	4640	7.09	3858	6939	7957	6251	9.56
12	5154	5331	5288	5257	8.04	4074	7549	8713	6778	10.36

R1 , R2, R3 Replicates of the sample ,Decay/min.(DPM)

Y1, Y2 % mineralization of 2,4 D

T-test Significant

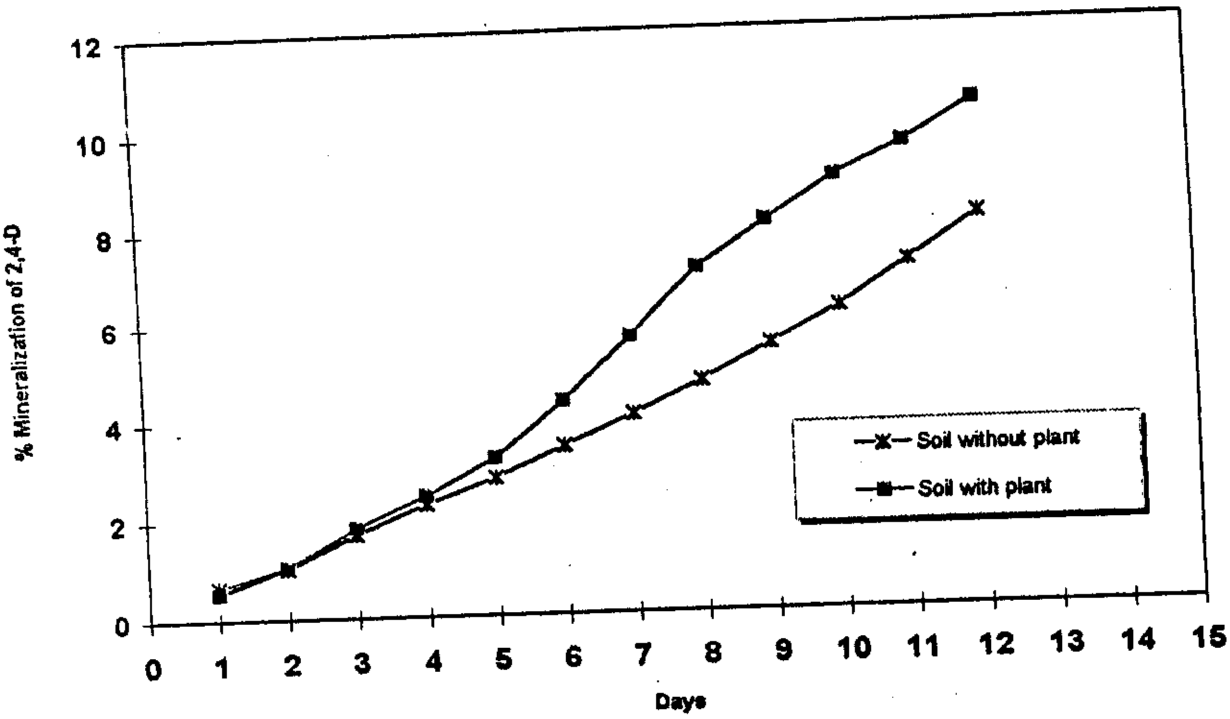


Figure (11) Mineralization of 2, 4-D in the presence of corn plant in clay loam soil .

experiment, 10.36% of 2,4-D was mineralized in soil with corn plant compared with 8.04% in soil without plant. The difference in 2,4-D mineralization between the two treatments was significant.

The slow mineralization of 2,4-D in this type of soil may be attributed to the soil which does not contain a sufficient numbers of microorganisms able to mineralize 2,4-D. Another factor which might be considered in such phenomena is that 2,4-D was adsorbed to the particles of clay loam soil(Ogram et. al.1985).

In a separate experiment, the pH of 2,4-D soln. was adjusted to pH=6 and added to the surface of the same type of soil with and without corn plant. It was assumed that the adjustment of pH in 2,4-D from pH=4 to pH=6 might be effective in accelerating 2,4-D mineralization as reported by (Thompson et. al.1984)

Data in Table (12) and Fig (12) showed that, 4.85% of $^{14}CO_2$ released from 2,4-D in soil with corn plant at pH=6 compared with 4% in soil without corn plant. The results in table (12) showed that there was a significant difference between 2,4-D mineralization in soil with corn plant and soil without corn plant.Therefore, the presence of plant rhizosphere was probably responsible for the increase of 2,4-D mineralization.

Our results are similar to those reported by (Loos et. al.1979). They found that sugar cane plant

Table (12):Mineralization of 2,4-D in the presence of corn plant in clay loam soil "pH=6 "

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	69	54	54	59	0.118	89	155	103	115	0.23
2	122	93	99	104	0.2	231	268	223	240	0.48
4	258	226	229	237	0.47	532	596	537	555	1.11
6	409	365	374	382	0.76	949	914	904	922	1.84
7	484	449	453	462	0.92	1119	1102	1079	1100	2.2
9	606	612	597	605	1.12	1533	1490	1460	1494	2.98
11	720	771	734	741	1.48	1905	1884	1749	1846	3.69
13	954	966	943	964	1.92	2325	2252	2111	2229	4.45
14	1044	1052	1031	1042	2.08	2531	2445	2310	2428	4.85

R1 , R2, R3 Replicates of the sample ,Decay/min.(DPM)

Y1, Y2 % mineralization of 2,4 D

T-test Significant

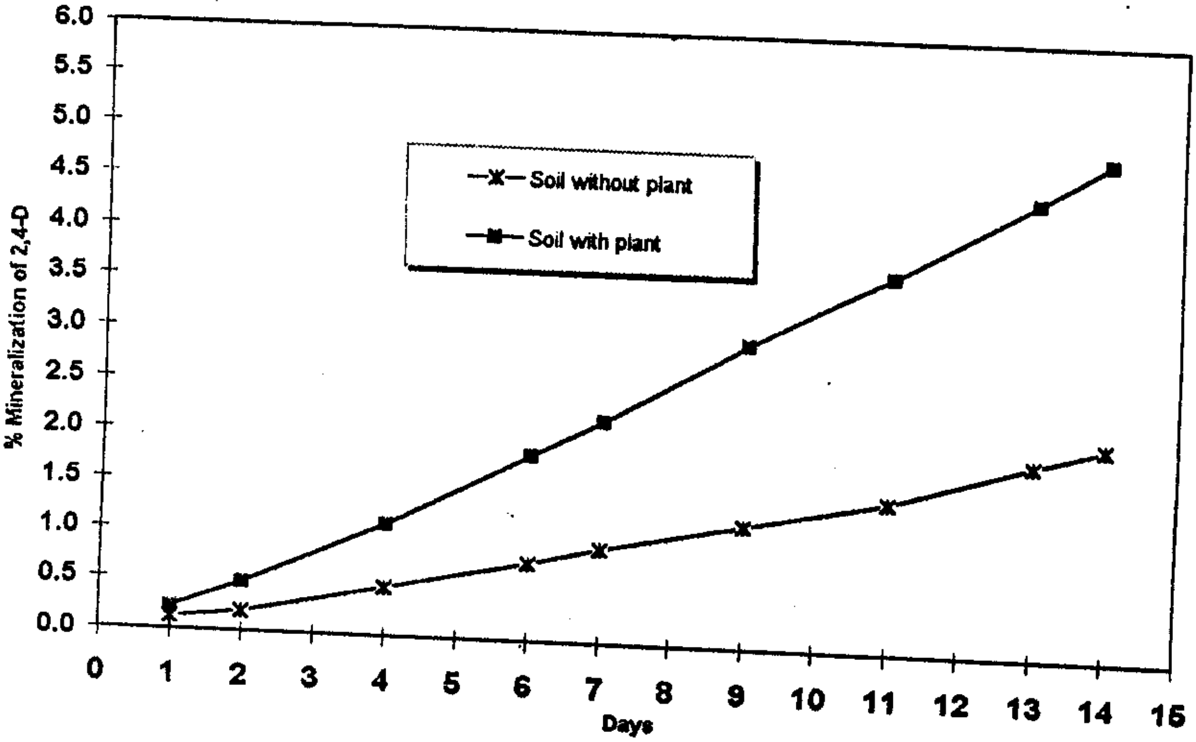


Figure (12) Mineralization of 2,4-D in the presence of corn plant in clay loam soil " pH =6" .

has a pronounced stimulating effect on soil populations of 2,4-D degrading microorganisms.

The same trend was observed about the enhancement of 2,4-D mineralization in the rhizosphere by Sandmann and Loos (1984). They found that an increase in 2,4-D degrading microorganisms in the rhizosphere of sugar cane plant. A possible mechanism by which sugar cane was protected from the herbicidal effect of 2,4-D was suggested by the same authors.

Regarding to the acceleration 2,4-D mineralization in the rhizosphere the latter may provide a growth substrate necessary to cometabolise 2,4-D as discussed by (Horvath,1972).

4.2.2. Mineralization of 2,4-D in the presence of soybean plant in clay loam soil.

The effect of the rhizosphere of soybean plant on 2,4-D mineralization was investigated and compared with that in soil without plant.

The results in Table (13) and Fig (13) showed that no difference in 2,4-D mineralization between soil with plant and soil without plant. After 13 days, 11.07% of 2,4-d was mineralized in soil without plant whears 10.30% was mineralized in soil with plant.Thus the presence of soybean plant did not affect the mineralization of 2,4-D.and Such observation might be reasonable since

Table (13): Mineralization of 2,4-D in the presence of soybean plant in clay loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	235	220	310	255	0.51	283	250	179	237	0.47
2	544	547	644	378	1.15	395	422	282	366	0.73
3	922	948	976	948	1.89	596	844	672	704	1.4
4	1359	1390	1196	1315	2.63	1010	1264	804	1026	2.05
6	2191	2230	2099	2173	4.34	1747	2066	1674	1829	3.65
7	2907	2911	2931	2916	5.83	2463	2767	2411	2547	5.09
9	3794	3780	3679	3751	7.5	3323	3594	3212	3376	6.75
11	4770	4720	4528	4666	9.33	4355	4524	4102	4327	8.65
13	5631	5550	5424	5535	11.07	5188	5416	4848	5150	10.3

R1 , R2, R3 Replicates of the sample ,Decay/min.(DPM)

Y1, Y2 % mineralization of 2,4 D

T-test Non significant

soybean plant is particularly sensitive to damage from using the herbicide as reported by (Anderson et al.1994). They stated that degradation of herbicides may be enhanced only in the rhizosphere of tolerant plants.

4.2.3. Mineralization of 2,4-D in the presence of corn plant in silty loam soil.

The results illustrated in Table (14) and Fig (14) showed that 2,4-D added to silty loam soil with and without corn plant was mineralized, but the disappearance of 2,4-D in both treatments was slow. Mineralization of 2,4-D indicated that a number of microbial populations were present in silty loam soil which were able to mineralize 2,4-D. After 9 days, 8.29% of 2,4-D was mineralized in soil with corn plant whears 6.63% of 2,4-D was mineralized in soil without plant.

4.2.4. Mineralization of 2,4-D in the presence of soybean plant in silty loam soil

2,4-D mineralization was estimated in the presence of soybean plant instead of corn plant under the same conditions. The results shown in Table (15) and Fig (15) indicated that there was no difference in 2,4-D mineralization between soil with soybean plant and soil without plant. At the end of the experiment, 10.31% of 2,4-D was mineralized in soil with plant whears 10.96% of 2,4-D was mineralized in soil without plant.

Table (14): Mineralization of 2,4-D in the prescence of corn plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	213	208	210	210	0.42	271	254	214	246	0.49
2	486	554	539	526	1.05	628	607	567	600	1.2
3	805	904	889	866	1.73	1090	1053	1012	1051	2.1
4	1190	1325	1299	1271	2.54	1600	1541	1505	1548	3.09
6	1926	2152	2077	2051	4.1	2714	2567	2532	2604	5.2
7	2353	2585	2502	2480	4.96	3232	3066	3042	3113	6.22
9	3174	3458	3315	3315	6.63	4404	4145	3896	4148	8.29

R1 , R2, R3 Replicates of the sample ,Decay/min.(DPM)

Y1, Y2 % mineralization of 2,4 D

T-test Non significant

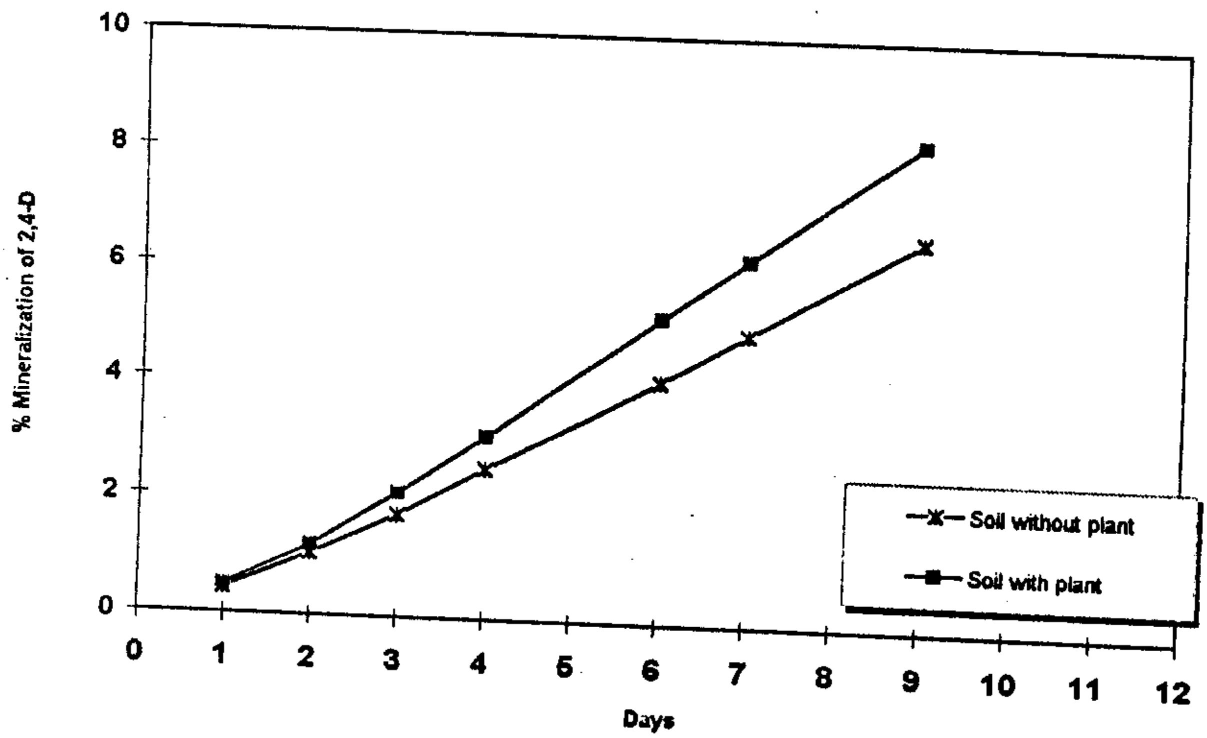


Figure (14) **Mineralization of 2,4-D in the presence of corn plant in silty loam soil .**

Table (15):Mineralization of 2,4-D in the presence of soybean plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	245	290	250	261	0.52	285	207	250	247	0.49
2	548	621	560	576	1.15	597	490	510	532	1.06
3	931	1013	920	954	1.9	984	851	870	901	1.8
4	1349	1445	1341	1378	2.75	1371	1210	1228	1269	2.53
6	2153	2347	2183	2227	4.45	2242	1991	1961	2064	4.12
7	2554	2728	2558	2613	5.22	2662	2370	2334	2455	4.91
9	3434	3726	3481	3547	7.09	3832	3107	3024	3321	6.64
11	4403	4658	4401	4487	8.97	5522	3837	3764	4374	8.74
13	5294	5487	5261	5480	10.96	6304	4617	4544	5155	10.31

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of 2,4 D

T-test Non significant

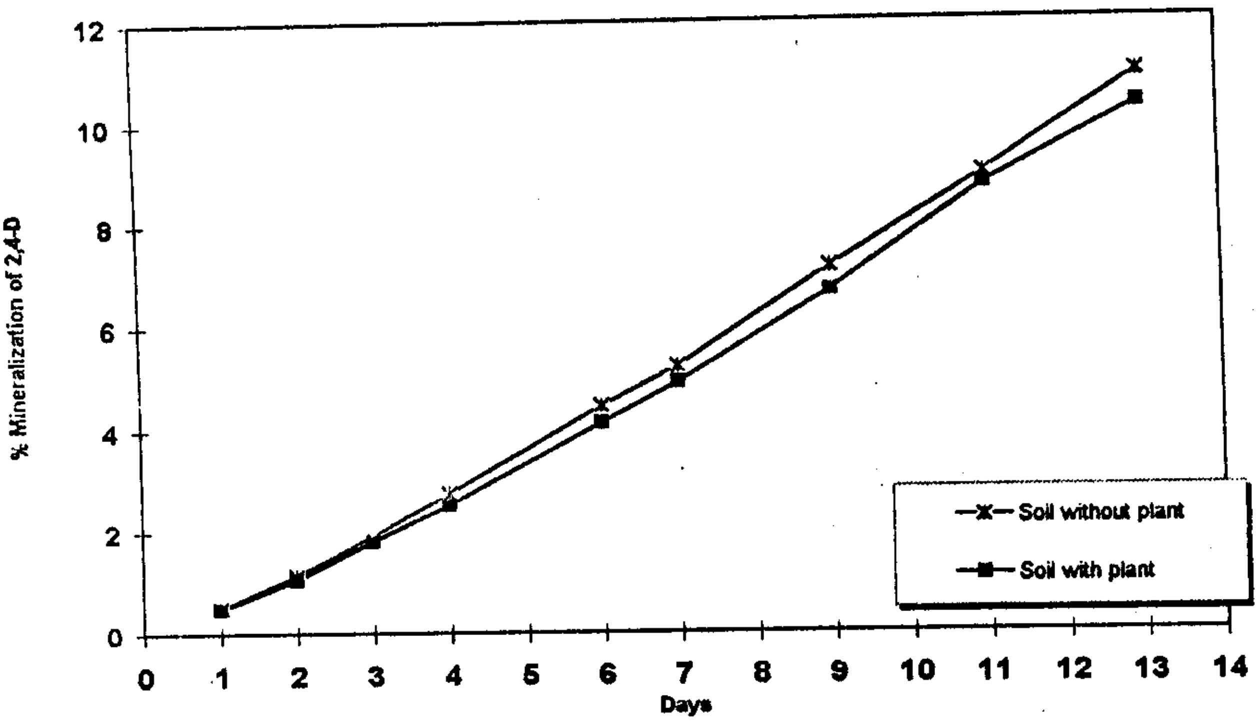


Figure (15) **Mineralization of 2,4-D in the presence of soybean plant in silty loam soil .**

The above results indicated that the presence of corn and soybean plants in silty loam soil was not effective in accelerating 2,4-D mineralization. The same trend was also observed on PNP mineralization in the presence of the same plans.

Such results might be due to the adsorptive behaviour of this kind of soil. Therefore, bioavailability of 2,4-D is reduced by adsorption to solid soil components. Such conclusion is in a good agreement with that stated by (Grover ,1973)and (Ogram et al.1985)

4.2.5. Mineralization of 2,4-D in the presence of corn and soybean root exudates in clay loam soil

Plant roots secrete several biological compounds into the surrounding soil, some of these exudates might be utilized by rhizosphere microorganisms leading to the enhancement of the mineralization process of xenobiotics, especially in case of cometabolic compounds such as 2,4-D. Therefore, two experiments were conducted to investigate the effect of corn and soybean root exudates on the 2,4-D mineralization in the clay loam soil.

Corn root exudates was obtained under aseptic conditions and added to the surface of clay loam soil treated with a 2,4-D at a concentration of 1ppm. The mineralization was estimated over time and compared with the mineralization of 2,4-D in soil irrigated with nutrient solution as a control.

The results in Table (16) and Fig (16) showed that the mineralization extent of 2,4-D was slow until the end of the experiment, but there was a slight increase in the mineralization in soil treated with corn root exudates compared with soil treated with nutrient solution. The results however, indicated a non significant difference between the two treatments was observed.

In Table (17) and Fig (17) soybean root exudates was added to the same type of soil under the same conditions and there was a slight increase in 2,4-D mineralization but this increase was non significant when compared with that of the soil irrigated with nutrient solution.

From the previous results, it can be concluded that both corn and soybean roots exudates almost have similar effect on the mineralization of 2,4-D in clay loam soil.

The slight increase in the 2,4-D mineralization could be attributed to the biological substances excreted from the root system in corn and soybean plants, which provide the 2,4-D biodegraders with carbon and energy sources. This is why the mineralization of 2,4-D was slightly increased in soil provided with corn and soybean root exudates.

From data in Table (11) and Table (13), it can be concluded that both corn and soybean plants had a significant effect in accelerating 2,4-D mineralization. On the contrary, root exudates of corn and soybean plants have

Table (16):Mineralization of 2,4-D in the prescence of corn root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln .					Soil irrigated with corn root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	23	21	20	21	0.03	49	11	30	30	0.05
3	78	75	73	75	0.13	89	73	75	79	0.14
7	184	157	168	169	0.3	205	230	210	215	0.38
14	390	316	350	352	0.62	392	529	453	458	0.81

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant

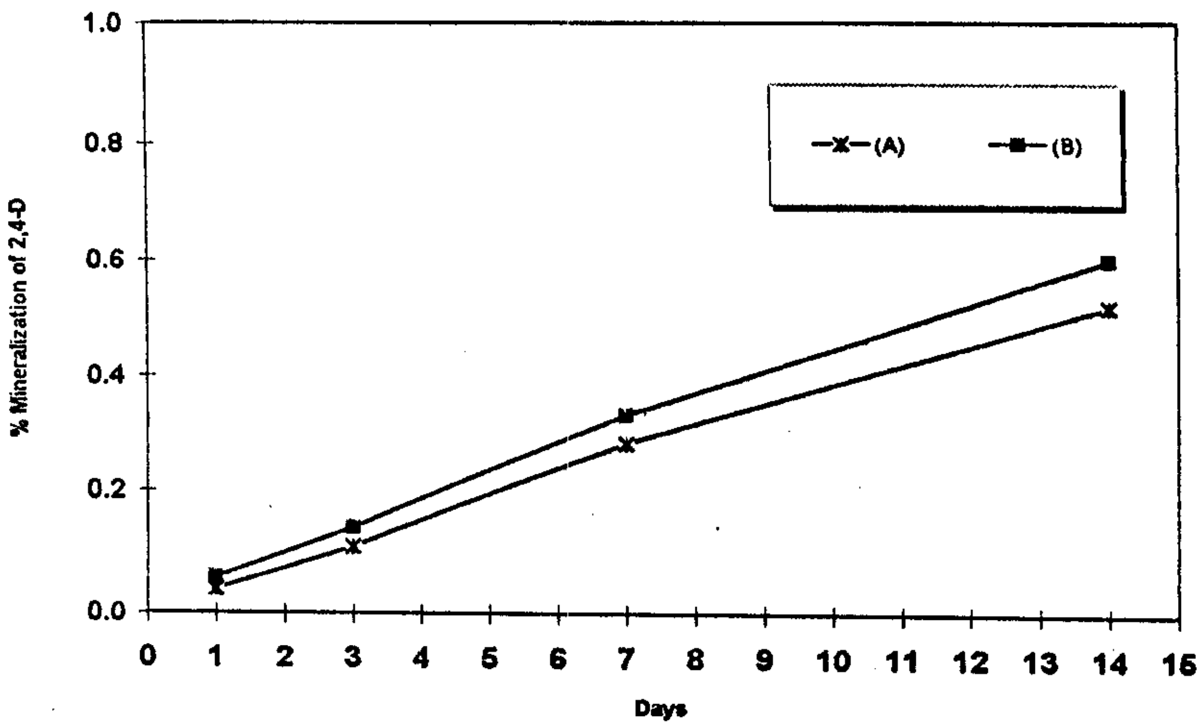
Table (17): Mineralization of 2,4-D in the prescence of soybean root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln .					Soil irrigated with soybean root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	18	38	25	27	0.04	56	28	30	38	0.06
3	56	75	62	64	0.11	100	69	72	80	0.14
7	136	186	152	158	0.28	187	200	181	189	0.33
14	250	349	290	296	0.52	298	393	334	341	0.6

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant



(A) Soil Irrigatad with nutrient soln .
(B) Soil irrigated with soybean root exudates .

Figure (17) Mineralization of 2,4-D in the presence of soybean root exudates in clay loam soil .

insignificant effect on 2,4-D mineralization. This probably occurred due to changes in the dynamics of the activities of the microbial community in the rhizosphere upon the presence of the plants.

4.2.6. Mineralization of 2,4-D in the presence of synthetic root exudates in clay loam soil.

In this study, a lab experiment was carried out to investigate the effect of adding a mixture of biological compounds in the form of synthetic root exudates similar to the chemical composition of natural root exudates on the mineralization of 2,4-D in a clay loam soil.

2,4-D was added at the same concentration previously used and synthetic root exudates was added to the surface of non sterilized soil. The mineralization was measured over a period of 15 days, and compared with 2,4 D mineralization in soil irrigated with deionized water as control.

The results in Table (18) and Fig (18) showed that there was a slight increase in the extent of 2,4-D mineralization in soil irrigated with synthetic root exudates compared with soil irrigated with deionized water. However, the difference between both treatments was insignificant. Several studies were carried out using the addition of some nutrients to enhance the mineralization of 2,4-D. The addition of glucose plus urea to the soil , slightly stimulated the breakdown of 2,4-D, as did the

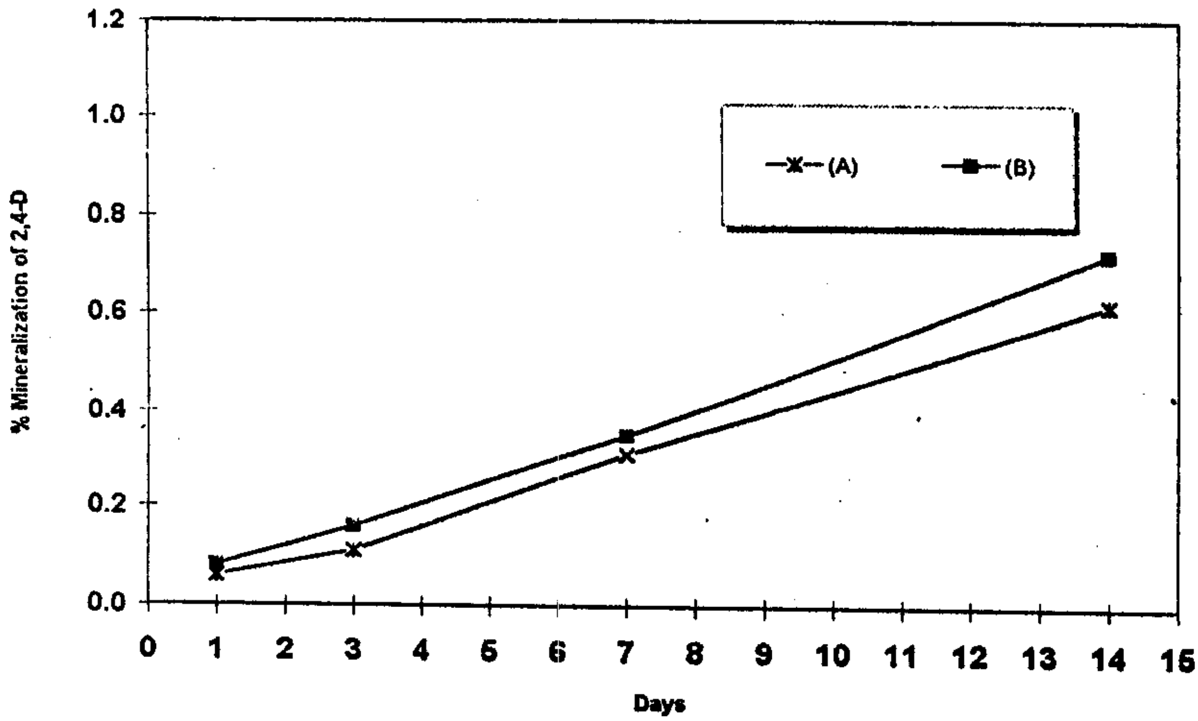
Table (18): Mineralization of 2,4-D in the presence of synthetic root exudates in clay loam soil

Days	Soil irrigated with deionized water					Soil irrigated with synthetic root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	25	49	35	36	0.06	45	49	46	46	0.08
3	47	89	64	66	0.11	98	92	94	94	0.16
7	148	213	176	179	0.31	245	172	176	197	0.35
14	284	418	346	349	0.62	475	359	384	406	0.72

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of PNP

T-test Non significant



(A) Soil irrigated with deionized distilled water .
(B) Soil irrigated with synthetic root exudates .

Figure (18) Mineralization of 2,4-D in the presence of synthetic root exudates in clay loam soil .

addition of yeast extract, but the stimulation was considerably less than the addition of lime (Ou et. al. 1978)

On the contrary, Dextadar and Saleh-Rastine (1974) found a decrease in numbers of 2,4-D degrading microorganisms after the addition of yeast extract.

Table (19):Mineralization of Glyphosate in the presence of corn plant in clay loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	6416	4800	5766	5660	7.38	6517	8560	6362	7146	9.32
2	10671	9142	9106	9639	12.57	10100	13149	10036	11095	14.47
3	14218	12749	11840	12935	16.87	13200	16282	13507	14329	18.69
4	17532	15558	14344	15811	20.62	15760	19092	16695	17182	22.41
5	19688	17259	15740	17562	22.9	19997	20830	18912	19913	25.97
6	20942	18553	16993	18829	24.56	21727	22136	20641	21501	28.04
7	22250	19262	18145	19885	25.93	23149	23698	21980	22942	29.92
8	23329	19745	19196	20756	27.07	24283	24888	23132	24101	31.43
9	24263	20161	19818	21414	27.93	25243	25927	24157	25109	32.75
10	24763	20965	20229	21985	28.67	26085	26808	25084	25992	33.9
11	25581	21548	20577	22568	29.43	26925	27638	25919	26827	34.99
12	26350	22946	21088	23461	30.6	28081	28268	26540	27635	36.04
13	27089	24153	21515	24252	31.63	28813	29034	27199	28348	36.97

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Significant

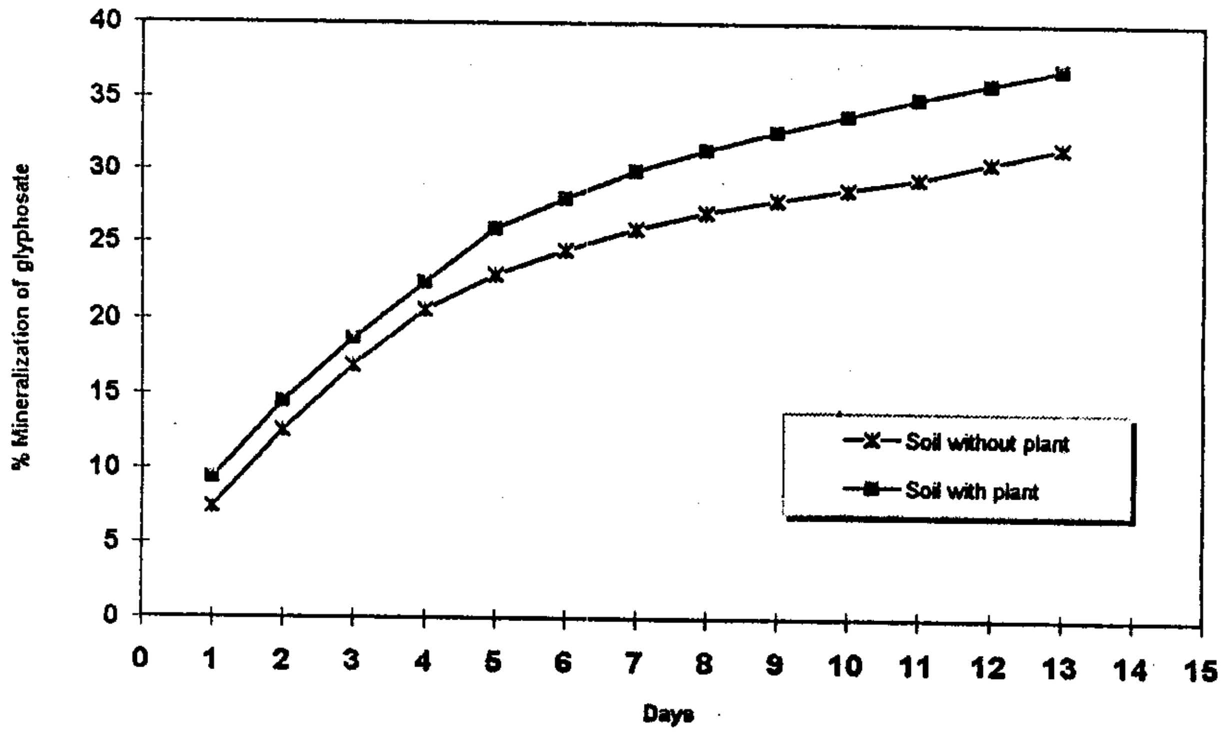


Figure (19) Mineralization of Glyphosate in the presence of corn plant in clay loam soil .

4.3.2. Mineralization of glyphosate in the presence of soybean plant in clay loam soil.

In this experiment, soybean was used under the same conditions and the mineralization was estimated during the whole period that followed the addition of glyphosate.

The obtained data in Table (20) and Fig(20) showed that there was a significant increase in glyphosate mineralization in the rhizosphere of soybean plant compared with its mineralization in soil without plant. At end of the mineralization experiment, 29.34% of glyphosate was mineralized compared with 24.62% in soil without plant. Therefore, It is clear from the results of the two previous experiments, that there was a significant effect on glyphosate mineralization in the presence of the rhizosphere of corn and soybean plants compared with than that in soil without soybean plants.

Accelerating glyphosate mineralization in the presence of corn plant than that observed with soybean plant might be due to the increased activity of soil microorganisms in the rhizosphere of corn plant. It was found that glyphosate is degraded by cometabolism. So, the rhizosphere of corn plant may provide a favourable environment for stimulating the breakdown of glyphosate (Hsu and Bartha,1979)

Increased degradation in plantd soil assumed that it is associated with the input of carbon compounds by plant

Table (20): Mineralization of Glyphosate in the presence of soybean plant in clay loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
2	8318	7739	4629	6895	9.37	8674	9335	10854	9621	13.07
4	11664	10730	8153	10182	13.84	11818	12638	14766	13074	17.77
5	13044	11916	9541	11500	15.63	13006	13896	16348	14416	19.59
6	13996	12754	10553	12434	16.9	13830	14893	17536	15419	20.96
7	14839	13594	11467	13300	18.07	14729	15776	18520	16341	22.21
9	16071	14760	12745	14525	19.74	15998	17141	19792	17643	23.98
10	16741	15416	13477	15211	20.67	16605	17846	20550	18333	24.92
12	17709	16267	14369	16115	21.9	17548	18780	21533	19287	26.21
13	18071	16567	14718	16452	22.36	17895	19109	21944	19649	26.71
14	18421	16879	15071	16790	22.82	18245	19481	22295	20007	27.19
16	19384	17805	15906	17698	24.05	19171	20496	23298	20988	28.53
17	19690	18291	16373	18118	24.62	19833	21023	23903	21586	29.34

R1, R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Significant

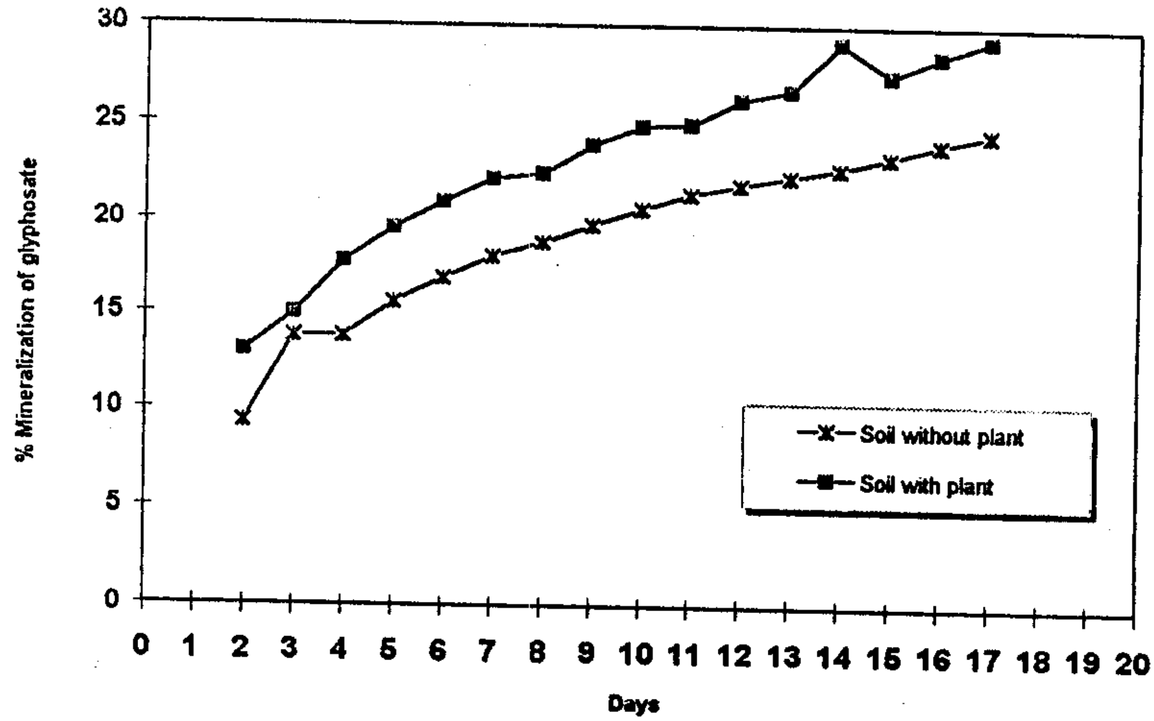


Figure (20) Mineralization of Glyphosate in the presence of soybean plant in clay loam soil .

roots. Such compounds may (1) support greater numbers of microorganisms .(2) provide growth substrates for cometabolizing organisms. (Reddy and Sethunathan 1983), (Shann and Boyle ,1994).

The increase in glyphosate mineralization in the presence of soybean plant, since it is a leguminous plant is likely to be due to the presence of symbiotic relationship between the nitrogen fixing bacteria *Bradyrhizobium Japonicum* and soybean that may altered the rhizosphere community, and this may led to the enhancement of glyphosate mineralization. Moreover, Liu et. al. (1991) indicated that, some strains of *Rhizobium* are able to degrade glyphosate as a sole source of phosphorus. They added that glyphosate degradation is widespread in the family Rhizobiaceae.

4.3.3. Mineralization of Glyphosate in the presence of corn and soybean plants in silty loam soil

This study concerned evaluating the effect of the rhizosphere of corn and soybean plants on glyphosate mineralizaton in silty loam soil.

The results illustrated in Table (21) and Fig (21) indicated that, at the end of the experiment, 9 days, 22.89% and 25.56% of glyphosate were mineralized in silty loam soil cultivated with and without corn plant respectively. The corresponding values reached 32.09% and 34.32% in the same soil cultivated with and without soybean plant respectively, Table (22) and Fig (22).

Table (21): Mineralization of Glyphosate in the presence of corn plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	4307	4073	4195	4191	7.36	3927	5274	4223	4474	7.86
2	6520	6166	6335	6340	11.14	5700	7945	6113	6586	11.57
3	8339	7863	8093	8098	14.23	7202	9447	7623	8090	14.21
4	9823	9263	9513	9533	16.75	8467	10712	8815	9331	16.39
6	12170	11345	12613	12042	21.16	10345	12590	10576	11170	19.63
7	13100	12220	13483	12934	22.73	11080	13322	11315	11905	20.92
9	14755	13788	15094	14545	25.56	12233	14472	12380	13028	22.89

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Non significant

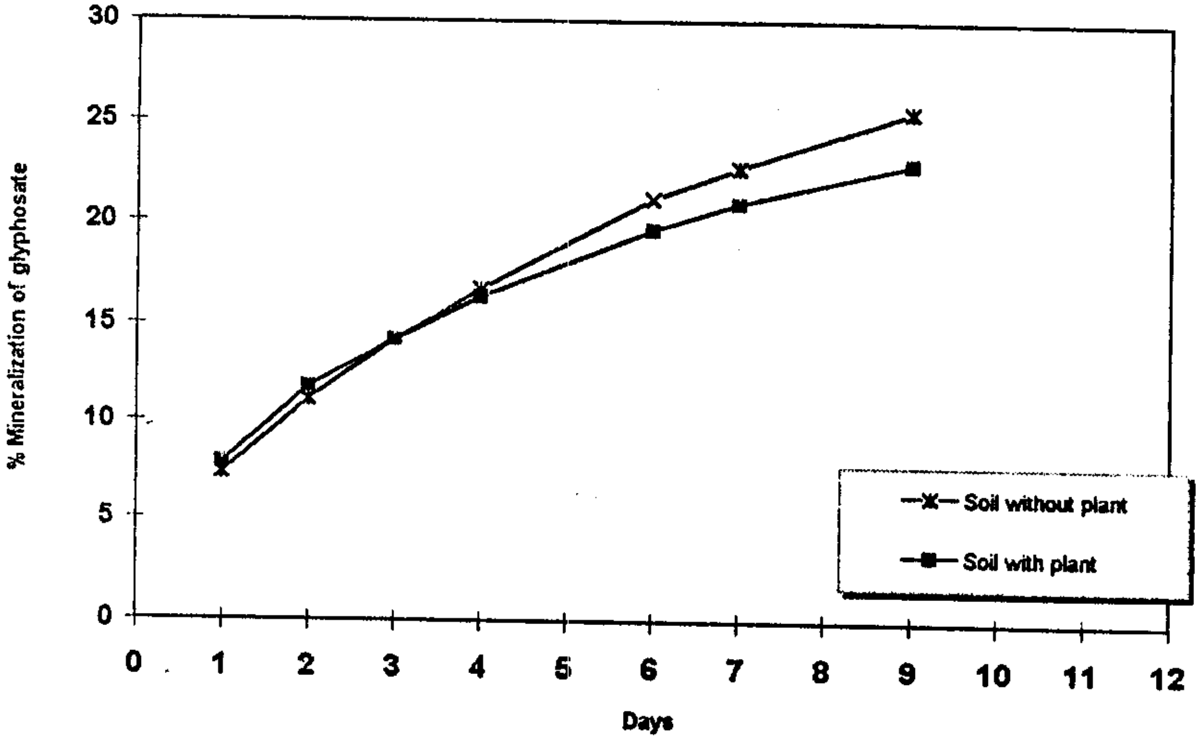


Figure (21) **Mineralization of Glyphosate in the presence of corn plant in silty loam soil .**

Table (22): Mineralization of Glyphosate in the presence of soybean plant in silty loam soil

Days	Soil without plant					Soil with plant				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	4511	4556	4050	4372	7.68	3866	4469	4040	4125	7.24
2	6801	7006	6277	6694	11.76	6072	6950	6298	6440	11.31
3	8638	9060	8136	8611	15.13	7919	8968	8136	8341	14.65
4	10157	10707	9642	10168	17.87	9410	10597	9617	9874	17.35
6	12519	12431	12103	12684	22.29	11479	13049	11839	12122	21.3
7	13454	14474	13092	13673	24.03	12286	14003	12709	12999	22.84
9	15132	16348	14799	15426	27.11	13600	15592	14157	14449	25.39
11	16568	17877	16187	16877	29.66	14648	16929	15374	15650	27.5
13	17651	19107	17342	18033	31.69	15511	17893	16224	16542	29.07
14	18193	19702	17904	18599	32.69	15931	19143	17115	17396	30.57
16	19137	20663	18793	19531	34.32	16648	20117	18014	18259	32.09

R1 , R2, R3 Replicates of the sample,Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Non significant

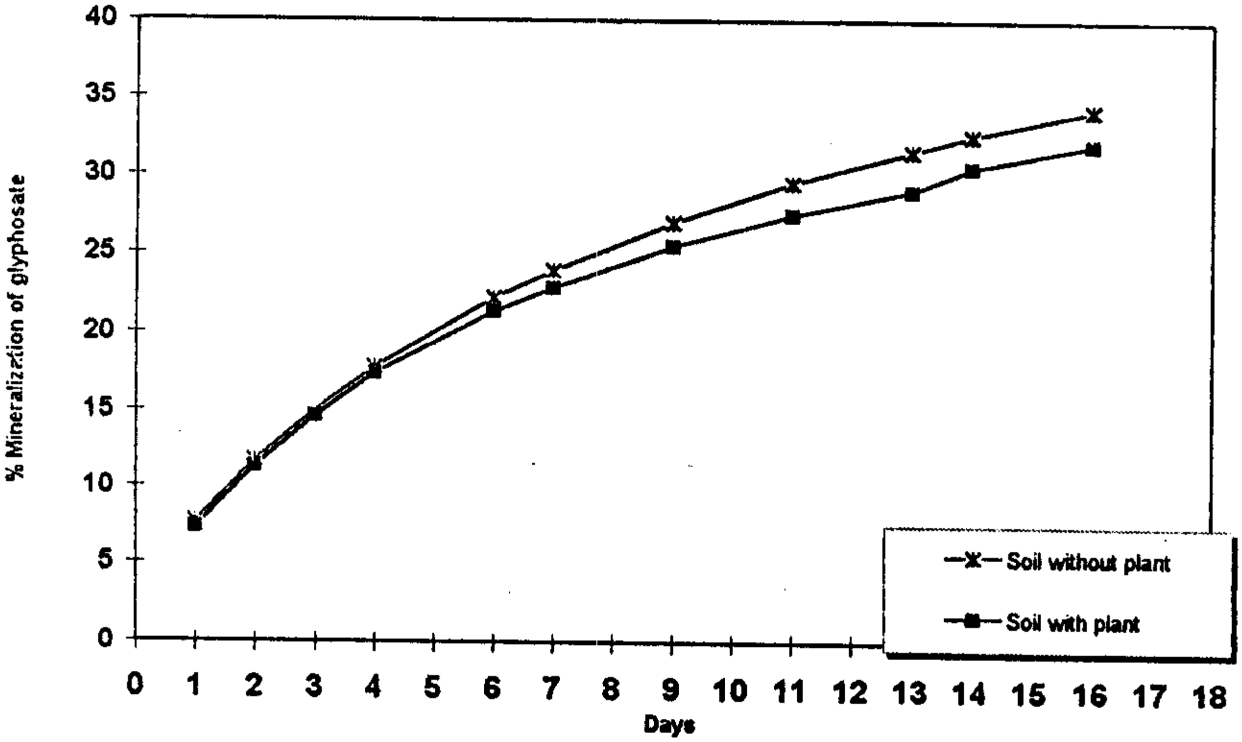


Figure (22) **Mineralization of Glyphosate in the presence of soybean plant in silty loam soil .**

From the previous data , it is worthy to indicate that neither corn nor soybean rhizosphere showed a significant effect on the mineralization of glyphosate in the silty loam soil, even the increase in glyphosate mineeralization in the presence of soybean plant was relatively higher with the same period under the same conditions

The previous experiments revealed that mineralization of glyphosate occurred in clay loam soil whether cultivated with corn or soybean plants was greater than that occurred in silty loam soil. This means that clay loam soil is more effective in glyphosate mineralization. Such an observation may be attributed to differences in soil characteristics between clay loam and silty loam soil which are reflected on glyphosate-plant-soil microorganisms interactions in soils (Knaebel and Vestal ,1994).

4.3.4. Mineralization of glyphosate in the presence of corn root exudates in clay loam soil

Corn root exudates were added to the surface of clay loam soil under the same previously mentioned conditions to investigate the mineralization of glyphosate .

Data in Table (23) and Fig(23) showed that irrigation of soil with natural root exudates failed to elicit any significant effect on $^{14}CO_2$ evolution from mineralization of glyphosate as compared with that of soil irrigated with nutrient soln. When comparing glyphosate mineralization in

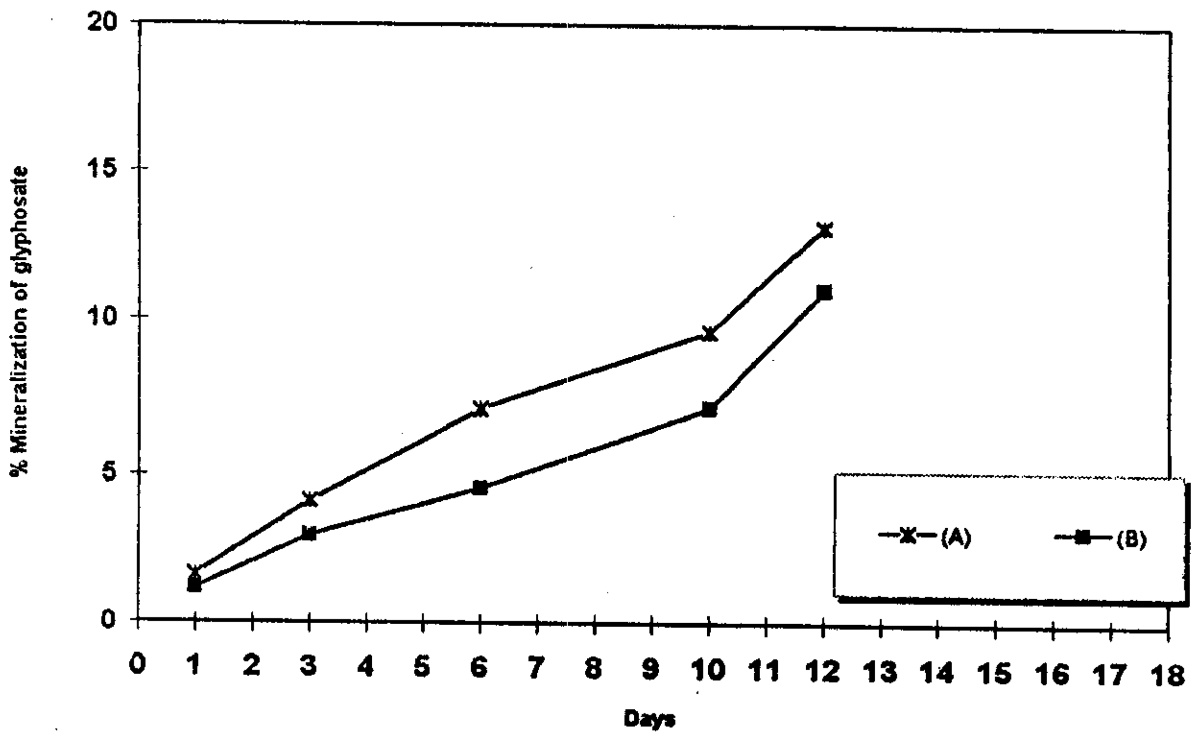
Table (23):Mineralization of Glyphosate in the presence of corn root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln .					Soil irrigated with corn root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1573	879	1122	1191	1.63	640	1032	955	875	1.19
3	3775	2345	2956	3025	4.14	1403	2857	2249	2169	2.97
6	6153	4353	5149	5218	7.14	1842	4752	3416	3336	4.57
10	6697	7416	6952	7021	9.61	3100	7347	5342	5263	7.2
12	10214	8966	9485	9555	13.08	6274	9643	8077	7998	10.95

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Non significant



(A) Soil Irrigatad with nutrient soln .
(B) Soil irrigated with corn root exudates.

Figure (23) Mineralization of Glyphosate in the presence of corn root exudates in clay loam soil .

the presence of corn plant with that in the presence of corn root exudates , The first case in Table (10), was accelerated significantly, while the effect of corn root exudates was non significant. This means that the presence of corn plant stimulated the mineralization of glyphosate. These results are in agreement with that reported by Hsu and Bartha (1979) .They stated that the processing and concentrations of natural root exudates may affect the mineralization process. At the same time, the superiority of corn root exudates in stimulating the evolution of $^{14}CO_2$ from glyphosate , suggests that the interaction may involve more than a simple transfer of carbon and energy source from plant to the rhizosphere microorganisms.

4.3.5. Mineralization of glyphosate in the presence of soybean root exudates in clay loam soil

Data obtained in Table (24) and fig (24) showed that, non significant increase in glyphosate mineralization was pointed out in the soil irrigated with soybean root exudates compared with that irrigated with nutrient solution . Glyphosate mineralization in soil cultivated with soybean plant, table (20), and that in soil irrigated with its root exudates table (24) ,gave evidence that, soybean plant play a role in accelerating glyphosate mineralization. This is probably due to the symbiotic releationship between *Rhizobium* and soybean plant, therefore, the absence of soybean plant may affect the mineralization of glyphosate in the soil.

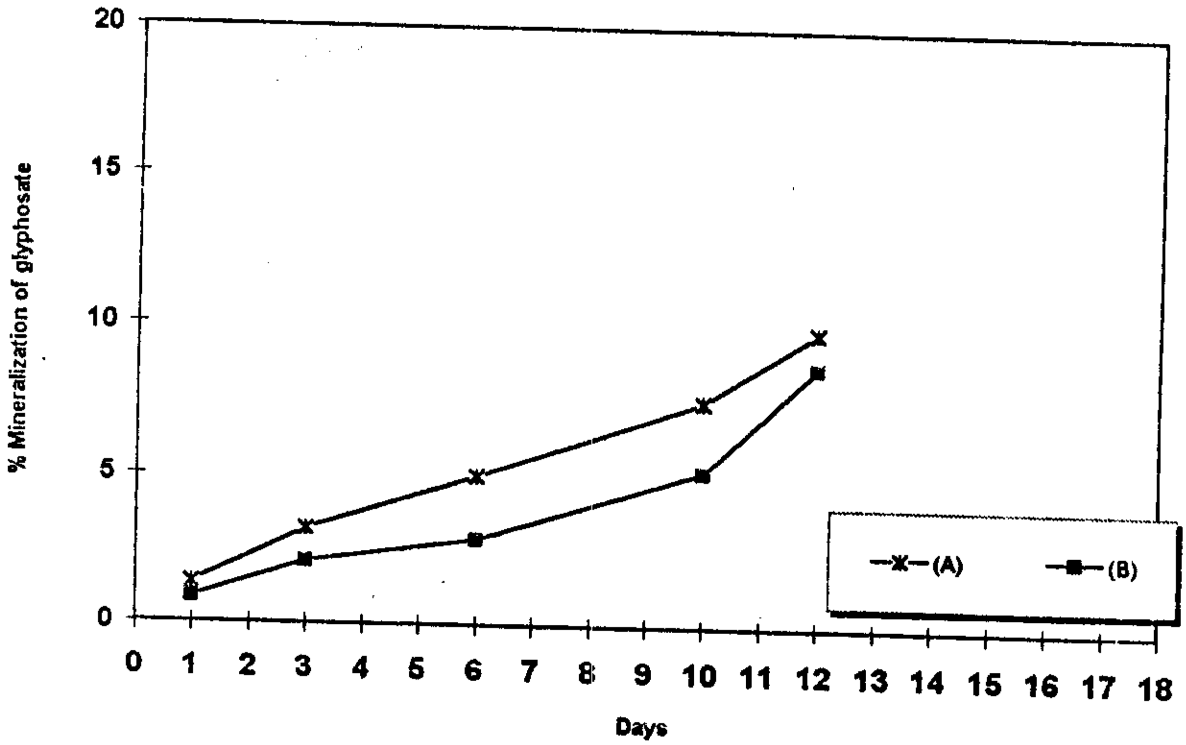
Table (24): Mineralization of Glyphosate in the presence of soybean root exudates in clay loam soil

Days	Soil Irrigatad with nutrient soln .					Soil irrigated with soybean root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1403	602	992	999	1.36	665	614	640	639	0.87
3	3140	1617	2292	2349	3.21	1617	1448	1533	1532	2.09
6	5023	2368	3609	3666	5.02	2206	2031	2113	2116	2.89
10	7300	3869	5412	5527	7.57	3909	3743	3820	3824	5.23
12	8994	5554	7101	7216	9.88	6505	6243	6368	6372	8.72

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Non significant



(A) Soil Irrigatad with nutrient soln .
(B) Soil irrigated with soybean root exudates.

Figure (24) Mineralization of Glyphosate in the presence of soybean root exudates in clay loam soil .

4.3.6. Mineralization of glyphosate in the presence of synthetic root exudates in clay loam soil.

The effect of application of synthetic root exudates on the mineralization of the herbicide glyphosate in clay loam soil was investigated. The effect was detected through measuring $^{14}CO_2$ released during the experimental period, compared with soil irrigated with deionized water from the soil irrigated with synthetic root exudates.

The obtained results are tabulated in Table (25) and fig (25) showed that a relatively slight increase in glyphosate mineralization in soil irrigated with synthetic root exudates as compared with soil irrigated with deionized water. At the end of the experiment (12 days), 15.40% and 13.40% of glyphosate were mineralized in the soil irrigated with synthetic root exudates and deionized water respectively. Such data are almost expected and in agreement with (Hsu and Bartha, 1979).

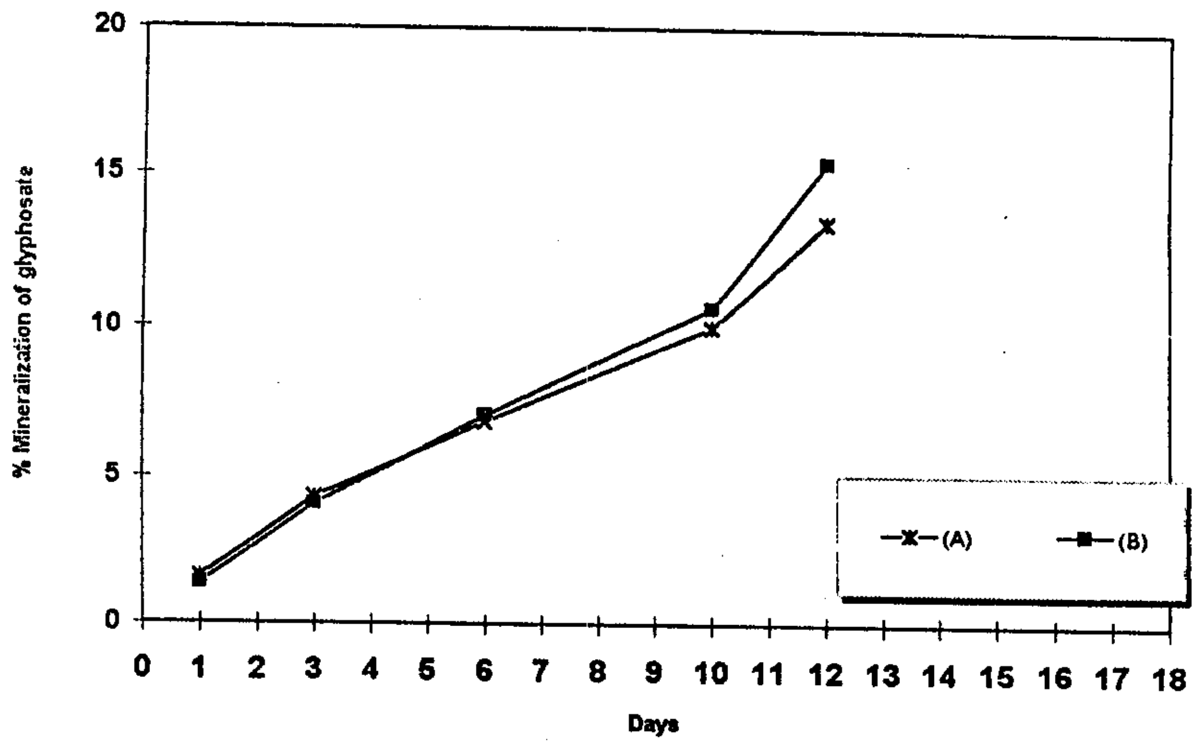
Table (25): Mineralization of Glyphosate in the presence of synthetic root exudates in clay loam soil

Days	Soil irrigated with deionized water					Soil irrigated with synthetic root exudates				
	R1	R2	R3	Mean	Y1	R1	R2	R3	Mean	Y2
1	1185	1154	1132	1157	1.58	999	926	968	964	1.32
3	3237	3127	3133	3165	4.33	2797	3201	2988	2995	4.1
6	5298	4676	4953	4975	6.81	4696	5618	5146	5153	7.05
10	7709	4928	7284	7307	10	7018	8513	7746	7759	10.62
12	10340	9345	9808	9831	13.46	10509	12002	11236	11249	15.4

R1 , R2, R3 Replicates of the sample Decay/min.(DPM)

Y1, Y2 % mineralization of glyphosate

T-test Non significant



(A) Soil irrigated with Deionized Distilled water .
(B) Soil irrigated with Synthetic root exudates.

Figure (25) **Mineralization of Glyphosate in the presence of synthetic root exudates in clay soil .**