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RESPONSE OF *KOCHIA INDICA* WIGHT, IRRIGATED WITH SALINE WATER, TO SOME PHOSPHATE FERTILIZER RESOURCES AT WADI SUDR AREA (SOUTH SINAI)

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Kochia indica is annual bushy herb growing through many geogrpahical areas. It is drought resistant, salt tolerant and grazed by many animal species. This research was carried out in Ras Sudr at South Sinai characterized by calcareous soils where phosphorus is found in unavailable form for plant absorption and the transformation of this element is a great problem. An experiment was conducted to study the effect of biofertilizer (phsophate dissolving bacteria, PDB) and two mineral resources of phosphorus, namely, rock phosphate and calcium superphosphate at three levels (0, 30 and 60 kg P_2O_5 /fed.) Studied parameters were forage fresh yield (FFY), forage dry yield (FDY), crude protein yield (CPY), phosphorus yield (PY), crude fibre yield (CFY) and total ash yield.

The results showed that by adding the biofertilzier resource, all studied parameters have been significantly increased. Also, increasing the rate of rock phosphorus lead to significant increase of FFY, FDY, CPY, CFY, PY and total ash. This increase was more pronounced under the medium level (30 kg P_2O_5/fed). The same trend was observed for calcium superphosphate. The greatest values of all previous parameters were obtained under the combination of the three phosphorus resources.

Microbiological determinations indicated that applying PDB together with inorganic phosphate fertilizer led to considerable increase in microbial densities and activities in the plant rhizosphere zone, including total microbial count, counts of *Azotobacter, Azospirillum,* phosphate dissolving bacteria and rate of CO_2 evolution.

Keywords: *Kochia indica* Wight, rock phosphate, calcium superphosphate, phosphate dissolving bacteria, *Bacillus megaterium*, *Pseudomonas fluorescens*.

Kochia indica Wight (blue bush) is a rapidly growing annual bushy herb adapted to many geographical areas. It is drought resistant, salt tolerant and summer forage which is accepted and grazed by many species of grazing animals. Therefore, the effect of different sources of phosphorus fertilizer, under saline and calcareous soil conditions of Ras Sudr area (South of Sinai) on the productivity and the Quality of this plant might be studied.

In general, phosphorus in these conditions is found in complex precipitated form. The transformation of this element into unavailable salts is considered as one of the common problems under these conditions.

Phosphate dissolving bacteria, (PDB) posses the ability to transform unavailable phosphorus in soil into available forms by secreting organic acids which lower pH and bring about dissolving the bound forms of phosphate. They play an important role in releasing more available phosphorus from rock phosphate or other difficult phosphorus forms through producing organic and inorganic acids in addition to growth promoting substances such as auxins, gibberellins and cytokinin which may improve plant growth and stimulate the microbial development (Ali *et al.*, 2002, Abou El- Soud, *et al.*, 2003 and Abd El- Rasoul *et al.*, 2003).

Phosphorus has been recognized as a major element for plant nutrition. El Toukhy (1997), mentioned that low- level of phosphorus enhanced generally the different growth parameters as well as the productivity of *Atriplex sp.* On the other hand, El-Deek *et al.* (1991) reported that adding phosphorus fertilization to *Atriplex sp.* had no significant effect on fresh or dry weight, while Abo El-Soud *et al.* (2003) found that, in newly reclaimed soils, superphosphate appliction as a source of phosphorus slightly increased the dry weight compared to those obtained from rock – phosphate. Nezam *et al.* (2004) reported that the appliction of phosphorus alone did not produce significantly high yield.

So, the purpose of this study is to investigate the effect of rock phosphate, calcium superphosphate and phosphorus dissolving bacteria on the productivity, chemical contents of *Kochia indica* plant as well as the microbial content of the soil.

MATERIALS AND METHODS

Two field experiments were carried out under the saline conditions of Ras Sudr experimental farm, South Sinai, on *Kochia indica* plant throughout 2004 and 2005 growing seasons.

Determination of soil physical and chemical properties of the experiment area (Table 1) and analysis of irrigation water (Table 2) were done according to the standard methods described by Page *et al.* (1982).

Table (1). Physical and chemical analyses of soil at Ras Sudr Exp. Farm.

$CaCO_3$%	Particle size distribution %					
	Coarse sand	Fine sand	Silt	Clay	Texture	O.M.%
52.91	13.77	70.89	6.96	8.36	loamy Sand	0.237

EC (dS/m)	pH	soluble cations (me/l)				soluble anions (me/l)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
5.29	8.08	32.5	9.5	54.2	4.1	-	1.7	21.17	77.43

Table (2). Analyses of irrigation brakish under ground water

T.S.S. ppm	pH	Cations (me/l)				Anions (me/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8400	7.45	20.45	16.10	47.93	0.43	3.27	60.19	37.83

* T.S.S total soluble salts

The plant material used in this study is blue bush seeds (*Kochia Indica* wight) which were collected from shrubs grown naturally at North Western Coast of Egypt. Seeds were planted in polyethylene bags filled with loamy and sandy soil (1:1) in January 4th and 5th during 2004 and 2005 respectively, under green house conditions. After three months later, uniform and healthy seedlings were chosen and transplanted in the experimental site.

30 and 60 kg P_2O_5/fed. of each of calcium superphosphate and rock phosphate fertilizer were mixed thought preparing the soil on 1st April each year. Seedlings were distributed at a distance of 2×2 meter (1050 plants/fed.)

Biofertilization treatments were carried out using selected cultures of *Pseudomonas fluorescens* and *Bacillus megaterium* as phosphate dissolving bacteria. These cultures have the capability to withstand stress of desert soil conditions such as salinity, drought and pH. They were provided from soil microbiology unit, Desert Research Center, Cairo (Abd El-Ghany, 1997 and Abdel-Azeem 1998). Both organisms were grown individually on Bunt and Rovira medium (Taha *et al.*, 1969). A mixture of equal volumes, of fresh liquid cultures, with concentration of about 10^8 cell/ml, of each organism was used as a biofertilizer surrounding roots of Kochia plants and irrigated immediately to activate growth of bacteria. Ground brakish well-water, which contains about 8400 ppm dissolved salts, was used for irrigation. Refertilization by the same dose of phosphate dissolving bacteria was applied after one month of seedlings. First harvest was two months later (1st July), the second harvest was after 45 days from the first one. Two cuts were taken every season.

Every experiment included 18 treatments in split- split plot design with three replicates. where the two main plots were assigned to inoculation with (PDB) and without inoculation, the sub plots were devoted for rock phosphate rates (0, 30 and 60 kg P_2O_5/fed) and the sub- sub plots were distributed to calcium superphosphate fertilizer rates (0, 30 and 60 kg P_2O_5/fed)

The forage fresh yield (FFY) for each cut was collected and weighed, then the net accumulated yield at the end of the year was recorded. Sub-samples were removed and dried to estimate the dry matter. Forage dry yield (FDY) was calcualted on a dry basis. Samples were prepared and analysed by using the modified micro-kjeldahl method as discribed by Peach and Tracy (1956) to determine crude protein concentration (CP%). Crude protein yield (CPY) was calculated using CP% and (FDY). Total ash and crude fibre yield (CFY) were determined by using the method outlined by A.O.A.C. (1970) and were calculated as Ash%, Crude Fiber % (CF) and (FDY). Phsophorus % (P%) was obtained by ascorbic acid method according to Frie *et al.* (1964) and phosphorus yield (PY) was calculated by using P% and (FDY).

Microbiological Determinations

Samples of plant rhizosphere were taken at the two cuts and subjected to microbial determinations. Total microbial count (heterotrophic plate count) on soil extract agar (Page *et al.*, 1982). Counts of *Azotobacter* on modified Ashby's medium (Abdel- Malek and Ishac, 1968), *Azospirillum* counts on semi-solid malate medium (Döbereiner, 1978). Phosphate dissolving bacterial counts on Bunt and Rovira agar medium after modification by Taha *et al.* (1969). Carbon dioxide evolution was determined according to Alef and Nannipieri (1995) as an index of biological activity in the plant rhizosphere zones.

Data of the two years and their average were statistically analysed as a split- split- plot design according to Snedecor and Cochran (1989) using Cost at computer program. Duncin's multiple rang test was used to test treatment means for the two years and average as described by Steel and Torrie (1960).

RESULTS AND DISCUSSION

The significant effect of biofertilizer inoculations by phosphate dissolving bacteria (PDB); phosphorus application resources on the productivity parameters (FFY and FDY) and chemical content (CPY, CFY, PY and total ash yield) for the two years and their combination are concluded in table (3).

Inoculations by PDB were highly significant for all studied parameters in both years and their average.

Application of rock phosphorus exhibited highly significant effect for CPY and PY of second year whereas, this effect also extended to the average of all parameters except of CFY and total Ash. Meanwhile, the effect was significant only on FDY, CPY and CFY at first year.

The effect of applied calcium superphosphate was highly significant only on the average of FFY, FDY as well as CPY of the second year and total ash of first one.

The interaction between biofertilizer x rock phosphorus was highly significant on the average of FFY and CPY total ash as well as CPY of the first year.

The interaction between biofertilizer x calcium superphosphate was highly significant on the average of FFY and PY as well as PY of second year.

The interaction between rock phosphrous x calcium superphosphate was more effective on the average of FFY, FDY and highly significant on CPY and total ash.

The combinations of the three main phosphorus resources were highly significant for all parameters studied.

Table (3). Productivity and chemical content as influenced by three phosphorus fertilizer resources in two years and their combination on *Kochia indica* .

Resource	FFY (ton/fed.)			FDY (ton/fed.)			PY (kg/fed.)			CPY (kg/fed.)			CFY (kg/fed.)			Total ash yield (kg/fed.)		
	1st year	2nd year	com.	1st year	2nd year	com.	1st year	2nd year	com.	1st year	2nd year	com.	1st year	2nd year	com.	1st year	2nd year	com.
Biofectilizer	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
rock phosphorus			**	*	*	**	*	**	**	*	**	**	*	*	*		*	*
Calcium phosphorus	*	*	**	*	*	**	*	*	*	*	**			*	*	**	*	*
Bio x rock			**			*		*	*	**		**	**	*	*			**
Bio×calcium			**			*		**	**			*						*
Rock×calcium	*	*	**	*	*	**				**	**	**		*	*	**	**	**
Rock×calcium × Bio.	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

* significant at 5% level
** significant at 1% level
FFY: forge fresh yield   FDY: forge dry yield   PY: phosphorus yield
CPY: Crude protein yield   CFY: Crude fibre yield   Com: Combination

Forage Fresh Yield (FFY)

Results in table (4) show the fresh forage yield of Kochia plants as influenced by three phosphorus resources. There was highly significant difference between fresh forage yield with the addition of biofertilizer resource comparing to the control for the two years and their average. These results may be attributed to the colonization of plant roots by the inoculated bacteria which can produce phytohormones rather than solubilize the indigenous soil phosphate and other nutrients.

These results are in line with those of Dipleep *et al.* (2001) who stated that fluorescent pseudomonas could produce phytohormones, siderophores and hydrogen cyanide, also it exhibited antagonistic effects against many plant pathogenic fungi.

Table (4). Fresh forage yield (ton/fed.) as influenced by three phosphorus resources in two years and their average on *Kochia indica*.

Treatments		First year			Second year			Two years average		
Rock	**Super Ph. (P_2O_5)**	**Without (Bio)**	**With (Bio)**	**Means**	**Without (Bio)**	**With (Bio)**	**Means**	**Without (Bio)**	**With (Bio)**	**Means**
0	0	3.70	2.86	3.28	3.20	2.36	2.78 Bb	3.45	2.61	3.03 Bb
	30	4.70	7.90	6.30	4.20	7.40	5.8 Aa	4.45	7.65	6.05 Aa
	60	1.52	7.06	4.29	1.02	6.56	3.79 Bb	1.27	6.81	4.04 ABb
	Means	3.31	5.94	4.62	2.81	5.44	4.12	3.06	5.69	4.37 c(2)
30	0	3.19	8.48	5.84	2.69	7.95	5.32 Aa	2.94	8.22	5.58 Aa
	30	4.37	7.39	5.88	3.86	6.89	5.38 Aa	4.12	7.14	5.63 Aa
	60	5.38	4.54	4.96	4.88	4.02	4.45 Aab	5.13	4.28	4.71 ABb
	Means	4.31	6.80	5.56	3.81	6.29	5.05	4.06	6.55	5.31 a(2)
60	0	1.77	4.70	3.24	1.27	4.20	2.74 Bb	1.52	4.45	2.99 Bb
	30	5.04	4.70	4.87	4.54	4.21	4.38ABab	4.79	4.46	4.63ABab
	60	4.70	8.74	6.72	4.20	8.24	6.22 Aa	4.45	8.49	6.47 Aa
	Means	3.84	6.05	4.94	3.34	5.55	4.45	3.59	5.80	4.70 b(2)
Super Ph.	0	2.89	5.35	4.12 b (3')	2.39	4.84	3.62 b (3'')	2.64	5.09	3.87 c (3)
	30	4.70	6.66	5.68 a(3')	4.20	6.17	5.19 a(3'')	4.45	6.42	5.44 a(3)
	60	3.87	6.78	5.33 ab(3')	3.37	6.27	4.82 ab(3'')	3.62	6.53	5.08 b(3)
	Means	3.82	6.26	5.04	3.32	5.76	4.54	3.57	6.01	4.79
		B(1')	A(1')		B(1'')	A(1'')		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at p = 0.05 level of significancy.

Application of rock phosphorus significantly increased FFY. This increase was clearly true and significant at the combined of the two years only giving (5.31) and (4.70) ton/fed. when added 30 and 60 kg P_2O_5/fed., respectively whereas control gave (4.37) ton/fed. Calcium superphosphate increased (FFY) for the two years and their average. This increase was more significant under 30 kg P_2O_5/fed. which surpassed 60 kg P_2O_5/fed. Abo- El-Soud *et al.* (2003), Abdo, Fatma (2003) and Abd El-Rasoul (2003) who mentioned that phosphorus had superiorly impact as compared with rock phosphate fertilizer.

The interaction effect between the three main factors was highly significant for the two years and their average. The highest FFY was obtained under the high level of both rock and calcium superphosphate in the presence of biofertilizer, (8.74), (8.24) and (8.49) ton/ fed., while the lowest FFY was obtained under the high level of calcium superphosphate in the absence of biofertilizer and rock phosphorus, being (1.52), (1.02) and (1.27) ton/fed. for the two years and their average, respectively.

The interaction effect between rock phosphorus and calcium superphosphate was significantly obtained at the 2nd year and the average. Data showed that the maximum FFY was found under the high level of both rock phosphorus and calcium superphosphate together (6.22) and (6.47), respectively, while the lowest FFY was found under the high level of rock phosphorus alone (2.74) and (2.99), respectively.

Forage dry yield (FDY)

Results in table (5) show the forage dry yield as influenced by three phosphorus resources and their combinations.

Table (5). Dry forage yield (ton/ fed.) as influenced by three phosphorus resources in two years and their average on *Kochia indica.*

Treatments		First year			Second year			Two years average		
Rock	Super Ph. kg/fed.	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means
0	0	1.45	0.90	1.18	0.95	0.74	0.85 Bb	1.20	0.82	1.01 Bc
	30	1.97	2.99	2.48	1.47	2.80	2.13Aa	1.72	2.89	2.31Aa
	60	0.65	2.30	1.47	0.44	2.14	1.29 ABb	0.54	2.22	1.38Bb
	Means	1.36	1.81	1.71 b(2')	0.98	1.90	1.42 b(2'')	1.16	1.98	1.57 c (2)
30	0	1.12	2.93	2.03	0.95	2.75	1.85Aa	1.04	2.84	1.94 Aa
	30	1.73	2.98	2.35	1.53	2.77	2.15Aa	1.63	2.88	2.26 Aa
	60	2.2	1.69	1.93	1.96	1.50	1.73Aa	2.06	1.60	1.83 Aa
	Means	1.67	2.53	2.10 a(2')	1.48	2.34	1.91 a(2'')	1.58	2.44	2.01 a(2)
60	0	0.99	1.75	1.37	0.71	1.56	1.13 Bb	0.85	1.65	1.25 Bb
	30	2.00	1.73	1.87	1.80	1.55	1.67ABb	1.90	1.64	1.77Aab
	60	1.73	3.14	2.43	1.54	2.96	2.25 Aa	1.64	3.05	2.35Aa
	Means	1.57	2.21	1.89 ab(2')	1.35	2.02	1.69 ab(2'')	1.46	2.11	1.79 b(2)
Super Ph.	0	1.19	1.86	1.52 b(3')	0.87	1.68	1.28 b(3'')	1.03	1.77	1.4 c(3)
	30	1.90	2.57	2.23 a(3')	1.60	2.37	1.99a(3'')	1.75	2.47	2.11 a(3)
	60	1.51	2.38	1.95 a(3')	1.31	2.20	1.76a(3'')	1.41	2.29	1.85 b(3)
	Means	1.53	2.27	1.9	1.26	2.09	1.68	1.40	2.18	1.80
		B(1')	A(1')		B(1'')	A(1'')		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at $p = 0.05$ level of significancy.

FDY had been significantly increased by using biofertilizer resource. This increase was observed for the two years and their average comparing to unbiofertilizerd treatment. Increasing the rate of rock phosphorus, increased FDY. This increase was significant at the 1^{st}, 2^{nd} year and their average. The highest dry production, (2.10), (1.91) and (2.01), was obtained under the moderate level of rock phopshorus (30 kg P_2O_5) which surpassed the higher level.

Calcium superphosphate increased FDY. Such increase was significant for the two years and their average. The rate of 30 kg P_2O_5/fed. was the best level.

The interactions effect between rock phosphorus and calcium superphosphate were significant for the second year and the years average. The highest productivity of dry yield was found under the high level of both P resources (2.25 and 2.35 ton/fed.), while the lowest one was (0.85 and 1.01 ton/fed.), respectively, whereas no phosphorus applied. On the other hand, the combination of the three resources introduced significant effect on FDY. The maximum productivity was found under the high level of both phosphorus resources and the presence of biofertilizer, i.e. (3.14), (2.96) and (3.05) while the lowest production was obtained under the high level of calcium superphosphate alone, that is (0.65), (0.44) and (0.54). Such result was significant on the two years and years average.

Crude Protein Yield (CPY)

Results in table (6) show the crude protein yield as affected by three phosphorus resources. CPY increased significantly with inoculation of biophosphorus resource, either for the two years or the years average.

Table (6). Crude protein yield (kg/fed.) as influenced by three phosphorus resources in two years and their average on *Kochia indica*.

Treatments		First year			Second year			Two years average		
Rock	Super Ph. (P_2O_5)	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio) *	Means	Without (Bio)	With (Bio)	Means
0	0	219.8	113.9	166.9Bb	144.26	97.32	120.9	182.03	105.71	143.9Bb
	30	209	519.5	364.3Aa	156.02	490.68	323.4	182.51	505.09	343.8Aa
	60	92	310.6	201.3ABab	62.66	269.18	165.1	77.33	264.89	171.1Bb
	Means	173.6	314.7	244.2ab(2')	120.9	285.8	203.4b(2'')	147.3	291.9	219.6b(2)
30	0	151.65	442.6	297.1Aa	127.85	414.71	271.3	139.75	428.66	284.2Aa
	30	213.93	435.45	324.9Aa	189.85	405.74	297.8	201.67	420.59	311.1Aa
	60	371.75	235.15	303.5Aa	336.76	207.99	272.4	354.26	221.57	287.9Aab
	Means	245.6	371.1	308.4a(2')	218.2	342.8	280.5a(2'')	231.9	356.9	294.4a(2)
60	0	129.3	165.1	147.2Bb	92.82	147.15	119.9	111.06	156.13	133.6Bb
	30	268.2	193.7	230.9Aab	241.59	173.14	207.4	254.9	183.42	219.2Bb
	60	240.58	338.2	289.4Aa	214.62	471.46	343.0	227.60	404.83	316.2Aa
	Means	212.7	232.3	222.5b(2')	183.1	263.9	223.5b(2'')	197.9	248.1	223.0b(2)
Super Ph.	0	166.9	240.5	203.7c(3')	121.6	219.8	170.7b(3'')	144.3	230.2	187.2b(3)
	30	230.2	382.9	306.5a(3')	195.8	356.5	276.2a(3'')	213.0	369.7	291.4a(3)
	60	234.8	294.7	264.7b(3')	204.7	316.2	260.5a(3'')	219.73	297.1	258.4a(3)
	Means	210.6	306.0	258	174.0	297.5	235.8	192.3	299	245.7
		B(1')	A(1')		B(1'')	A(1'')		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at $p = 0.05$ level of significancy.

Applied rock phosphorus increased significantly for the tow years and their average especially with 30 kg P_2O_5 / fed. application only.

Increasing calcium superphosphate increased CPY. Such increase was significant at the 1st, 2nd years and their average and applied 30 kg P_2O_5 / fed. surpassed 60 kg P_2O_5 / fed.

The interaction between the three phosphorus resources affected significantly CPY. The largest CPY was obtained under 30 kg P_2O_5 / fed. of calcium superphosphate with biophosphorus inoculation and without rock phosphorus, i.e. (519.5), (490.68) and (505.09) kg/fed., while the lowest

CPY was found under the high level of calcium superphosphate (60 kg P_2O_5/fed.) alone, i.e. (92), (62.66) and (77.33) kg/fed. Such effect was observed at the two growing years and the years average.

The interaction between rock phosphorus and calcium superphosphate affected CPY significantly. The maximum CPY was obtained with 30 kg P_2O_5 / fed application of Calcium superphosphate alone, (364.3) and (343.8). while the lowest one was observed under the high level of rock phosphorus alone (147.2) and (133.6). This result was significant at the 1st year and years average.

Calcium phosphrous and biofertilizer act together on CPY. The highest amount of CPY was found under 30 kg P_2O_5/fed. of calcium superphosphate with biofertilizer resource (369.7 kg/fed.). On the other hand, the lowest CPY was obtain under the absence of both (144.3 kg/fed.). Such result was significant at the average year.

Phosphorus Yield (PY)

Results in table (7), show phosphorus yield PY as influenced by three phosphorus resources.

Table (7). Phosphorus yield (kg/ fed.) as influenced by three phosphorus resources in two years and their average on *Kochia indica* .

Treatments		First year			Second year			Two years average		
Rock	Super Ph. (P_2O_5)	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means
0	0	0.178	0.118	0.148	0.049	0.099	0.074	0.114	0.109	0.112
	30	0.232	0.381	0.307	0.173	0.362	0.268	0.203	0.372	0.288
	60	0.085	0.287	0.186	0.058	0.228	0.143	0.072	0.258	0.165
	Means	0.165	0.262	0.214b(2')	0.093	0.230	0.162b(2'')	0.130	0.246	0.188 b(2)
30	0	0.241	0.357	0.299	0.201	0.335	0.268	0.221	0.346	0.284
	30	0.237	0.427	0.332	0.203	0.398	0.301	0.220	0.413	0.317
	60	0.356	0.211	0.284	0.321	0.187	0.254	0.339	0.199	0.269
	Means	0.278	0.332	0.305a(2')	0.242	0.307	0.274a(2'')	0.26	0.319	0.290a(2)
60	0	0.081	0.265	0.173	0.058	0.235	0.147	0.070	0.250	0.160
	30	0.29	0.249	0.270	0.261	0.223	0.242	0.276	0.236	0.256
	60	0.174	0.419	0.297	0.155	0.023	0.089	0.165	0.221	0.193
	Means	1.181	0.311	0.247a(2')	0.158	0.160	0.159b(2'')	0.170	0.236	0.203b(2)
Super Ph.	0	0.166	0.247	0.206b(3')	0.103	0.223	0.163b(3'')	0.135	0.235	0.185b(3)
	30	0.253	0.352	0.303a(3')	0.212	0.328	0.270a(3'')	0.223	0.340	0.287a(3)
	60	0.205	0.306	0.255ab(3')	0.178	0.146	0.162b(3'')	0.192	0.226	0.209ab(3)
	Means	0.208	0.302	0.255	0.164	0.232	0.198	0.186	0.267	0.227
		B(1')	A(1')		B(1'')	A(1'')		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at p = 0.05 level of significancy.

Data showed that biofertilizer resource increased PY. Such increase was significant at the 1st, 2nd years and their average comparing to unbiofertilized treatments.

Applied rock phosphorus at 30 kg P_2O_5/fed. increased PY. This increase was clearly true and significant at the two years and their average. The same trend was observed under calcium phosphorus. Data showed that

30 kg P_2O_5/fed. surpassed 60 kg P_2O_5/fed. Such result was observed at the two years and their average.

The interaction effect of the three phosphorus resources affected (PY) significantly. The highest PY was found under using 30 kg P_2O_5/fed. of both phosphorus resources with biofertilizer inoculation (0.427) and (0.398) kg/fed. while the lowest one was obtained as using the high level of calcium superphosphate alone (0.085) and (0.058) kg/fed. Such result was obtained at the 1st and 2nd years, respectively. On the other hand, lowest PY was found as using the high level of rock phosphorus alone also at the average yield (0.070). This means that the high level of both phosphorus as calcium superphosphate or rock under calcareous and saline conditions of Sinia was unavailable to be absorbed from the soil by Kochia plants.

Crude Fiber Yield (CFY)

Results in table (8), show the effect of three phosphorus resources on CFY of Kochia plants at the different years and the average.

Table (8). Crude fibre yield (kg/ fed.) as influenced by three phosphorus resources in two years and their average on *kochia indica.*

Treatments		First year			Second year			Two years average		
Rock	Super Ph. (P_2O_5)	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means
0	0	208.9	121.55	165.2	137.0	101.4	119.2	172.9	111.5	142.2 Bb
	30	356.4	402	379.2	266.0	379.8	322.9	311.2	390.9	351.0Aa
	60	80.8	186.8	133.8	55.0	319.7	187.4	67.9	253.3	160.6Bb
	Means	215.4	236.8	226.0b(2\)	152.7	267	209.8c(2\\)	184	251.9	217.9c(2)
30	0	158.1	591.3	374.7	136.0	554.0	345	147.1	572.6	359.9Aa
	30	194	581.2	387.6	181.4	541.6	361.5	187.7	561.4	374.6Aa
	60	376.2	299.7	337.9	341.1	265.1	303.1	358.6	282.4	320.5Aa
	Means	242.8	490.7	366.8a(2\)	219.5	453.6	336.5a(2\\)	231.1	472.1	351.7a(2)
60	0	178	362.4	270.2	127.7	323.1	225.4	152.9	342.7	247.8Aa
	30	398.2	315.8	357	358.6	282.3	320.5	378.4	299.0	338.7Aa
	60	255.4	439.8	347.6	229.8	414.9	322.4	242.6	427.4	335Aa
	Means	277.2	372.7	324.9a(2\)	238.7	340.1	289.4b(2\\)	257.9	356.4	307.2b(2)
Super Ph.	0	181.7	358.4	270.0	133.6	326.2	229.9b(3\\)	157.6	342.2	249.9b(3)
	30	316.2	433	374.7	268.7	401.2	334.9a(3\\)	292.4	417.1	354.8a(3)
	60	237.5	308.8	273.1	208.4	333.2	270.8ab(3\\)	223.0	321.0	272.0b (3)
	Means	245	366.7	305.9	203.6	353.5	278.6	224.3	360.1	292.2
		B(1\)	A(1\)		B(1\\)	A(1\\)		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at p = 0.05 level of significancy.

Data showed that biofertilizer resource increased the CFY. Such increase was significant at the 1st, 2nd years and their average comparing to the control.

Increased rock phosphorus levels led to a significant increase in CFY. This increase was significant at the two years and their average. Meanwhile, the rate of 30 kg P_2O_5/fed. surpassed 60 kg P_2O_5/fed. at both years and their average. Increasing calcium superphosphate increased CFY. Such increase was significant at 2nd and average years. The rate of 30 kg P_2O_5/fed. was found to be more effective on CFY than 60 kg P_2O_5/fed.

The interaction effect between the three main factors was effective on CFY. The highest amount of CFY was obtained as applied 30 kg P_2O_5/fed. of both rock phosphorus and calcium superphosphate with biofertilizer resource (581.2), (541.6) and (561.4) kg/fed. while the lowest amount of (CFY) was found as applied 60 kg P_2O_5 / fed of calcium superphosphate alone (80.8), (55) and (67.9) kg/fed. Such result was clearly true and significant at 1st, 2nd years and their average, respectively.

The interaction effect between calcium superphosphate and rock phosphorus was observed at the average of years. The highest amount of CFY was found as added 30 kg P_2O_5 / fed. of both types of phosphorus, (374.6) kg/fed. Meanwhile the lowest one was observed under the absence of both.

Total ash yield

Results in table (9) show the effect of three phosphorus resources on total ash yield of Kochia plants at different growth years and their average.

Table (9). Total Ash yield (kg/fed.) as influenced by three phosphorus resources in two years and their average on *Kochia indica*.

Treatments		First year			Second year			Two years average		
Rock	Super Ph. (P_2O_5)	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means	Without (Bio)	With (Bio)	Means
0	0	349.2	207.5	278.4Ba	229.1	159.2	194.2Bab	289.2	183.3	236.3Bab
	30	492.5	741.1	616.8Aa	367.6	691.4	529.5Aa	430.2	716.2	573.2Aa
	60	130.2	541.2	335.7Bb	89.6	462.9	276.3Bb	109.9	502.1	306ABab
	Means	324.0	496.6	410.3	228.8	437.8	333.3b(2'')	276.4	467.2	371.8b(2)
30	0	249.	547.6	398.3Aa	207.8	509.1	358.5Aa	228.4	528.3	378.4Aa
	30	344.9	572.3	458.6Aa	227.8	514.6	396.2Aa	311.3	543.4	427.4Aa
	60	512.9	406.1	459.5Aa	455.4	344.0	399.7Aab	484.1	375.0	429.6Aa
	Means	368.9	508.7	438.8	313.7	455.9	384.8a(2'')	341.3	482.2	411.8 a(2)
60	0	162.1	344.9	253.5Bb	136.5	287.9	212.2Bb	149.3	316.4	232.9Bb
	30	401.7	372.2	386.9Ab	378.5	330.9	354.7Aa	390.1	351.6	370.9Aab
	60	423.7	684.1	553.9	382.5	645.3	513.9Aa	403.1	664.7	533.9Aa
	Means	329.2	467.0	398.1	299.2	421.4	360.3a(2'')	314.2	666.4	379.2b(2)
Super Ph.	0	253.4	366.7	310.0b(3')	191.1	318.7	254.9b(3'')	222.3	342.7	282.5b(3)
	30	413.0	561.9	487.4a(3')	341.3	512.3	426.8a(3'')	377.2	537.1	457.2a(3)
	60	355.6	543.8	449.7a(3')	309.2	484.1	396.7a(3'')	332.4	513.7	423.1a(3)
	Means	340.7	490.8	415.8	280.5	438.4	359.5	310.6	464.5	387.6
		B(1')	A(1')		B(1'')	A(1'')		B(1)	A(1)	

* Means having the same capital letters in the same rows and small letters in the same column are not statistically differed at p = 0.05 level of significancy.

Data showed a significant increase of total ash yield as using biofertilizer. Such result was clearly true and significant at the two years as well as the average.

Increasing rock phosphorus levels lead to the increase of total ash yield. The increasing was significant at 2nd year and average of years, with noticing that the medium level of rock phosphorus surpassed the high level.

Increasing calcium superphosphate rates cause the increase of total ash yield. Such increase was significant at the 1st and 2nd year, as well as their average. On the other hand, 30 kg P_2O_5/fed. gave the highest total ash (487.4), (426.8) and (457.2) kg/fed., respectively.

This result means that 30 kg P_2O_5/fed. of each of rock or calcium superphosphate was the best level under the conditions of Sinia to obtain the greatest amount of ash .

The interaction effect between the three main factors affected the total ash yield. The maximum total ash yield was found under 30 kg P_2O_5/fed. of calcium superphosphate alone with the presence of biofertilizer resource, (741.1), (691.4) and (716.2) kg/fed., while the lowest total ash was observed under the high level of calcium phosphorus and the absence of biofertilizer or rock phosphours. Such result was clearly true and significant at the 1st, 2nd years and their average, respectively.

Calcium superphosphate x rock phosphorus affected together total ash yield. Applied 30 kg P_2O_5/fed. of calcium superphosphate alone was more effective to obtain the highest total ash yield (616.8), (529.5) and (573.2) kg/fed. at the same time the lowest quantity of total ash yield was observed when using the high level of rock phosphorus only (60 kg P_2O_5/fed.) (253.5), (212.2) and (232.9). This result was true and significant at the
1st, 2nd years and average of years, respectively.

So, it is appeared that phosphorus helped to develop more extensive root-system, which might have help the absorption of more water and nutrients from deeper soil layers for higher photosynthetic activity and translocation of photo synthates to the sites of their requirement consequently increased all the parameters studied.

In general, it could be concluded that the low level of calcium superphosphate or rock phosphorus is more essential than the high level especially when adding microorganisms which release more available phosphorus which is reflected on the productivity and the quality of Kochia plants under calcareous saline conditions. Using biofertilizer alone gave the same results as using chemical fertilizer without any pollution of the environment.

Microbiological Determinations

Samples of plant rhizosphere were taken at the first and second cuts during two successive seasons (2004, 2005) and subjected directly to microbiological analysis. Results in table (10) show that plant inoculation with phosphate dissolving bacteria led to a significant increase in total microbial counts (heterotrophic plate count) in the rhizospheric soil of all treatments as compared to the uninoculated ones. This may be due to the role of phosphate dissolving bacteria in the release of available phosphorus which serves as an essential factor for microbial growth and energy yield. Increasing amounts of rock phosphate, calcium superphosphate or both of them, applied to soil, relatively increased the microbial densities in most treatments. It was also noticed that the numbers of microorganisms at the second cut were generally higher than those recorded at first cut. This phenomenon may be due to the accumulation of root fragments and exudates, providing soil with organic carbon compounds, in addition to decreasing pH value as a result of CO_2 accumulation from root respiration and microbial acid secretion. Such conditions could make suitable nutritional medium around root system enhancing microbial growth and activity in plant rhizosphere zones.

Table (10). Effect of fertilization of *Kochia indica* by rock phosphate, superphosphate and phosphate dissolving bacteria on total microbial counts (heterotrophic plate count) in plant rhizosphere under calcareous saline desert soil conditions (count × 10^6 cfu/g dry soil).

Rock (P_2O_5) phosphate	0 kg/fed.						30 kg/fed.						60 kg/fed.					
Super (P_2O_5) phosphate	0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.	
Cutting time	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1st year 2004																		
Without PDB	5	5	21	26	29	22	14	19	33	-	26	-	5	8	25	28	30	-
With PDB	7	11	29	22	35	26	16	26	58	66	-	-	12	12	53	51	42	-
2nd year 2005																		
Without PDB	3	6	16	18	18	18	10	13	24	26	19	20	12	10	21	24	18	24
With PDB	12	10	25	-	-	26	-	19	31	38	26	32	20	-	27	27	25	30

PDB: Phosphate dissolving bacteria. - : Not determined
Significance at 5% level, Significant : (*) , insignificant: (O):

	First season 1st cut	First season 2nd cut	Second season 1st cut	Second season 2nd cut
Rock phosphate:	O	*	O	*
Phosphorus	*	*	*	*
PDB:	*	*	*	*
Interaction (PDB x rock phosphate)	O	*	O	*

Data in tables (11 and 12) show the response of nitrogen fixing bacteria, namely *Azotobacter* and *Azospirillum,* respectively to phosphate fertilization. Results exhibited that addition of rock phosphate alone has almost no or slight effect on nitrogen fixers. Meanwhile, applying calcium superphosphate either alone or together with rock phosphate improved their growth. Combining those mineral fertilizers with the biofertilizer, phosphate dissolving bacteria had an incrementally significant beneficial effect on the growth of nitrogen fixers. Obtained findings could be due to the production of acids by phosphate dissolving bacteria converting the unavailable mineral phosphate, especially in such alkaline calcareous soil, into available phosphorus which greatly stimulated the growth and proliferation of nitrogen fixers in the rhizosphere zone.

Table (11). Effect of fertilization of *Kochia indica* by rock phosphate, superphosphate and phosphate dissolving bacteria on counts of *Azotobacter* in plant rhizosphere under calcareous saline desert soil conditions. (count × 10^4 cfu/g dry soil).

Rock (P_2O_5) phosphate	0 kg/fed.						30 kg/fed.						60 kg/fed.					
Super (P_2O_5) phosphate	0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.	
Cutting time	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1st year 2004																		
Without PDB	0	0	2	2	8	12	0	6	20	32	-	-	-	6	15	20	20	20
With PDB	0	2	4	6	12	14	12	16	27	44	42	-	12	10	27	33	40	43
2nd year 2005																		
Without PDB	-	-	3	4	6	8	6	6	15	18	17	21	8	11	-	-	16	21
With PDB	4	6	8	6	12	11	12	15	19	29	-	30	11	16	22	26	31	37

PDB: Phosphate dissolving bacteria. - : Not determined

Significant at 5% level, Significant : (*) , insignificance: (O):

	First season		Second season	
	1st cut	2nd cut	1st cut	2nd cut
Rock phosphate:	*	*	*	*
Phosphorus	*	*	*	*
PDB:	*	*	*	*
Inter action (PDB x rock phosphate)	*	*	*	*

Table (12). Effect of fertilization of *Kochia indica* by rock phosphate, superphosphate and phosphate dissolving bacteria on counts of *Azospirillum* in plant rhizosphere under calcareous saline desert soil conditions. (count × 10^3 cells/g dry soil).

Rock (P_2O_5) phosphate	0 kg/fed.						30 kg/fed.						60 kg/fed.					
Super (P_2O_5) phosphate	0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.	
Cutting time	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1st year 2004																		
Without PDB	4	6	10	12	23	26	16	16	36	-	38	43	14	12	23	32	31	-
With PDB	4	7	14	17	30	41	29	33	49	61	50	60	26	28	41	48	50	51
2nd year 2005																		
Without PDB	2	3	6	8	14	18	13	16	24	27	21	18	10	10	21	19	25	-
With PDB	10	12	16	20	13	28	20	18	32	38	33	-	-	16	-	24	36	-

PDB: Phosphate dissolving bacteria. - : Not determined
Significant at 5% level, Significant : (*) , insignificance: (O):

	First season		Second season	
	1st cut	2nd cut	1st cut	2nd cut
Rock phosphate:	*	*	*	*
Phosphorus	*	*	O	*
PDB:	*	*	*	*
Interaction (PDB x rock phosphate)	*	O	*	O

Results in table (13) exhibited that soil fertilization by rock phosphate, superphosphate or both fertilizers led to remarkable increase in counts of phosphate dissolving bacteria in plant rhizosphere at all examined P_2O_5 concentrions. However, this increase was significant at 2nd cut of the first seasons. Inoculation of plants with phosphate dissolving bacteria significantly increased their numbers in rhizosphere zones in all treatments, which is logical.

Table (13). Effect of fertilization of *Kochia indica* by rock phosphate, superphosphate and phosphate dissolving bacteria ,on counts of phosphate dissolving bacteria in plant rhizosphere under calcareous moderately saline desert soil conditions. (count × 10^3 cfu/g dry soil).

Rock (P_2O_5) phosphate	0 kg/fed.						30 kg/fed.						60 kg/fed.					
Super (P_2O_5) phosphate	0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed.	
Cutting time	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1st year 2004																		
Without PDB	14	14	27	-	-	33	22	30	31	36	41	-	19	34	29	24	42	44
With PDB	81	81	80	92	66	84	80	86	90	-	79	-	85	94	85	98	81	-
2nd year 2005																		
Without PDB	8	12	13	16	16	18	19	22	26	27	31	31	12	13	28	30	30	-
With PDB	36	36	42	55	-	26	30	35	64	60	-	-	24	19	49	62	51	36

PDB: Phosphate dissolving bacteria. - : Not determined

Significance at 5% level, Significant : (*) , insignificant: (O):

	First season		Second season	
	1st cut	2nd cut	1st cut	2nd cut
Rock phosphate:	*	O	O	*
Phosphorus	O	O	*	*
PDB:	*	*	*	*
Interaction (PDB x rock phosphate)	O	O	O	*

The generation of CO_2 was determined as an indication of the biological activity in plant rhizosphere. Results in table (14) show that application of either biofertilizer, or inorganic fertilzers, significantly increases the rate of CO_2 evolution. However, combining biofertilizer with inorganic phosphate fertilizers led to more CO_2 generation than any of them alone.

Table (14). Effect of fertilization of *Kochia indica* by rock phosphate, superphosphate and phosphate dissolving bacteria on carbon dioxide evolution in plant rhizosphere under calcareous saline desert soil conditions. (mg CO_2 /100 g dry soil).

Rock (P_2O_5) phosphate	0 kg/fed.						30 kg/fed.						60 kg/fed.					
Super (P_2O_5) phosphate	0 kg/fed.		30 kg/fed.		60 kg/fed.		0 kg/fed.		30 kg/fed.		60 kg/fed		0 kg/fed.		30 kg/fed.		60 kg/fed.	
Cutting time	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1st year 2004																		
Without PDB	-	2	11	12	9	14	5	6	15	17	14	12	-	4	12	12	16	18
With PDB	3	-	16	-	18	22	11	15	31	40	-	31	7	10	18	21	20	-
2nd year 2005																		
Without PDB	5	5	10	12	8	11	10	10	12	14	16	16	11	13	12	17	15	15
With PDB	9	4	15	15	14	16	19	22	19	22	30	19	17	18	24	25	28	23

PDB: Phosphate dissolving bacteria.   - : Not determined
Significance at 5% level, Significant : (*) , insignificant: (O):

	First season		Second season	
	1st cut	2nd cut	1st cut	2nd cut
Rock phosphate:	*	*	*	*
Phosphorus	*	*	O	*
PDB:	*	*	*	*
Interaction (PDB x rock phosphate)	O	O	O	O

Data of CO_2 evolution are almost in harmony with those of total microbial counts recorded in table (10).

In general, the trends of microbiological changes and activities, in plant rhizosphere zones, were found to be almost similar in both growing seasons 2004 and 2005.

Summing up, it could be concluded that application of phosphate dissolving bacteria in the presence of rock phosphate and/or calcium superphosphate markedly activated soil microorganisms. This could be resulted in improving soil fertility and nutrients availability which consequently led to increasing plant growth and yield.

Obtained results are generally in agreement with those reported by El-Gibaly *et al.* (1977); Abdel Ghany and Ashoub (1994); Tomar *et al.* (1996) and Abdo (2003) who stated that applying phosphate dissolving bacteria together with inorganic phosphate markedly activated soil microorganisms and improved growth and phosphorus uptake by the seedlings, of different plants grown in sandy soil, in comparison to chemical phosphate fertilizer alone.

The Economic Importance of the Research

It is worthy to mention that, any success in cultivating Wadi Sudr desert soil (South of Sinai), would be appreciated. That is because, this desert area suffers from high content of calcium carbonate, alkalinity and salinity. Under such environmental stress, plant nutrients particularly; phosphate salts occur in insoluble forms, unavailable for plant nutrition.

Thus, the successful trial of the present research by applying rock phosphate, which is abundant with low price in Egypt together with phosphate dissolving bacteria, leading to significant increase in forage yield and improving soil fertility could be evaluated from the economic point of view.

However, further economic studies should be done, to precisely determine the feasibility of investment, in such desert area, for forage production.

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استجابة نبات الكوخيا المروى بمياه مالحة لبعض مصادر السماد الفوسفاتى بمنطقة رأس سدر (جنوب سيناء)

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تعتبر الكوخيا إحدى نباتات المراعى الحولية التابعة للعائلة الرمرامية التى تتحمل الجفاف والملوحة وتصلح لتغذية العديد من الحيوانات . ولذلك تم اجراء هذا البحث فى محطة تجارب رأس سدر بجنوب سيناء والتى تتميز تربتها بارتفاع نسبة كربونات الكالسيوم والتى جعلت الفوسفور فى صورة غير ميسرة للامتصاص والتى تعتبر من أهم المشاكل فى تلك المناطق ولهذا تم إجراء هذا البحث باضافة صورة مختلفة من الفوسفور (البكتريا المذيبة للفوسفات) فى صورة تسميد حيوى مقارنة بالكونترول (غير مضافة) ومصدرين معدنيين للسماد الفوسفاتى وهما صخر الفوسفات وسوبرفوسفات الكالسيوم فى ثلاثة مستويات (صفر ، ٣٠ ٦٠ فو٢ أ ٥) فى موسمين متتالين واثر ذلك على الانتاجية الغضه والجافة فى نهاية المحصول كذلك المحتوى من (البروتين - الالياف- الرماد - الفوسفور) فى موسمين زراعيين وكذلك المتوسط لتلك السنوات.

ويمكن تلخيص النتائج المتحصل عليها كما يلى:

١-اوضحت النتائج أن استخدام البكتريا المذيبة للفوسفات قد سجلت استجابة معنوية فى زيادة جميع الصفات المدروسة (الوزن الغض- الوزن الجاف- محتوى البروتين - محتوى الالياف والرماد وكذلك محتوى الفوسفور).

٢-كان للمستوى المنخفض (٣٠ كجم فو٢ أ ٥/ فدان) لكلا من من صخر الفوسفات- وسوبر فوسفات الكالسيوم أثر فى الزيادة المعنوية للوزن الغض والجاف التجمعى فى نهاية الموسم. كذلك محتوى البروتين والالياف والفوسفور والرماد.

٣- أدى التفاعل بين مصدرى الفوسفور فى وجود البكتريا المذيبة للفوسفات فى الحصول على اعلى محصول غض وجاف كذلك اعلى محتوى لكلاً من (البروتين - الألياف- الرماد - الفوسفور).

٤- تم تقدير الأعداد الكلية للميكروبات والبكتريا المثبته للنيتروجين (الأزوتوباكتر والأزوسبيرلم) والبكتريا المذيبة للفوسفات ومعدل تصاعد ثانى أكسيد الكربون فى منطقة الريزوسفير.

٥- أدى اضافة البكتريا المذيبة للفوسفات كسماد حيوى مع كل من الفوسفات الصخرى أو السوبر فوسفات أو مع كليهما إلى زيادة النشاط الميكروبى وأعداد الميكروبات السابقة فى منطقة الريزوسفير مقارنة بإضافة كل منهم بمفرده.