Results and Discussion

4. Results and Discussion

4-1- Dry weight and N, P and K uptake by maize plants at 50 and 70 days after sowing DAS as affected by cultivars, N-levels and biofertilizers:

4-1-1- Effect of maize cultivars on dry weight and N, P and K-uptake by maize plants at 50 and 70 DAS (main plots):

Data in Table (2 and Fig 1) show dry weight and uptake of N, P and K- nutrient elements by maize plants cv. Single Way Cross 10 (SWC 10) and cv. Three Way Cross 322 (TWC 322) at 50 and 70 DAS in growing season of 2000. Results illustrated that both cultivars were statistically indifferent in dry weight at 50 and 70 DAS. Concerning nutrient uptake, maize plants TWC 322 were significantly superior to their counterparts SWC 10 in the uptake of N, P and K at 50 DAS and N and P at 70 DAS, whereas the uptake of K at 70 DAS by both cultivars were insignificant. The difference between the two maize genotypes in the uptake of nutrients may be attributed to the superiority of TWC 322 in root length and root surface area. This result is in agreement with that found by **Aboulroos *et al.* (1992 a)** who concluded that at any given plant age, N and K uptake were highly correlated with both root length and root surface area whereas P uptake was highly correlated with both root length and root surface area at 60 and 90 days of growth. Data in the same Table clarified that K uptake by both cultivars was insignificant at 70 DAS. This result could be explained through the dilution of K in the larger biomass production at 70 DAS, similar trend was illustrated by **Fan and Moshe (2002)**.

4-1-2- Effect of mineral N-level on dry weight and N, P and K-uptake by maize plants at 50 and 70 DAS (sup-plots):

Results in Table (2 and Fig 1) indicated that increasing N-level from 80 to 100 kg N fed^{-1} was accompanied by significant increase in dry weight and N-uptake by maize cultivars at 50 and 70 DAS. Such results were corresponding to those found by **Aboulroos *et al.* (1992 b)** who emphasized that raising the rate of applied N from 60 to 90 kg N fed^{-1} increased shoot dry weight by 43.2, 35.6, 60.6 and 22.5% at 30,45, 60, and 90 days, respectively. They added that further increase in N level from 90 to 120 kg N fed^{-1} resulted in further significant increase in shoot and root dry weight only at 60 and 90 days of growth. **Esmail and El-Sheikh (1994)** reported that at 150 kg N fed^{-1} there was a more luxuriant use of nitrogen from the soil to plant, which ultimately resulted in favorable vegetative growth. The increase in N-uptake could be attributed to the increase in N content in maize plants and dry matter accumulation as stated by **Suliman and Monem (1995)**. Meanwhile, **Ibrahim (1997)** stated that applying nitrogen fertilizer to maize plants encourages the dry matter production in the different parts and consequently the whole plant due to increasing the photosynthetic apparatus efficiency. However, **El-Akabawy *et al.* (2001)** mentioned that the applied treatments (either nitrogen or biofertilizer) increased the availability of N, P and K and plant growth and consequently, encouraging the absorption of such nutrients from

Table (2) : Dry weight and N, P and K uptake by maize plants at 50 and 70 DAS* as affected by maize cultivars, N-levels and biofertilizers.

Experimental Treatment	Days after sowing							
	50				70			
	D.W (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)			D.W (g $plant^{-1}$)	Nutrient uptake (mg plant-1)		
		N	P	K		N	P	K
Maize cultivar								
SWC 10**	66.67	981.27	199.33	488.93	425.85	2203.13	675.79	5684.41
TWC 322***	75.45	1356.85	246.01	534.32	408.19	2387.03	736.66	5593.89
L.S.D. .05	N.S	8.98	9.58	36.62	N.S	14.53	34.84	N.S
N-level (kg fed^{-1})								
80	62.28	1045.85	223.58	511.53	341.23	2012.32	677.09	5674.33
100	77.90	1373.70	222.85	530.94	476.46	2431.25	675.31	5135.82
120	68.30	1153.01	208.66	478.45	443.10	2399.20	782.41	6036.85
140	75.74	1103.69	235.58	525.58	407.29	2337.54	690.10	5709.59
L.S.D. .05	7.57	41.06	9.83	39.33	57.36	27.34	26.99	276.55
Biofertilizer								
Cerealin	72.39	1178.50	205.28	499.66	451.15	2295.86	675.41	5656.12
Rhizobacterin	76.13	1187.89	227.22	488.51	463.67	2357.05	694.43	5575.01
Uninoculated	64.64	1140.79	235.51	546.70	336.25	2232.32	748.84	5686.31
L.S.D. .05	6.48	27.78	8.05	40.43	68.83	31.56	35.95	N.S

* Days after sowing
**Single Way Cross 10
*** Three Way Cross 322

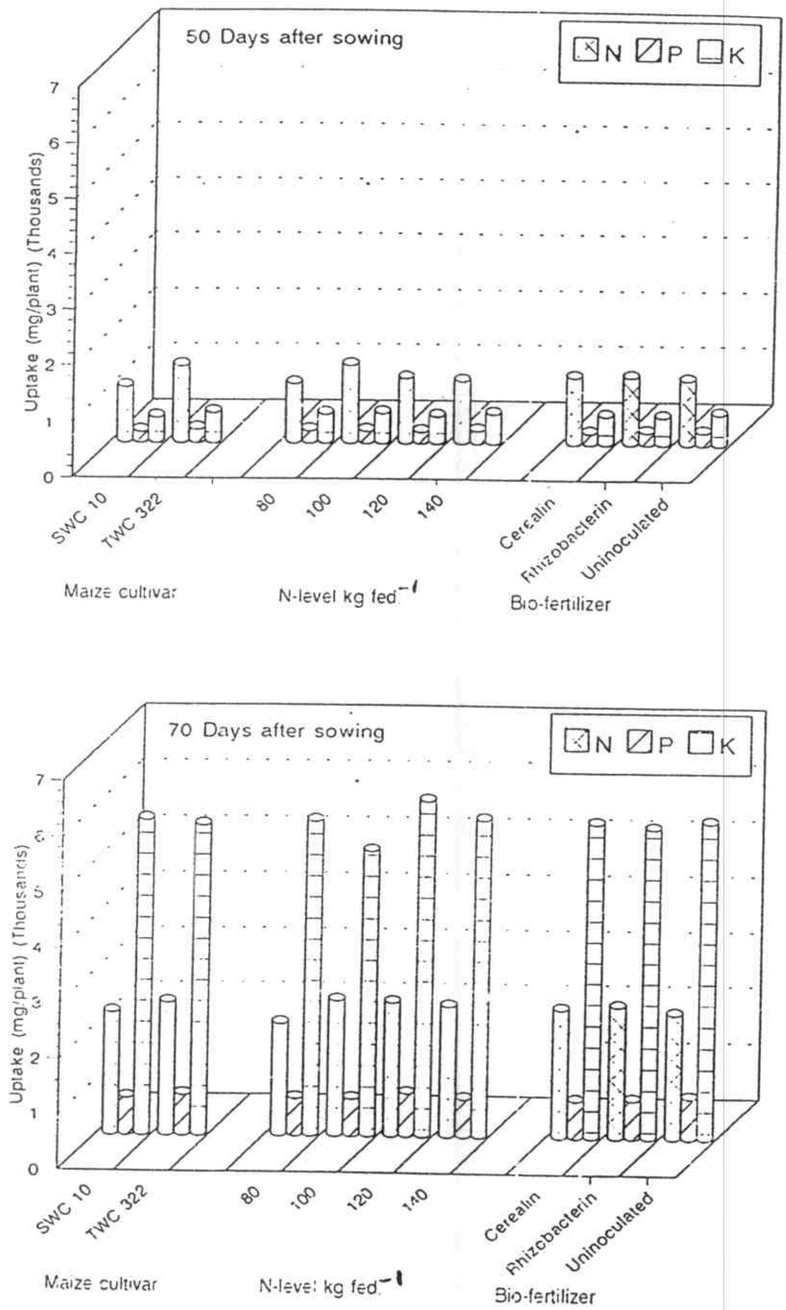


Fig.(1): N,P and K uptake by maize plants at 50 and 70 DAS as affected by maize cultivar, N-level and biofertilifer in season of 2000.

soil and then the synthesis, assimilation and translocation to grains. Data also showed that additional N-doses i.e. 120 and 140 kg N fed^{-1} significantly decreased N-uptake at 70 DAS. These results may be due to the relative reduction of shoot dry weight at this growth stage **(Aboulroos *et al.*1992)**. It is noticed from the same Table that applying N by 140 kg N fed^{-1} significantly increased P-uptake at 50 DAS. Whereas, application of 120 kg N fed^{-1} significantly increased P-uptake at 70 DAS. These results may indicate that N and P supply mostly affected plant growth via their effect on chlorophyll production and consequently on photosynthesis **(Fan and Moshe, 2002)**. In respect of K-uptake, the same Table showed that N-levels had no effect at 50 DAS. However, K-uptake at 70 DAS significantly increased as N-level increased up to 120 kg N fed^{-1}. This trend may be because of the greater biomass production at 120 kg N fed^{-1} at 70 DAS.

4-1-3- Dry weight and N, P and K-uptake by maize plants as affected by seed inoculation with biofertilizer (sub-sub-plots):

Data in Table (2 and Fig 1) pointed out that dry weight and N uptake by maize cultivars at 50 and 70 DAS was significantly affected by seed inoculation with Cerealin biofertilizer of ***Azospirillum brasilense*** and Rhizobacterin biofertilizer of ***Azospirillum lipoferum*** and ***Azotobacter chroococcum*** mix. The two-biofertilizer treatments were significantly better than those uninoculated treatments concerning dry weight and N-uptake at 50 and 70 DAS, however, Rhizobacterin significantly surpassed Cerealin in N uptake at 70 DAS. The enhancement of N-uptake by the effect of biofertilizer seed inoculation could be attributed to the development of root and shoot dry matter and their N-content as mentioned by **El-Hoseiny and Rabie (1979)** who found that ***Azotobacter chroococcum*** stimulated maize plant growth as indicated by increased root and shoot length and weight compared with untreated controls. Meanwhile, **Tilak *et al.* (1982)** emphasized that inoculation of maize and sorghum with a mixture of ***Azotobacter chcroococcum*** and ***Azospirillum brasilense*** increased dry matter production by both crops, while inoculation with each bacterium alone did not significantly affect yields. **Paredes *et al.* (1988)** found that root and leaf dry matter as well as N content increased by (22 to 118%), (10 to 91%) and 101%, respectively when maize plant inoculated with ***Azospirillum brasilense***. **Woodard and Bly (2000)** indicated that shoot dry matter and its N concentration significantly increased as maize seeds inoculated with ***Azospirillum brasilense***. **Shahaby *et al.* (2000)** showed that nitrogen yield of 75 and 110 day-old maize shoots were 7.68 and 72.84 kg N fed^{-1}; respectively by application of 60 kg N fed^{-1} (urea) and inoculation of maize seeds with Rhizobacterin. Data also refer that P-uptake by maize plants at 50 and 70 DAS was not affected by seed inoculation with both biofertilizers. However, Rhizobacterin biofertilizer was significantly better than Cerealin in this respect. Meanwhile both biofertilizers were ineffective in K-uptake at 50 DAS and 70 DAS. The effect of the three-biofertilizer treatments in K-uptake was insignificant. This trend may be due to the microbial strains in biofertilizers in the current investigation are not P and K professional.

4-1-1-1- Effect of interaction of treatments on dry weight and N, P and K-uptake at 50 and 70 DAS:

4-1-1-2- Dry weight and N, P and K-uptake by maize plants as affected by maize cultivar x N-level interaction:

Data in Table (3) demonstrate the response of dry weight and N, P and K uptake by maize plants at 50 and 70 DAS as affected by cultivar x N-level interaction. Results indicated that dry weight at 50 DAS recorded the highest value when SWC 10 plants were supplied with 140 kg N fed^{-1} whereas this interaction produced the highest value of dry weight at 50 DAS when TWC 322 plants were given 100 kg N fed^{-1}. N and P-uptake at 50 DAS and N uptake at 70 DAS significantly reached the highest value when N-fertilizer was applied at the level of 140 kg N fed^{-1} to SWC 10 plants while K-uptake at 50 DAS significantly recorded its highest value when 80 kg N fed^{-1} was added to SWC 10 plants. P and K-uptake at 70 DAS were significantly maximum when N-levels of (80, 100) and (80, 120) kg N fed^{-1} were applied to SWC 10 plants, respectively. Conversely, N, P and K-uptake at 50 DAS and N-uptake at 70 DAS were significantly highest when 100 kg N fed^{-1} was used with TWC 322 plants. P and K uptake by maize plants at 70 DAS significantly achieved the highest level when 120 kg $Nfed^{-1}$ was supplied to TWC 322 plants. This interaction revealed that both cultivars differentially responded to N- levels to uptake as high as possible of nutrients.

Table (3) : Dry weight and N, P and K uptake by maize plants at 50 and 70 DAS* as affected by maize cultivar x N-level interaction in season of 2000.

Treatment	N-level (kg fed^{-1})	Days after sowing							
		50				70			
		D.W (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)			D.W (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)		
			N	P	K		N	P	K
SWC 10**	80	170.53	2764.47	631.04	1723.54	1015.23	5352.77	2094.04	17005.87
	100	214.14	2666.31	512.64	1266.73	1542.75	6969.70	2169.27	16218.28
	120	168.61	3064.50	548.21	1370.12	1194.97	7006.98	1998.54	17558.91
	140	239.86	3279.98	700.02	1506.77	1357.23	7108.06	1847.70	17429.88
TWC 322***	80	196.26	3507.60	710.46	1345.63	1023.16	6721.13	1968.49	17040.10
	100	253.32	5575.90	824.45	1918.89	1316.02	7617.78	1882.58	14596.66
	120	241.17	3853.56	703.76	1500.56	1463.65	7388.23	2695.93	18662.21
	140	214.59	3342.14	713.43	1646.69	1086.47	6917.17	2292.9	16827.67
L.S.D .05		13.12	58.07	13.91	55.62	99.36	38.67	38.17	391.14

* Days after sowing
* *Single way cross 10
*** Three way cross 322

4-1-1-3- Dry weight and N, P and K uptake by maize plants as affected by maize cultivar x biofertilizer interaction:

Data in Table (4) detect the response of dry weight and N, P and K uptake by maize plants at 50 and 70 DAS as affected by maize cultivar x biofertilizer interaction. Results indicate that this interaction insignificantly affected dry weight at 50 and 70 DAS. N-uptake by maize plants at 50 DAS significantly recorded its highest value when seeds of SWC10 cultivar were inoculated with Cerealin, whereas P and K-uptake at 50 DAS achieved maximum significant values when seeds of the same cultivar were not inoculated with both biofertilizers. Results also show that N-uptake by maize plants at 70 DAS significantly reached its best value when seeds of SWC 10 were inoculated with Rhizobacterin, while P-uptake was slightly higher when maize seeds of the same cultivar were not inoculated with both biofertilizers without significant difference from those inoculated with Rhizobacterin. However this high value was significantly higher than those inoculated with Cerealin. N and P-uptake by maize plants of TWC 322 at 50 DAS was significantly affected by seed inoculation with Rhizobacterin, while K-uptake by the same cultivar recorded its best value when seeds were not inoculated with both biofertilizers. N-uptake at 70 DAS was significantly affected by inoculation of seeds of TWC 322 cultivar with both biofertilizers, whereas P-uptake was not affected by inoculation of seeds of TWC322 cultivar with both biofertilizers. Results revealed also that K-uptake by maize

Table (4) : Dry weight and N, P and K uptake by maize plants at 50 and 70 DAS* as affected by maize cultivar x biofertilizer interaction in season of 2000.

Maize cultivar	Biofertilizer	Days after sowing							
		50				70			
		DW ($g\ plant^{-1}$)	Nutrient uptake ($mg\ plant^{-1}$)			DW ($g\ plant^{-1}$)	Nutrient uptake ($mg\ plant^{-1}$)		
			N	P	K		N	P	K
SWC 10**	Cerealin	258.62	4070.33	762.21	1900.31	1882.05	8747.78	2604.70	22814.64
	Rhizobacterin	282.57	3996.00	766.54	1903.87	1932.81	9255.46	2746.22	22182.08
	Uninoculated	251.95	3709.00	863.16	2062.98	1295.31	8434.27	2758.62	23216.22
TWC 322***	Cerealin	252.43	5357.65	880.00	2097.00	1727.12	9619.10	2798.58	22434.33
	Rhizobacterin	322.61	5504.44	1051.19	2004.19	1776.51	9600.93	2809.19	22418.01
	Uninoculated	262.23	5417.00	1020.92	2310.59	1394.67	9424.28	3232.14	22274.29
L.S.D. .05		N.S	39.26	11.38	57.15	N.S	44.61	50.82	N.S

* Days after sowing
** Single way cross 10
*** Three way cross 322

plants of both cultivars at 70 DAS was not affected by inoculation of seeds with both biofertilizers.

4-1-1-4- Dry weight and N, P and K- uptake by maize plants as affected by N-level x biofertilizer interaction:

Data in Table (5) show the response of dry weight and N, P and K uptake by maize cultivars as affected by N-level x biofertilizer interaction. Results pointed out that dry weight at 50 and 70 DAS responded very well to this interaction when either Cerealin or Rhizobacterin inoculated seeds were supplied with 100 kg N fed^{-1} and dry weight produced was statistically indifferent. N uptake by maize plants at 50 DAS was significant at the maximum level when Cerealin inoculated seeds were supplied with 80 kg N fed^{-1}. Whereas, P and K uptake by maize plants at 50 and 70 DAS was not affected by seed inoculation with both biofertilizers. N-uptake at 70 DAS recorded the highest value when Rhizobacterin inoculated seeds were supplied with 100 kg N fed-1. It could be concluded that the lower amount of mineral N fertilizer applied to maize plants the better nutrients uptake values occurred. Similar trend was achieved by many authors viz. **Favilli *et al.* (1987); Kaloyanova *et al.* (1990); Nanda *et al.* (1995); Stancheva *et al.* (1995); Abdullah (1998); Mishra *et al.* (1998) and Woodard and Bly (2000).**

Table (5) : Dry weight and N,P and K uptake by maize plants at 50 and 70 DAS* as affected by N-level x biofertilizer interaction in season of 2000.

N-level (kg fed^{-1})	Biofertilizer	Days after sowing							
		50				70			
		D.W (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)			D.W (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)		
			N	P	K		N	P	K
80	Cerealin	109.71	2054.64	446.02	977.82	677.54	4056.88	1402.56	11455.15
	Rhizobacterin	128.87	2157.16	443.65	866.53	727.52	3980.96	1235.05	11488.54
	Uninoculated	128.21	2060.28	451.83	1224.83	642.32	4036.06	1424.92	11102.29
100	Cerealin	177.05	2974.33	435.09	1039.53	1166.89	5044.89	1188.57	10092.85
	Rhizobacterin	165.33	2931.49	487.51	1052.05	1124.18	5184.78	1418.11	10219.03
	Uninoculated	125.08	2336.39	414.49	1094.05	567.7	4357.81	1445.17	10503.06
120	Cerealin	158.13	2227.34	379.59	858.20	846.33	4728.32	1481.77	12198.29
	Rhizobacterin	134.69	2272.43	380.68	961.23	1083.95	4843.32	1443.60	11796.71
	Uninoculated	116.97	2418.29	491.71	1051.25	728.34	4823.57	1769.10	12226.12
140	Cerealin	134.24	2171.67	381.51	1121.76	918.42	4536.8	1330.37	11502.69
	Rhizobacterin	176.29	2139.07	505.89	1028.25	773.67	4847.32	1458.65	11095.82
	Uninoculated	143.92	2311.38	526.06	1003.45	751.61	4641.11	1351.57	11659.05
L.S.D .05		29.65	55.53	16.09	80.82	288.67	63.09	71.88	N.S

* Days after sowing

4-1-1-5- Dry weight and N, P and K-uptake by maize cultivars at 50 and 70 DAS as affected by maize cultivars x N level x biofertilizer interaction:

Data in Table (6) illustrated that the effect of this interaction was insignificant in producing dry weight by maize plants of SWC 10 at 50 DAS whereas the same interaction was significantly effective on producing dry weight by plants of TWC 322 when Cerealin or Rhizobacterin inoculated seeds were provided with 100 kg N fed^{-1}, however, Cerealin was significantly better than Rhizobacterin. In the meantime, dry weight produced at 70 DAS was insignificant. N-uptake by maize plants of cultivars SWC 10 at 50 DAS was optimum when Cerealin or Rhizobacterin inoculated seeds were given 100 kg N fed^{-1}, whereas at 70 DAS, the amount of N-uptake recorded its best value when Cerealin or Rhizobacterin inoculated seeds of cultivar SWC 10 received 100 kg N fed^{-1}. However, Rhizobacterin was significantly better than Cerealin. P-uptake by maize plants of SWC 10 at 50 DAS was significantly affected by both biofertilizers when plants of this cultivar received 120 kg N fed^{-1}, while P-uptake by the same cultivar at 70 DAS significantly achieved its best value when seeds were inoculated with Cerealin and given 80 kg N fed^{-1}. K-uptake by maize plants of SWC 10 at 50 DAS significantly reached its best value when seeds of this cultivar inoculated with Cerealin or Rhizobacterin and received 120 kg N fed^{-1}. With respect to N-uptake by maize plants of TWC 322 at 50 DAS, data illustrate that the highest value was recorded when Cerealin or Rhizobacterin inoculated

Table (6): Dry weight and N, P and K uptake by maize plants at 50 and 70 DAS* as affected by maize cultivar x N-level x biofertilizer interaction in season of 2000.

Maize cultivar	N-level (kg fed^{-1})	Biofertilizer	Days after sowing							
			50				70			
			D.W. (g $plant^{-1}$)	Nutrient uptake (mg $plant^{-1}$)			D.W. (g plant-1)	Nutrient uptake (mg $plant^{-1}$)		
				N	P	K		N	P	K
SWC 10**	80	Cerealin	62.17	943.24	222.10	553.28	322.20	1815.67	761.74	5791.92
		Rhizobacterin	50.93	932.58	163.64	496.31	379.79	1742.28	697.04	5790.94
		Uninoculated	57.43	888.65	245.30	673.96	313.24	1794.82	635.26	5423.02
	100	Cerealin	69.27	939.69	182.14	407.96	599.47	2499.55	730.82	5204.55
		Rhizobacterin	77.76	916.23	151.56	396.99	642.74	2624.26	729.32	5363.39
		Uninoculated	67.11	810.39	178.95	461.78	300.55	1845.89	709.13	5650.35
	120	Cerealin	61.01	1096.51	203.28	502.12	450.08	2251.43	633.15	6000.89
		Rhizobacterin	58.64	1095.48	185.35	494.13	455.20	2387.31	569.78	5602.45
		Uninoculated	48.97	872.51	159.59	373.87	289.69	2368.24	795.61	5955.57
	140	Cerealin	66.17	1090.89	154.70	436.96	510.31	2181.12	478.99	5817.29
		Rhizobacterin	95.24	1051.42	266.00	516.44	455.09	2501.62	750.09	5425.31
		Uninoculated	78.45	1137.67	279.33	553.37	391.83	2425.32	618.62	6187.29
TWC 322***	80	Cerealin	47.54	1111.40	223.93	424.55	355.34	2241.21	640.82	5663.23
		Rhizobacterin	77.95	1224.58	280.01	370.22	347.74	2238.69	538.00	5697.60
		Uninoculated	70.78	1171.63	206.53	550.87	392.08	2241.24	789.66	5679.27
	100	Cerealin	107.78	2034.64	252.95	631.57	567.42	2545.34	457.75	4888.31
		Rhizobacterin	87.57	2015.26	335.96	655.06	481.44	2560.53	688.80	4855.65
		Uninoculated	57.97	1526.00	235.54	632.27	267.16	2511.92	736.04	4852.71
	120	Cerealin	97.12	1130.83	176.31	356.08	396.25	2476.88	848.62	6197.40
		Rhizobacterin	76.05	1176.95	195.34	467.11	628.75	2456.01	873.82	6194.25
		Uninoculated	68.00	1545.78	332.12	677.38	438.66	2455.34	973.49	6270.56
	140	Cerealin	68.07	1080.78	226.82	684.81	408.11	2355.68	851.39	5685.40
		Rhizobacterin	81.05	1087.65	239.89	511.81	318.58	2345.70	708.57	5670.51
		Uninoculated	65.48	1173.71	246.73	450.08	359.77	2215.79	732.95	5471.76
L.S.D. .05			18.32	78.53	22.76	114.29	N.S	89.22	101.65	N.S

* Days after sowing
** Single way cross 10
*** Three way cross 322

seeds were supplied with 100 kg N fed^{-1} P and K-uptake by plants of this cultivar were significantly affected by inoculation with Rhizobacterin and Cerealin and supplied with 80 and 140 kg N fed^{-1}, respectively. P-uptake by maize plants of TWC 322 at 70 DAS significantly recorded its best value when Cerealin inoculated seeds were given 140 kg N fed^{-1}. Concerning K-uptake by both cultivars at 70 DAS, data illustrate that both biofertilizers had insignificant effect.

4-2- N, P and K concentration in ear leaf of maize cultivars at 50% silking as affected by maize cultivar, N-level, biofertilizer:

4-2-1- N, P and K concentration in ear leaf of maize cultivars at 50% silking as affected by cultivars (main plots):

Data in Table (7 and Fig 2) present N, P and K concentrations in ear leaf of maize cultivars at 50% silking under the effect of main treatments. Results show that maize plants of TWC 322 had significantly more N concentration than that in SWC 10 while P and K concentration had insignificant difference in both cultivars. The superiority of TWC322 in N concentration in ear leaf resulted from having better root length and root surface area, which made plants of this cultivare absorb and retranslocate more nutrients than plants of SWC 10. This trend was emphasized by **Aboulroos *et al.* (1992 a)** who found that at any given plant age, N and K uptake were highly correlated with both root length and root surface area. In this concern, **Ibrahim (1997)** stated that maize genotypes with a

Table (7): N, P and K concentration in ear leaf at 50% silking as affected by maize cultivar, N-level and biofertilizer in season of 2000.

Treatment	Nutrient concentration (%)		
Main plots	N	P	K
SWC 10*	2.50	0.24	2.06
TWC 322**	2.54	0.25	2.01
L.S.D. .05	0.02	N.S	N.S
Sub-plots (kg N fed^{-1})			
80	2.42	0.24	2.03
100	2.59	0.25	1.98
120	2.52	0.24	2.07
140	2.55	0.24	2.05
L.S.D. .05	0.07	N.S	N.S
Sub-sub-plots			
Cerealin	2.56	0.25	2.01
Rhizobacterin	2.53	0.24	2.05
Uninoculated	2.47	0.23	2.03
L.S.D. .05	0.05	N.S	N.S

Table (8): N,P and K concentration in ear leaf at 50% silking as affected by maize cultivar **x** N-level interaction in season of 2000

Maize cultivar	N-level (kg fed^{-1})	Nutrient concentration (%)		
		N	P	K
SWC 10*	80	7.30	0.72	6.05
	100	7.75	0.72	6.09
	120	7.35	0.69	6.41
	140	7.57	0.71	6.13
TWC 322**	80	7.23	0.74	6.14
	100	7.77	0.77	5.76
	120	7.76	0.76	6.00
	140	6.92	0.70	6.17
L.S.D .05		N.S	N.S	N.S

* Single way cross 10

** Three way cross 322

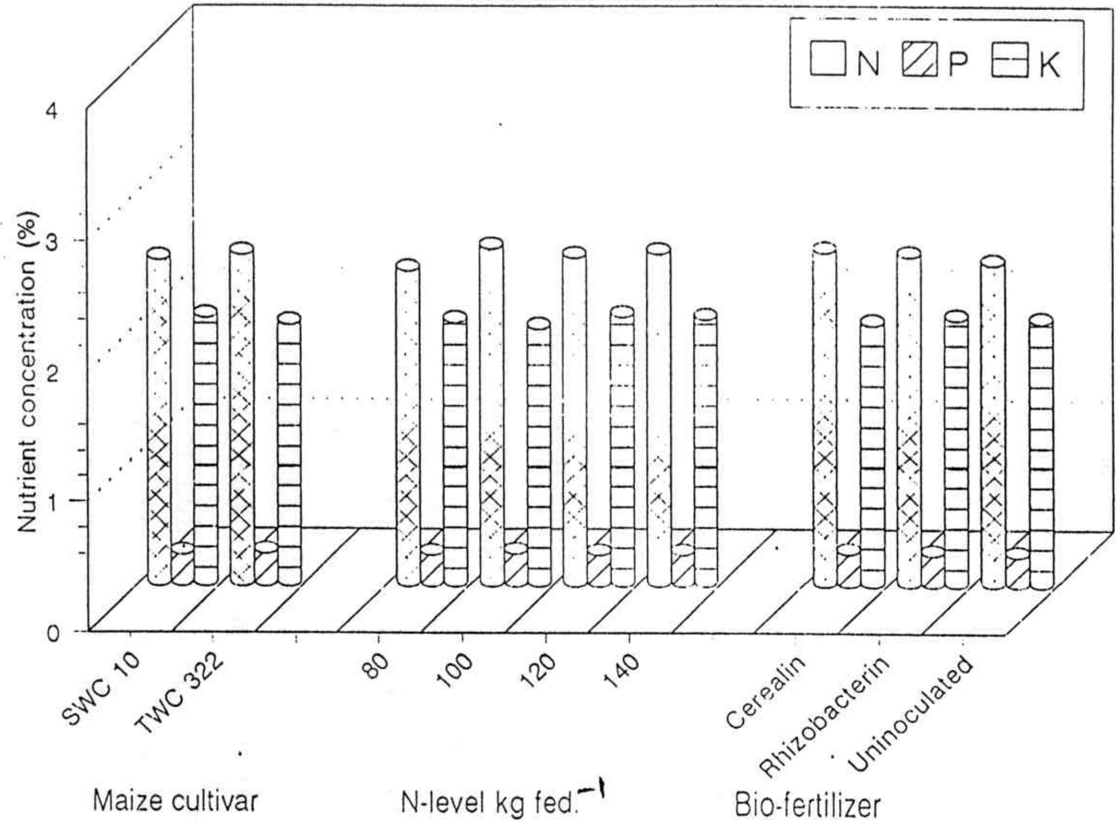


Fig.(2): N,P and K concentration in the ear leaf at 50% silking as affected by maize cultivar, N-level and biofertilizer.

greater average of ear number were more efficient in using accumulated N in producing grains and partitioned more of the total plant N and dry matter to grain production.

4-2-2-Effect of N-level on N, P and K concentration in ear leaf of maize cultivars at 50 % silking (sub-plots):

Data in Table (7 and Fig 2) also show that increasing N-level from 80 to 100 kg N fed^{-1} increased significantly N concentration in ear leaf at 50% silking. Similar result was reported by **Gascho *et al.* (1984)** and **Genaidy *et al.* (1992),** who illustrated that raising N rate elevated maize ear leaf N concentration and the highest value was recorded at the highest N-rate. **Genaidy** justified this trend on the basis that increasing N fertilization accelerated maize growth rate, hence, dry matter accumulation increased.

4-2-3-Effect of biofertilizer on N, P and K concentration in ear leaf of maize cultivars at 50 % silking (sub-sub-plots):

Data in Table (7and Fig 2) pointed out that when seeds of both cultivars were inoculated with Cerealin and Rhizobacterin, microbial strains in these biofertilizers led to significant effect on N concentration in ear leaf over those uninoculated with biofertilizer. It is also noticed from the results that biofertilizers had no significant effect on P and K concentration in ear leaf, as they were not P and K professionals. The positive effect of biofertilizers on N concentration in ear leaf could be attributed to their role in N-fixation as prescribed by **Lin *et al* (1983);**

Paredes *et al* (1988) ;Kaloyanova *et al* (1990) ; Stancheva *et al* (1995) and Anita *et al* (1998).

4-2-1-1 N, P and K concentration in ear leaf as affected by interaction of the experimental treatments:

4-2-1-2- Effect of the interaction of maize cultivar x N-level on N, P and K concentration in ear leaf at 50 % slking:

Data in Table (8) revealed that N, P and K concentration in ear leaf at 50% silking in both SWC 10 and TWC 322 were not significantly affected by maize cultivar x N-level interaction.

4-2-1-3-Effect of maize cultivar x biofertilizer interaction on N, P and K concentration in ear leaf at 50 % silking:

Data in Table (9) Illustrated that TWC 322 x Rhizobacterin interaction had significant effect on N concentration in ear leaf at 50% silking, whereas SWC 10 x Cerealin or Rhizobacterin interaction had insignificant effect on N, P and K concentration in ear leaf.

4-2-1-4- Effect of N-level x biofertilizer interaction on N, P and K concentration in ear leaf at 50% silking :

Data in Table (10) pointed out that the interaction between N-levels and Cerealin and Rhizobacterin recorded significantly different effect on N concentration in ear leaf based on the amount of N fertilizer given to maize plants. Results

Table (9): N, P and K concentration in ear leaf at 50% silking as affected by maize cultivar x biofertilizer interaction in season of 2000.

Maize cultivar	Biofertilizer	Nutrient concentration (%)		
		N	P	K
S.W.C. 10*	Cerealin	9.87	0.96	8.21
	Rhizobacterin	10.02	0.95	8.48
	Uninoculated	10.08	0.93	7.99
T.W.C. 322**	Cerealin	9.75	1.05	7.88
	Rhizobacterin	10.25	0.98	7.94
	Uninoculated	9.69	0.94	8.25
L.S.D. .05		0.08	N.S	N.S

* Single way Cross 10

** Three way Cross 322

Table (10): N, P and K concentration in ear leaf at 50% silking as affected by N-level **x** biofertilizer interaction in season of 2000.

N-level (kg fed^{-1})	Biofertilizer	Nutrient concentration (%)		
		N	P	K
80	Cerealin	4.76	0.48	4.09
	Rhizobacterin	4.97	0.50	4.09
	Uninoculated	4.82	0.48	4.01
100	Cerealin	5.54	0.53	3.86
	Rhizobacterin	5.16	0.50	4.07
	Uninoculated	4.82	0.46	3.93
120	Cerealin	5.09	0.50	4.06
	Rhizobacterin	4.95	0.47	4.09
	Uninoculated	5.08	0.48	4.26
140	Cerealin	4.24	0.50	4.08
	Rhizobacterin	5.21	0.46	4.17
	Uninoculated	5.05	0.45	4.05
L.S.D .05		0.12	N.S	N.S

clarified that interaction between 100 kg N fed^{-1} and Cerealin or Rhizobacterin had significantly best effect on N concentration in ear leaf. However, this interaction had insignificant effect on P and K concentration in ear leaf at 50% silking. This interaction shows that N_2 fixing bacterial strains contained in Cerealin and Rhizobacterin significantly effective in rhizosphere with low to medium level of N fertilizer concerning N concentration in ear leaf. Similar findings were reported by many authors such as **Nanda *et al.* (1995) ; Stancheva *et al.* (1995) ; Abdullah (1998) and Rout *et al.* (2001).**

4-2-1-5- Effect of maize cultivar x N-level x biofertilizer interaction on N, P and K concentration in ear leaf at 50% silking :

Data in Table (11) emphasized that maize cultivar SWC 10 x 100 kg N fed^{-1} x Cerealin had significant effect on N concentration in ear leaf at 50% silking, whereas maize cultivar TWC 322 x 100 kg N fed^{-1} x Cerealin or Rhizobacterin interaction had a significant effect on N concentration in ear leaf at 50% silking. However, Cerealin in this interaction had more significant effect than Rhizobacterin. This triple interaction had insignificant effect on P and K concentration in ear leaf at 50% silking.

Table (11): N, P and K concentration in ear leaf at 50% silking as affected by maize cultivar **x** N-level **x** biofertilizer interaction in season of 2000.

Maize cultivars	N-level (kg fed^{-1})	Biofertilizer	Nutrient concentration (%)		
			N	P	K
S.W.C10*	80	Cerealin	2.28	0.24	2.12
		Rhizobacterin	2.51	0.25	1.99
		Uninoculated	2.52	0.23	1.94
	100	Cerealin	2.70	0.26	1.93
		Rhizobacterin	2.51	0.24	2.19
		Uninoculated	2.54	0.23	1.97
	120	Cerealin	2.34	0.22	2.07
		Rhizobacterin	2.44	0.22	2.15
		Uninoculated	2.57	0.24	2.19
	140	Cerealin	2.56	0.24	2.09
		Rhizobacterin	2.57	0.24	2.15
		Uninoculated	2.45	0.23	1.89
T.W.C322**	80	Cerealin	2.48	0.25	1.97
		Rhizobacterin	2.46	0.25	2.10
		Uninoculated	2.30	0.25	2.07
	100	Cerealin	2.84	0.27	1.93
		Rhizobacterin	2.65	0.26	1.88
		Uninoculated	2.28	0.23	1.96
	120	Cerealin	2.75	0.27	1.99
		Rhizobacterin	2.51	0.24	1.94
		Uninoculated	2.51	0.24	2.07
	140	Cerealin	1.68	0.26	1.99
		Rhizobacterin	2.64	0.23	2.02
		Uninoculated	2.60	0.22	2.16
L.S.D. .05			0.17	N.S	N.S

* Single Way Cross 10
** Three Way Cross 322

4-3- Effect of maize cultivars, N-levels, biofertilizers on maize yield and its components:

4-3-1-Effect of maize cultivars on maize yield and its component (main plots):

Data in Table (12 and Fig 3) illustrate the response of grain yield Ardab fed^{-1}, grain weight ear^{-1} (g), weight of 100-kernels (g) and straw yield t fed^{-1} of high-yielding maize cultivars viz. SWC 10 and TWC 322. Data revealed that maize cultivar SWC 10 significantly surpassed its counterpart TWC 322 in respect of grain yield, grain weight ear^{-1} and weight of 100-kernels with the exception of straw yield, which recorded no significant difference between both cultivars under investigation. This trend may be attributed to genetic constitution of these cultivars as emphasized by **El-Agmy *et al.* (1986)** and **Gouda *et al.* (1993)** or it may be due to heritable superiority of single cross maize variety over the other three way cross as stated by **Esmail and El-Sheikh (1994).** This trend could be related to the superiority in grain weight ear^{-1} and weight of 100-kernels as reported by **Basha (1994).**

4-3-2- Effect of N-levels on maize yield and its components (sub-plots):

Data in Table (12and Fig 3) demonstrate the response of grain yield, weight of grain ear^{-1}, weight of 100-kernels and straw yield to increase N-levels successively from 80, 100, 120 and140 kg N fed^{-1}. Results pointed out that increasing N-levels from 80 to 100 kg fed^{-1} caused significant increase in grain yield and its components. However, further doses of N application

Table (12): Response of maize grain yield and its components to maize cultivar, N-level and biofertilizer as combined analysis of variance of 1999 and 2000 seasons.

Experimental treatment	Grain yield (Ardab fed^{-1})	Grain(wt ear^{-1}) (g)	Wt. of 100-kernels (g)	Straw Yield (t fed^{-1})
Main plots				
SWC10*	25.18	255.76	37.34	4.79
TWC322**	23.86	240.46	36.47	4.53
L.S.D. .05	0.74	5.16	0.87	N.S
Sub-plots (kg N fed^{-1})				
80	23.42	235.92	35.96	4.43
100	25.27	252.47	37.71	4.97
120	24.73	251.89	36.83	4.69
140	24.68	252.11	37.14	4.56
L.S.D. .05	0.64	7.65	0.59	0.21
Sub-sub-plots				
Cerealin	24.70	253.75	36.94	4.79
Rhizobacterin	24.91	254.90	37.79	4.62
Uninoculated	23.96	235.65	35.99	4.58
L.S.D. .05	0.41	5.51	0.64	0.16

Table (13): Grain yield and its components as affected by maize cultivar **x** N-level interaction as interaction as combined analysis of variance of 1999 and 2000 seasons.

Maize cultivar	N-level (kg fed^{-1})	Grain yield (*Ardab fed^{-1})	Grain (wt ear^{-1}) (g)	Wt of 100 kernels (g)	Straw yield (t fed^{-1})
SWC 10	80	23.31	245.78	36.94	4.52
	100	25.55	260.50	38.08	5.10
	120	25.70	255.44	37.19	4.88
	140	26.17	261.22	37.16	4.66
.TWC 322	80	23.53	226.06	34.98	4.34
	100	24.98	244.44	37.34	4.84
	120	23.76	248.33	36.46	4.94
	140	23.18	243.00	37.11	4.45
L.S.D. .05		0.65	N.S	0.82	0.29

* Single Way Cross 10
** Three Way Cross 322
Ardab = 140 kg

rhizosphere. These results correspond to those found by **Hussain *et al* (1987); Nieto (1989) and Saxena *et al* (1990).**

4-3-1-1 Effect of the interaction of the involved treatments on maize yield and its components:

4-3-1-2- Effect of maize cultivar x N-level interaction on maize yield and its components:

Data in Table (13) show maize grain yield, weight of grains ear^{-1}, weight of 100-kernels and straw yield as affected by interaction of maize cultivar x N-level. The results clarified that excluding grain weight ear^{-1}, grain yield, 100-kernel weight and straw yield of the two cultivars under investigation were significantly affected by this interaction when N fertilizer was applied at the rate of 100 kg N fed^{-1}.

4-3-1-3- Effect of maize cultivar x biofertilizer interaction on maize yield and its components:

Data in Table (14) show grain yield, weight of grains ear^{-1}, weight of 100-kernels and straw yield of maize cultivars under the effect of these cultivars x biofertilizer interaction. Results pointed out that SWC 10 with either biofertilizer had a significant effect on grain yield and grain weight ear^{-1}. However, this cultivar with Rhizobacterin had significant effect on 100-kernel weight. Meanwhile the interaction of SWC 10 with Cerealin had insignificant effect on 100-kernel weight. This cultivar also with either biofertilizer had insignificant effect on straw yield. The interaction of TWC 322 with either biofertilizer significantly affected grain yield, grain weight ear^{-1} and weight of 100-kernels. On the other hand, this cultivar with Cerealin

Table (14) : Grain yield and its components as affected by maize cultivar x biofertilizer interaction according to combined analysis of variance of 1999 and 20 seasons.

Maize cultivar	Biofertilizer	Grain yield (Adab fed^{-1})	Grain (wt ear^{-1}) (g)	Wt. of 100-kernels (g)	Straw yield (t fed^{-1})
SWC10*	Cerealin	25.26	255.88	37.16	4.78
	Rhizobacterin	25.60	263.42	38.44	4.80
	Uninoculated	24.69	247.92	36.52	4.79
TWC322**	Cerealin	24.13	251.63	36.73	4.80
	Rhizobacterin	24.23	246.38	37.24	4.43
	Uninoculated	23.23	223.38	35.45	4.37
L.S.D. at .05		0.65	7.79	0.90	0.23

* Single way cross 10

** Three way cross 322

Table (15) : Grain yield and its components as affected by N-level x biofertilizer interaction according to combined analysis of variance of 1999 and 2000 seasons.

N-level (kg fed^{-1})	Biofertilizer	Grain yield (Adab fed^{-1})	Grain (wt ear^{-1}) (g)	Wt. of 100-kernels (g)	Straw yield (t fed^{-1})
80	Cerealin	22.92	247.50	35.83	4.48
	Rhizobacterin	23.59	233.25	36.67	4.19
	Uninoculated	23.73	227.00	35.37	4.62
100	Cerealin	26.26	263.33	37.85	5.05
	Rhizobacterin	26.10	275.83	39.81	4.98
	Uninoculated	23.43	218.25	35.48	4.89
120	Cerealin	24.57	253.75	36.84	5.03
	Rhizobacterin	25.33	255.75	37.29	4.65
	Uninoculated	24.29	246.17	36.34	4.38
140	Cerealin	25.03	250.42	37.25	4.58
	Rhizobacterin	24.63	254.75	37.41	4.65
	Uninoculated	24.37	251.17	36.75	4.44
L.S.D. at .05		0.81	11.01	1.28	0.33

brought about significant effect on straw yield. The interaction of TWC322 with Rhizobacterin had insignificant effect on straw yield.

4-3-1-4- Effect of N-level x biofertilizer interaction on maize yield and its components:

Data in Table (15) point out the effect of interaction of N level x biofertilizer on yield and its components of maize cultivars. It is clear that maize grain yield, grain weight ear^{-1} and weight of 100-kernels were significantly affected by either Cerealin or Rhizobacterin in the presence of N fertilizer at the rate of 100 kg N fed^{-1}, while this interaction insignificantly affected straw yield fed^{-1} except with 120 kg N fed^{-1} and seed inoculation with Cerealin. Data also indicate that the Rhizobacterin in this interaction was significantly more favorable than Cerealin concerning grain weight ear^{-1} and weight of 100 kernels. However, the interaction of 80 kg N fed^{-1} with Cerealin had significant effect on grain weight ear^{-1}.

4-3-1-5- Response of maize yield and its components to interaction of maize cultivar x N-level x biofertilizer:

Data in Table (16) identify yield and its components as affected by interaction of maize cultivar x N-level x biofertilizer. Results clearly outlined that inoculation of seeds of SWC 10 with either Cerealin or Rhizobacterin with application of 100 kg N fed^{-1} had significant effect on grain yield and grain weight ear^{-1}. Whereas seeds of the same cultivar inoculated with Rhizobacterin and given 100 kg N fed^{-1} caused significant effect

Table (16): Grain yield and its components as affected by maize cultivar **x** N-level **x** biofertilizer interaction according to combined analysis of variance of 1999 and 2000 seasons.

Maize cultivar	Nitrogen level (kg fed^{-1})	biofertilizer	Grain yield (Ardab fed^{-1})	Grain (wt ear^{-1}) (g)	Wt. Of 100-kernels (g)	Straw yield (t fed^{-1})
SWC 10 *	80	Cerealin	22.33	257.67	36.67	4.64
		Rhizobacterin	23.57	244.17	37.58	4.07
		Uninoculated	24.02	235.50	36.55	4.84
	100	Cerealin	26.44	264.33	37.39	4.92
		Rhizobacterin	26.49	279.17	40.51	5.20
		Uninoculated	23.73	238.00	36.33	5.18
	120	Cerealin	26.13	245.67	37.19	5.02
		Rhizobacterin	25.77	261.67	38.03	5.08
		Uninoculated	25.21	257.00	36.36	4.54
	140	Cerealin	26.16	255.83	37.36	4.54
		Rhizobacterin	26.56	268.67	37.28	4.86
		Uninoculated	25.79	259.17	36.85	4.60
TWC 322**	80	Cerealin	23.52	237.33	34.99	4.33
		Rhizobacterin	23.61	222.33	35.76	4.30
		Uninoculated	23.45	218.50	34.20	4.39
	100	Cerealin	26.09	262.33	38.30	5.18
		Rhizobacterin	25.72	272.50	39.10	4.75
		Uninoculated	23.14	198.50	34.63	4.60
	120	Cerealin	23.01	261.83	36.50	5.05
		Rhizobacterin	24.89	249.83	36.56	4.23
		Uninoculated	23.38	233.33	36.32	4.21
	140	Cerealin	23.90	245.00	37.13	4.63
		Rhizobacterin	22.70	240.83	37.54	4.44
		Uninoculated	22.96	243.17	36.66	4.28
L.S.D. .05			1.15	15.57	1.81	0.47

* Single way cross 10
** Three way cross 322

on weight of 100-kernels and Cerealin under this conditions had insignificant effect on this component. Meanwhile, straw yield of SWC 10 was significantly affected when seeds of this cultivar were inoculated with either biofertilizer and given 120 kg N fed^{-1}. Inoculation of seeds of TWC 322 with either biofertilizer under application of 100 kg N fed^{-1} brought about significant effect on grain yield, grain weight ear^{-1} and 100-kernel weight. Rhizobacterin in this interaction was significantly more effective than Cerealin. On the other hand, Cerealin other than Rhizobacterin inoculated seeds of TWC 322 under application of 100 kg N fed^{-1} caused significant effect on straw yield and also Cerealin inoculated seeds of SWC 10 and TWC 322 and supplied with 80 kg N^{-1} had significantly favorable effect on grain weight ear^{-1}.

4-4- Effect of maize cultivars, N-levels and biofertilizers on grain content of N, P and K according to combined analysis of variance of 1999 and 2000 seasons:

4-4-1- Effect of maize cultivars on N, P and K content in grains (main plots):

Data in Table (17 and Fig 4) clarify N, P and K content in grains as affected by maize cultivars viz. SWC 10 and TWC 322 in the light of the combined analysis of variance of 1999 and 2000 seasons. It is also noticed from the results that grains of both cultivars under investigation had no significant difference in their content of nutrient elements.

Table (17) : N, P and K content in grains as affected by maize cultivar, N-level and biofertilizer according to combined analysis of variance of 1999 and 2000 seasons.

Experimental treatment	Nutrient content in grains (%)		
	N	P	K
Main plots			
SWC 10*	1.55	0.37	0.45
TWC 322**	1.54	0.37	0.44
L.S.D. .05	N.S	N.S	.N.S
Sub-plots (kg N fed^{-1})			
80	1.49	0.36	0.45
100	1.64	0.38	0.45
120	1.54	0.37	0.43
140	1.51	0.37	0.44
L.S.D. .05	0.04	N.S	N.S
Sub-sub-plots			
Cerealin	1.62	0.38	0.45
Rhizobacterin	1.56	0.38	0.45
Uninoculated	1.46	0.36	0.43
L.S.D. .05	0.04	N.S	N.S

Table (18) : N, P and K content in grains as affected by maize cultivar **x** N-level interaction according to combined analysis of variance of 1999 and 2000 seasons.

Maize cultivar	N-level (kg fed^{-1})	Nutrient content in grains (%)		
		N	P	K
SWC 10	80	1.51	0.36	0.45
	100	1.73	0.39	0.47
	120	1.47	0.36	0.42
	140	1.51	0.38	0.44
TWC 322	80	1.46	0.37	0.45
	100	1.56	0.37	0.43
	120	1.61	0.39	0.44
	140	1.51	0.37	0.43
L.S.D. .05		0.06	N.S	N.S

* Single way cross 10
** Three way cross 322

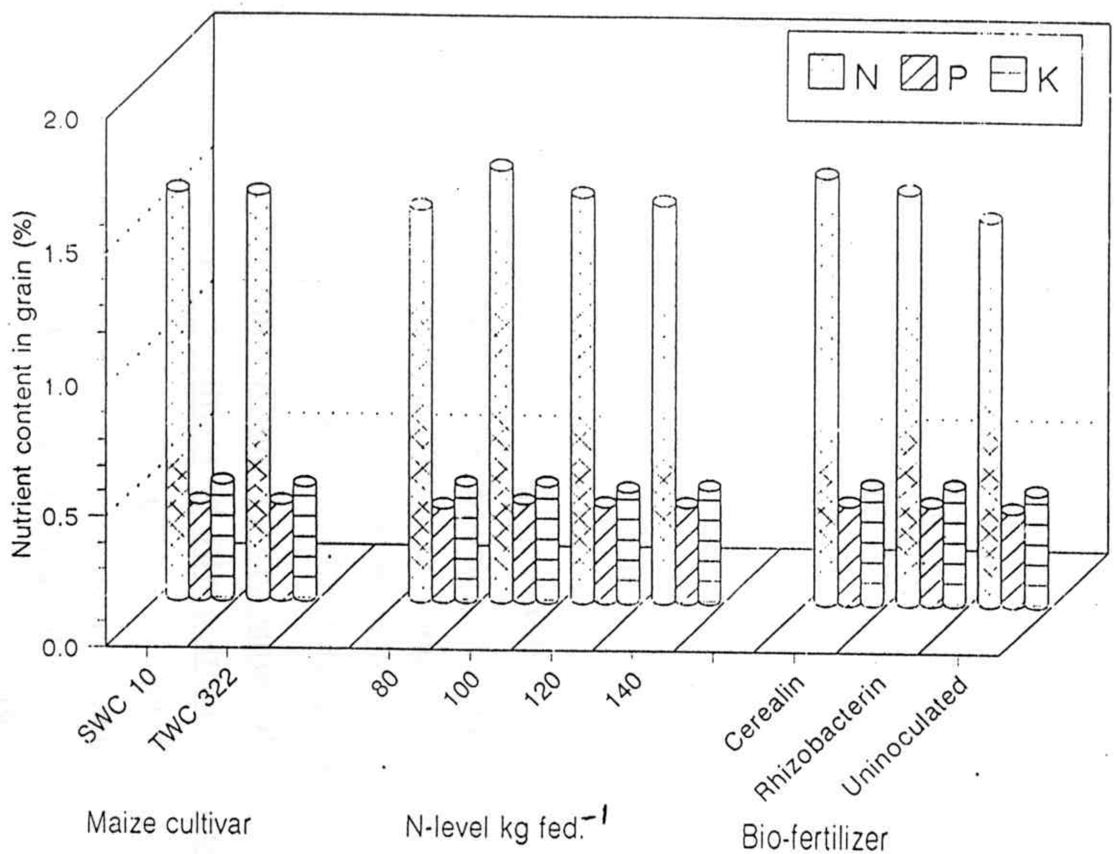


Fig.(4): N,P and K content in grains as affected by maize cultivar,N-level and biofertilizer according to combined analysis of variance of 1999 and 2000 seasons.

4-4-2- Response of N, P and K content in grains to mineral N-levels (sub-plots):

Data in Table (17and Fig 4) also show the effect of N-levels on N, P and K content in grains. The results clearly identified that raising N-level from 80 to 100 kg N fed^{-1} increased N content in grains. This significant effect may be related to the increase in dry matter accumulation under the encouragement of increasing N level as stated by **Ibrahim (1997)** or it may be as a result of the effect of N fertilizer on plant growth via chlorophyll production and consequently on photosynthesis and finally on dry matter accumulation as reported by **Fan Ling and Moshe Silberbus (2002).** Conversely, increasing N-level successively from 100, 120 or 140 kg N fed^{-1}. did not cause any significant effect on N content in maize grains. Concerning P and K content in grains as affected by N treatments, data in the above mentioned Table obviously indicated that N-treatments had insignificant effect. This result could be explained on the basis that P and K fertilization were added as basal sufficient (recommended) doses, which were diluted by the effect of plant growth up to its maturity (**Fan Ling and Moshe Silberbus, 2002**).

4-4-3- Response of N, P and K content in grains to seed inoculation with biofertilizers (sub-sub-plots):

Data in Table (17 and Fig 4) cast the light on N, P and K content in maize grains under the effect of biofertilizer treatments applied in the experimental work. Results indicated that Cerealin or Rhizobacterin inoculation had significant effect on grain content of N. However, Cerealin was significantly more effective than Rhizobacterin on grain content of N. Similar results were found by **Meshram and Shende (1982) and Hussain *et al.* (1987).** Regarding grain content of P and K, the results highlighted that neither Cerealin nor Rhizobacterin had significant effect. This finding could be explained on the fact that microbial strains in both biofertilizers are not professional in P and K availability.

4-4-1-1- Effect of interaction of the involved treatments on N, P and K content in grains according to combined analysis of variance of 1999 and 2000 seasons:

4-4-1-2- Response of N, P and K content in grains to interaction of maize cultivar x N-level:

Data in Table (18) indicated that the interaction of either SWC 10 or TWC 322 with N-level of 100 kg N fed^{-1} was significantly effective on N content in grain. The results also showed that N content in grains of SWC 10 significantly surpassed that of TWC322. Meanwhile, this interaction insignificantly affected P and K content in grains of both cultivars. This result could be explained on the ground that the main effect of both factors comprising the current interaction was insignificant.

4-4-1-3- Response of N, P and K content in grains to interaction of maize cultivar x biofertilizer:

Data in Table (19) revealed that the interaction originated from inoculation of seeds of maize cultivar SWC 10 with Cerealin caused significant effect on N content in grains of this

Table (19) : N, P and K content in grains as affected by maize cultivar x biofertilizer interaction according to combined analysis of variance of 1999 and 2000 seasons.

Maize cultivar	Biofertilizer	Nutrient content in grains (%)		
		N	P	K
SWC 10*	Cerealin	1.34	0.37	0.44
	Rhizobacterin	1.31	0.39	0.46
	Uninoculated	1.28	0.36	0.44
TWC 322**	Cerealin	1.90	0.39	0.45
	Rhizobacterin	1.81	0.37	0.44
	Uninoculated	1.63	0.36	0.42
L.S.D. .05		0.06	N.S	N.S

Table (20) : N, P and K content in grains as affected by N-level x biofertilizer interaction according to combined analysis of variance of 1999 and 2000 seasons.

N-level(kg fed^{-1})	Biofertilizer	Nutrient content in grains (%)		
		N	P	K
80	Cerealin	1.47	0.37	0.45
	Rhizobacterin	1.54	0.38	0.46
	Uninoculated	1.44	0.35	0.45
100	Cerealin	1.83	0.41	0.47
	Rhizobacterin	1.67	0.38	0.47
	Uninoculated	1.43	0.35	0.42
120	Cerealin	1.57	0.37	0.42
	Rhizobacterin	1.56	0.38	0.43
	Uninoculated	1.49	0.37	0.44
140	Cerealin	1.61	0.38	0.44
	Rhizobacterin	1.46	0.37	0.44
	Uninoculated	1.46	0.37	0.43
L.S.D. .05		0.09	N.S	N.S

* Single Way Cross 10
** Three Way Cross 322

cultivar. Whereas, seed inoculation with Rhizobacterin insignificantly affected this content. In the contrary, inoculation of seeds of TWC 322 with either Cerealin or Rhizobacterin caused significant effect on N content in grains of this cultivar. It is noticed that Cerealin was more effective than Rhizobacterin in this interaction. Concerning P and K content in grains of both cultivars, seed inoculation with either Cerealin or Rhizobacterin had insignificant effect.

4-4-1-4- Response of N, P and K content in grains to interaction of N-level x biofertilizer:

Data in Table (20) present the interaction of N-level with biofertilizer. Results demonstrated that in respect of seed inoculation with either Cerealin or Rhizobacterin significantly interacted with N fertilizer to the greatest extent when N fertilizer was applied at 100 kg N fed^{-1}. In this case, it is noticed that Cerealin was significantly more effective on N content in grains. Meanwhile, the interaction of N-levels with either biofertilizer had insignificant effect on P and K content in grains.

4-4-1-5- Response of N, P and K content in grains to interaction of maize cultivar x N-level x biofertilizer:

Data in Table (21) show values of this triple interaction and the results indicated that inoculation of seeds of SWC 10 with either Cerealin or Rhizobacterin in the presence of 100 kg N fed^{-1} significantly recorded the highest values of N content in grain. It is noticed that the two biofertilizers were statistically similar in their effect on N content in grains. On the other hand, Table (21) : N, Pand K content in grains as affected by maize cultivar x N-level x biofertilizer interaction according to combined analysis of variance of 1999 and 2000 seasons.

Maize cultivar	Nitrogen level (kg fed^{-1})	Biofertilizer	Nutrient content in grains (%)		
			N	P	K
SWC 10 *	80	Cerealin	1.45	0.35	0.45
		Rhizobacterin	1.64	0.38	0.46
		Uninoculated	1.46	0.36	0.46
	100	Cerealin	1.87	0.44	0.50
		Rhizobacterin	1.82	0.38	0.49
		Uninoculated	1.49	0.36	0.43
	120	Cerealin	1.46	0.33	0.39
		Rhizobacterin	1.53	0.39	0.43
		Uninoculated	1.41	0.36	0.45
	140	Cerealin	1.62	0.37	0.43
		Rhizobacterin	1.49	0.40	0.44
		Uninoculated	1.42	0.37	0.44
TWC 322**	80	Cerealin	1.50	0.38	0.46
		Rhizobacterin	1.45	0.37	0.45
		Uninoculated	1.43	0.34	0.45
	100	Cerealin	1.79	0.38	0.44
		Rhizobacterin	1.52	0.38	0.45
		Uninoculated	1.37	0.34	0.40
	120	Cerealin	1.68	0.40	0.45
		Rhizobacterin	1.60	0.38	0.42
		Uninoculated	1.56	0.38	0.43
	140	Cerealin	1.61	0.40	0.45
		Rhizobacterin	1.43	0.34	0.43
		Uninoculated	1.51	0.37	0.41
L.S.D. .05			0.13	N.S	N.S

* Single way cross 10
** Three way cross 322

inoculation of seeds of TWC 322 with Cerealin or Rhizobacterin in the presence of 100 kg N fed^{-1} recorded significant effect on N content in grains but Cerealin was significantly more effective in this respect. Results also showed that this triple interaction was insignificantly effective on P and K content in grains.

4-5- Effect of maize cultivars, N-levels and biofertilizers on soil concentration of NH^+_4 and NO^-_3:

4-5-1- Effect of maize cultivars on soil concentration of NH^+_4 and NO^-_3 (main plots):

Data in Table (22 and Fig 5 & 6) show soil concentration of NH^+_4 and NO^-_3 (ppm) as affected by maize cultivars viz. SWC 10 and TWC 322 grown in the experimental field in accordance with soil depth and sampling time. Results indicated that maize cultivars had insignificant effect on soil concentration of NH^+_4 and NO^-_3 at times and depths of soil sampling.

4-5-2- Effect of mineral N-levels on soil concentration of NH^+_4 and NO^-_3 (sub-plots):

Data in Table (22 and Fig 5 & 6) also reveal the extent to which soil concentration of NH^+_4 and NO^-_3 (ppm) as affected by application of N-fertilizer at the level of 80,100,120 or 140 kg N fed^{-1} after 50, 70 and 120 DAS at the depth of 0 to 15 and 15 to 30 cm. Results clarified that increasing N-level from 80 to 100 kg N fed^{-1} significantly increased soil concentration of NH^+_4 ppm after 50 and 70 DAS and soil concentration of NO^-_3 after 50, 70 and 120 DAS at the depth of 0 to15 cm while raising N-level from 80 to120 kg N fed^{-1} significantly enriched soil NH^+_4 after 120 DAS at the same depth. At the depth of 15 to 30 cm the

Table (22): Effect of experimental treatments on soil concentration of NH4 and NO3 according to soil depth and soil sampling time.

Soil depth (cm)	Experimental Treatment	Soil conc.of NH_4 and NO_3 (ppm)					
		NH_4			NO_3		
		Sampling time (DAS)**					
		50	70	120*	50	70	120*
0 to 15	main plots						
	SWC 10	16.39	10.56	17.50	136.92	56.81	25.42
	TWC 322	15.97	10.97	18.75	140.14	54.72	26.53
	L.S.D.05	N.S	N.S	N.S	N.S	N.S	N.S
	Sub-plots (kg N fed^{-1})						
	80	15.27	8.06	16.39	127.72	45.56	16.11
	100	18.61	11.94	16.11	146.39	65.56	29.17
	120	15.56	11.39	18.06	136.67	57.22	31.94
	140	15.28	11.67	21.94	143.33	54.72	26.67
	L.S.D .05	1.46	2.47	3.94	5.15	7.86	9.06
	sub-sub-plots						
	Cerealin	16.46	12.08	18.96	140.63	60.63	23.75
	Rhizobacterin	17.71	11.88	18.75	154.17	65.63	27.92
	Uninoculated	14.38	8.33	16.67	120.79	41.04	26.25
	L.S.D .05	1.93	1.64	N.S	5.19	5.83	N.S
15 to 30	main plots						
	SWC 10	21.39	49.86	15.56	132.50	53.05	22.78
	TWC 322	22.92	50.00	19.03	106.53	49.02	22.08
	L.S.D .05	N.S	N.S	N.S	N.S	N.S	N.S
	Sub-plots (kg N fed^{-1})						
	80	19.72	46.94	14.17	67.22	40.83	16.67
	100	23.33	50.83	18.06	151.67	54.17	18.33
	120	23.33	50.28	18.33	168.61	54.44	26.67
	140	22.22	51.67	18.61	90.56	54.72	28.06
	L.S.D .05	1.91	3.00	2.11	42.54	7.39	N.S
	sub-sub-plots						
	Cerealin	22.92	52.71	17.08	138.54	53.13	19.17
	Rhizobacterin	22.50	53.13	17.91	141.88	59.17	25.83
	Uninoculated	21.04	43.96	16.88	78.13	40.83	22.29
	L.S.D .05	1.32	4.28	N.S	40.41	7.77	N.S

* at harvest

** Days after sowing

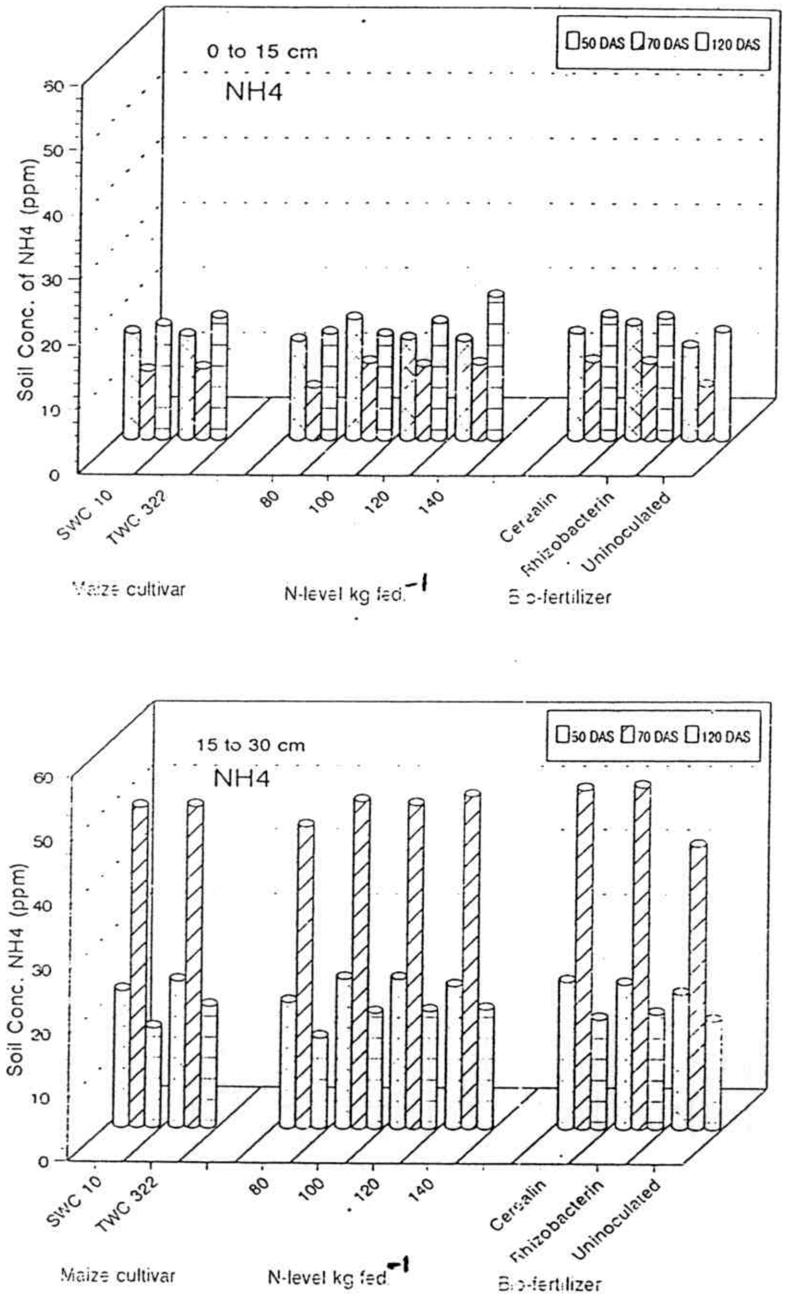
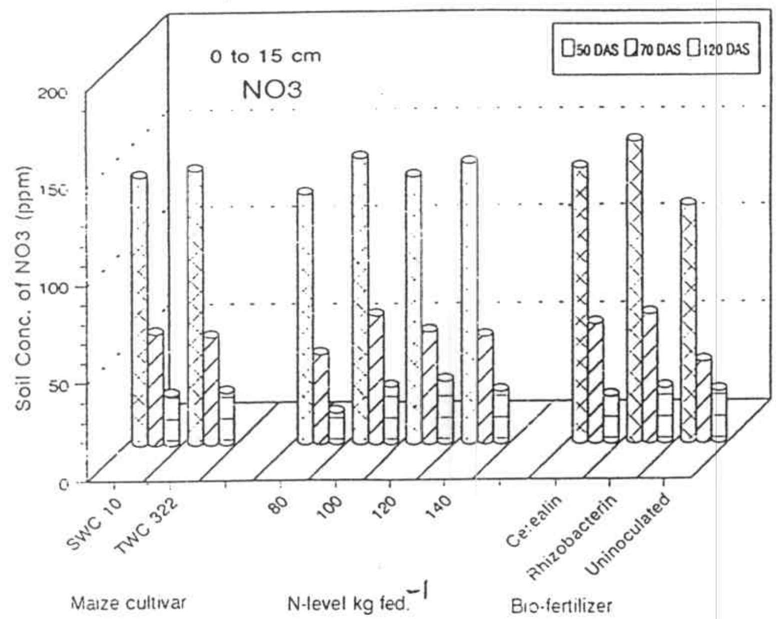


Fig.(5): Effect of experimental treatments on soil concentration of NH4 according to soil depth (0 to 15 and 15 to 30 cm) and soil sampling time.



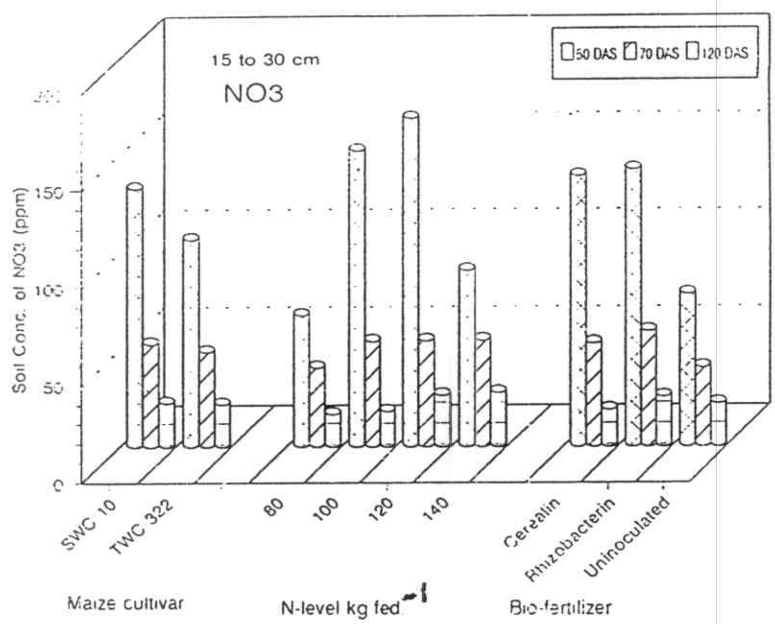


Fig.(6): Effect of experimental treatments on soil concentration of NO3 ppm according to soil depth (0 to 15 and 15 to 30 cm) and soil sampling time.

same grade of N fertilizer i.e. 100 kg N fed^{-1} significantly improved soil concentration of NH^{+}_{4} after 50, 70, 120 DAS and NO^{-}_{3} after 50, 70 DAS. However, this grade insignificantly affected NO^{-}_{3} concentration after 120 DAS. The improvement in soil concentration of NH^{+}_{4} and NO^{-}_{3} under the effect of increasing N-level from 80 to 100 kg N fed^{-1} could be due to the increase in N availability in soil rhizosphere. These results agreed with those achieved by **El-Shinnawi *et al.* (1990); Liang and Mackenzie (1992); Krishnan and Lourduraj (1997)** and **El-Akabawy *et al.* (2001)** who attributed the increase in NPK uptake by plant to the increase of the availability of such nutrients in soil and in turn encouraging absorption by plant. The significant increase of soil concentration of NH^{+}_{4} at 120 DAS by application of 140 kg N fed^{-1} means that this level of N fertilizer is more than sufficient to meet maize N-fertilizer requirement with the result that a significant amount of NH^{+}_{4} accumulated in the rhizosphere after harvest. This result is in agreement with that found by **Zhou *et al.* (1997)** who stated that if the applied N exceeds 180 kg N ha^{-1} (recommended N rate) for monocropped corn, it resulted in a lower N recovery. The decrease in soil concentration of NH_4 and NO_3 at the depth of 0 to 15 cm as compared to its concentration at 50 DAS may be as a result of the development of root growth and root surface area that led to improve absorption of NH_4 and NO_3 from soil rhizosphere as stated by **Viet (1956) and Aboulroos *et al.* (1992 b).**

4-5-3-Effect of biofertilizers on soil concentration of NH^{+}_{4} and NO^{-}_{3} (sub-sub-plots):

Data in Table (22 Fig 5 & 6) also point to the effect of Cerealin and Rhizobacterin as biofertilizers on soil concentration of NH^{+}_{4} and NO^{-}_{3} at the depth of 0 to15 and 15 to 30 cm after 50, 70 and 120 DAS. The results emphasized that both biofertilizers played an important role in enhancing soil fertility by improving soil concentration of NH^{+}_{4} and NO^{-}_{3} significantly after 50 and 70 DAS at the depth of 0 to 15cm and 15 to 30 cm. Both biofertilizers were statistically indifferent and their effect on the two soil parameters was insignificant at 120 DAS and at both depths. The enrichment of soil NH^{+}_{4} and NO^{-}_{3} at 50 and 70 DAS may be due to biofertilizers, which enhanced microbial multiplication in soil rhizosphere with the result that the rate of N_2-fixation increased. This conclusion was in support of that achieved by **Shahaby (2000).** The insignificant effect of biofertilizers on soil concentration of NH^{+}_{4} and NO^{-}_{3} at the depth of 0 to 15 and at 120 DAS may be originated because of the dry condition prevailing after harvesting that make bacterial activity and multiplication minimize. Hence, N_2-fixation went to its lowest rate (**Woodard and Bly, 2000).**

Table (24): Effect of maize cultivar x biofertilizer interaction on soil concentration of NH_4 and NO_3 according to soil depth and soil sampling time.

Soil depth (cm)	Maize cultivar	Biofertilizer	Soil conc.of NH_4 and NO_3 (ppm)					
			NH_4			NO_3		
			Sampling time (DAS)					
			50	70	120*	50	70	120*
0 to15	SWC 10**	Cerealin	66.67	48.33	76.67	555.00	225.00	98.33
		Rhizobacterin	70.00	43.33	70.83	616.67	278.33	100.00
		Uninoculated	60.00	35.00	63.33	471.33	178.33	106.67
	TWC 322***	Cerealin	65.00	48.33	75.00	570.00	260.00	91.67
		Rhizobacterin	71.67	51.67	80.00	616.67	246.67	123.33
		Uninoculated	55.00	31.67	70.00	495.00	150.00	103.33
	LSD .05		N.S	N.S	N.S	N.S	8.25	N.S
15 to 30	SWC 10	Cerealin	83.33	210.00	60.00	423.33	198.33	86.67
		Rhizobacterin	85.00	216.67	66.67	701.67	258.33	87.50
		Uninoculated	88.33	171.67	60.00	458.33	180.00	96.67
	TWC 322	Cerealin	90.00	211.67	76.67	678.33	226.67	66.67
		Rhizobacterin	91.67	208.33	76.67	446.67	210.00	116.7
		Uninoculated	88.33	180.00	75.00	166.57	146.67	81.67
	LSD .05		N.S	N.S	N.S	57.12	N.S	N.S

* at harvest
** Single way cross 10
*** Three way cross 322

soil sampling. The results outlined that the interaction emerged from both cultivars with either biofertilizer had insignificant effect on soil concentration of NH^+_4 at the depth of 0 to 15 cm and 15 to 30 cm at all times of soil sampling. Added to this, the results revealed that both cultivars with either biofertilizer had insignificant effect on soil concentration of NO^-_3 at the depth of 0 to 15 cm at 50 and 70 DAS. Whereas, both cultivars with both Cerealin and Rhizobacterin enriched soil concentration of NO^-_3 at the depth of 0 to 15 cm at 70 DAS. However, the interaction of SWC 10 with Rhizobacterin was significantly more effective on soil concentration of NO^-_3 than with Cerealin and TWC 322 with Cerealin was significantly more effective on soil concentration of NO^-_3 than with Rhizobacterin at the depth of 0 to 15 and at 70 DAS. On contrast, both cultivars with either Cerealin or Rhizobacterin at the depth of 0 to 15 cm and at 120 DAS and at the depth of 15 to 30 cm and at all times of soil sampling had insignificant effect on soil concentration of NO^-_3 and NH^+_4.

4-5-1-4- Effect of N-level x biofertilizer interaction on soil concentration of NH^+_4 and NO^-_3:

Data in Table (25) present the effect of interaction of N-levels viz. 80, 100, 120 and 140 kg N fed^{-1} with biofertilizers on soil concentration of NH^+_4.and NO^-_3 as per soil depth of 0 to 15 cm and 15 to 30 cm and times of soil sampling of 50, 70, 120 DAS. The results indicated that N-level of 100 kg N fed^{-1} with Rhizobacterin was significantly more effective than Cerealin on soil concentration of NH^+_4 at the depth of 0 to 15 cm and at 50 DAS. In this connection, N-level of 100 kg N fed^{-1} with either

Table (25): Effect of N-level x biofertilizer interaction on soil concentration of NH_4 and NO_3 according to soil depth and soil sampling time.

Soil depth (cm)	N-level (kg fed^{-1})	Biofertilizer	Soil conc.of NH_4 and NO_3 (ppm)					
			NH_4			NO_3		
			Sampling time (DAS)					
			50	70	120*	50	70	120*
0 to 15	80	Cerealin	31.67	15.00	35.00	295.00	103.33	30.00
		Rhizobacterin	30.00	20.00	33.33	273.33	116.67	35.00
		Uninoculated	30.00	13.00	30.00	198.00	53.33	31.67
	100	Cerealin	36.67	30.00	40.00	270.00	150.00	63.33
		Rhizobacterin	50.00	28.33	32.50	293.33	155.00	41.67
		Uninoculated	25.00	13.33	25.00	218.33	88.33	70.00
	120	Cerealin	33.33	26.67	33.33	240.00	110.00	48.33
		Rhizobacterin	33.33	23.33	36.67	270.00	130.00	95.00
		Uninoculated	26.67	18.33	38.33	310.00	103.33	48.33
	140	Cerealin	30.00	25.00	43.33	320.00	121.67	48.33
		Rhizobacterin	28.33	23.33	48.33	300.00	123.67	51.67
		Uninoculated	33.33	21.67	40.00	240.00	83.33	60.00
	L.S.D. .05		3.86	3.29	N.S	56.65	11.66	10.17
15 to 30	80	Cerealin	38.33	93.33	26.67	120.00	93.33	41.67
		Rhizobacterin	40.00	103.33	31.67	176.67	103.33	25.83
		Uninoculated	40.00	85.00	26.67	106.67	85.00	30.00
	100	Cerealin	45.00	106.67	31.67	390.00	106.67	30.00
		Rhizobacterin	45.00	101.67	35.00	420.00	101.67	43.33
		Uninoculated	45.00	96.67	41.67	106.67	96.67	36.67
	120	Cerealin	45.00	106.67	41.67	345.00	106.67	40.00
		Rhizobacterin	46.67	103.33	38.33	356.00	103.33	71.67
		Uninoculated	48.33	91.67	30.00	310.00	91.67	48.33
	140	Cerealin	45.00	115.00	36.67	246.67	115.00	41.67
		Rhizobacterin	45.00	116.67	38.33	195.00	116.67	63.33
		Uninoculated	43.33	78.33	36.67	101.67	78.33	63.33
	L.S.D. .05		N.S	N.S	N.S	N.S	15.53	N.S

* at harvest

Cerealin or Rhizobacterin was significantly effective on soil concentration of NH^{+}_{4} and NO^{-}_{3} at the depth of 0 to 15 cm and at 70 DAS. However, all N-levels with either biofertilizer had insignificant effect on soil concentration of NH^{+}_{4} at the depth of 0 to 15 cm and at 120 DAS. Concerning soil concentration of NO^{-}_{3} at the depth of 0 to 15 cm and at 50 DAS, the results clarified that N-level of 80 kg N fed^{-1} with either Cerealin or Rhizobacterin significantly improved soil concentration of NO^{-}_{3}. Whereas, N-level of 120 kg N fed^{-1} with Rhizobacterin significantly enriched soil concentration of NO^{-}_{3} at 120 DAS. On the other hand, the results referred that this interaction was insignificantly effective on soil concentration of NO^{-}_{3} at the depth of 15 to 30 and at 50 and 120 DAS. However, at 70 DAS, N-level of 80 kg N fed^{-1} with either Cerealin or Rhizobacterin improved soil concentration of NO^{-}_{3}.

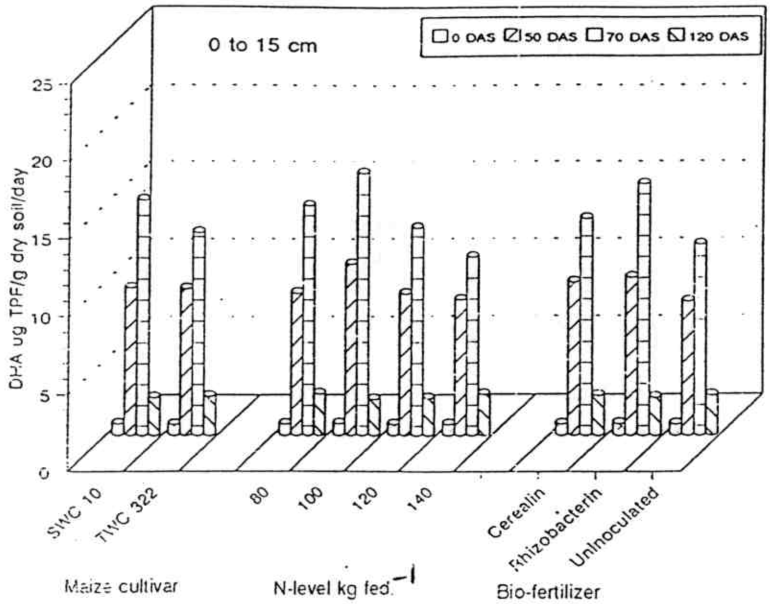
4-5-1-5- Effect of maize cultivar x N-level x biofertilizer interaction on soil concentration of NH^{+}_{4} and NO^{-}_{3}:

Data in Tables (26 & 27) refer to the effect of interaction of maize cultivars viz. SWC 10 and TWC 322, N-levels of 80, 100 and 120 and 140 kg N fed^{-1} and biofertilizers of Cerealin and Rhizobacterin on soil concentration of NH^{+}_{4} and NO^{-}_{3} in the light of soil depth of 0 to 15 cm and 15 to 30 cm and times of soil sampling of 50, 70 and 120 DAS. The results indicated that maize cultivar SWC 10 with N-level of 100 kg N fed^{-1} and either Cerealin or Rhizobacterin significantly enriched soil concentration of NH^{+}_{4} at the depth of 0 to 15 cm and at 50 DAS. Whereas, at 70 and 120 DAS this triple interaction was insignificantly effective. Moreover, this interaction is also insignificantly effective on soil concentration of NH^{+}_{4} at the depth of 15 to 30 cm and at all times assigned of soil sampling. As concern soil concentration of NO^{-}_{3} at the depth of 0 to 15 cm, the results indicated that SWC 10 with 100 kg N fed^{-1} and Rhizobacterin significantly raised soil concentration of NO^{-}_{3} at 50 DAS. Whereas, the same cultivar and N-level with either Cerealin or Rhizobacterin raised soil concentration of NO^{-}_{3} at 70 DAS but at 120 DAS, this interaction was significantly ineffective. At the depth of 15 to 30 cm and at 50 and 70 DAS, this interaction was significantly ineffective on soil concentration of NO^{-}_{3}. However, TWC 322 with N-level of 140 kg N fed^{-1} and Rhizobacterin was significantly effective at 120 DAS. In conclusion the last finding emphasized that the experimental treatments currently used in this investigation increased soil content of NO^{-}_{3} at harvest and as a consequence, soil fertility improved. Similar results were reported by numerous authors such as **Zaghloul *et al.* (1996), Krishnan and Lourduraj (1997)**, **Shahaby *et al.* (2000)** and **Santhy *et al.* (2001).**

Table (28): Effect of experimental treatments on soil dehydrogenase activity as per soil depth and soil sampling time.

Soil depth (cm)	Experimental Treatment	Dehydrogenase activity (DHA) µg TPF* g^{-1} dry soil day^{-1} Soil sampling time (DAS) 0	50	70	120
0 to 15	Main plots				
	SWC 10**	0.77	9.54	15.17	2.51
	TWC 322***	0.72	9.47	13.08	2.58
	L.S.D .05	N.S	N.S	N.S	N.S
	Sub-plots(kg N fed^{-1})				
	80	0.75	9.18	14.80	2.72
	100	0.78	11.04	16.89	2.36
	120	0.72	9.12	13.36	2.44
	140	0.73	8.71	11.46	2.66
	L.S.D .05	N.S	1.44	2.03	N.S
	Sub-sub-plots				
	Cerealin	0.74	9.84	13.95	2.58
	Rhizobacterin	0.77	10.13	16.18	2.46
	Uninoculated	0.73	8.57	12.25	2.59
	L.S.D .05	N.S	0.97	1.38	N.S
15 to 30	Main plots				
	SWC 10	1.30	6.82	3.70	2.80
	TWC 322	0.99	6.60	3.29	2.88
	L.S.D .05	N.S	N.S	N.S	N.S
	Sub-plots(kg N fed^{-1})				
	80	1.07	6.41	3.57	2.88
	100	1.25	7.48	4.13	2.44
	120	1.11	6.42	2.93	2.79
	140	1.14	6.53	3.34	3.26
	L.S.D .05	N.S	0.50	0.53	N.S
	Sub-sub-plots				
	Cerealin	1.00	7.52	3.31	2.91
	Rhizobacterin	1.40	6.89	4.22	2.73
	Uninoculated	1.03	5.72	2.94	2.89
	L.S.D .05	0.23	0.64	0.39	N.S

* Triphenyl formazan
** Single way cross 10
*** Three way cross 322



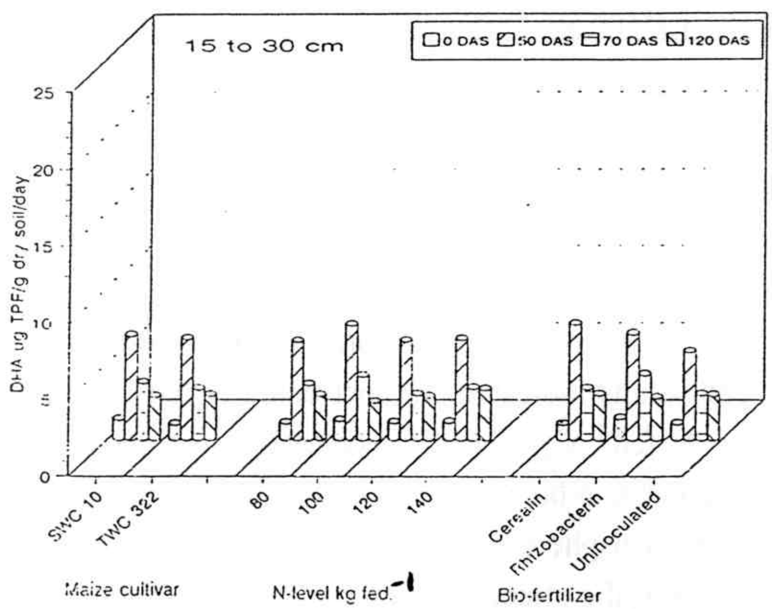


Fig.(7): Effect of experimental treatments on soil dehydrogenase activity as per soil depth (0 to 15 and 15 to 30 cm) and soil sampling times.

4-6- Effect of maize cultivars, N-levels and biofertilizers on soil microbiological activity as per soil depth and time of soil sampling:

4-6-1- Effect of maize cultivars on soil microbiological activity as per soil depth and time of soil sampling (main plots):

Data in Table (28 and Fig 7) present the effect of maize cultivars viz. SWC 10 and TWC 322 on dehydrogenase activity (DHA) as per soil depth 0 to 15 cm and 15 to 30 cm and times of soil sampling 0, 50, 70 and 120 DAS. Results emphasized that these cultivars had insignificant effect on soil DHA at the depth of 0 to 15 cm and 15 to 30 cm of the soil rhizosphere.

4-6-2- Effect of N-levels on soil microbiological activity as per soil depth and time of soil sampling (sub-plots):

Data in Table (28 and Fig 7) identify the effect of increasing N fertilizer from 80, 100, 120 or 140 kg N fed^{-1} successively on DHA at the depth of 0 to 15 cm and 15 to 30 cm of the soil rhizosphere in accordance with times of soil sampling. The results indicated that increasing N fertilizer from 80-100 kg N fed^{-1} significantly increased microbial activity represented by DHA at both depths (i.e. 0 to 15 cm and 15 to 30 cm) of the soil rhizosphere and at soil sampling times of 50 and 70 DAS. However, the effect of N-levels had insignificant effect on microbial activity via DHA at both depths and at 120 DAS. These results are in harmony with those concluded by **Woodard and Bly (2000)** who stated that maize yield responsive to inoculation tended to be from soils with a lower N availability status. In this respect, **Shahaby *et al.* (2000)** found that diazotrophe inoculation in combination with 60 kg N fed^{-1} revealed the superior dehydrogenase activity in soil. The same trend was found by **El-Akabawy *et al.* (2001)** who illustrated that the highest increase in maize grain yield was obtained when biofertilizer Microbin inoculation combined with N at the rate of 90 kg N fed^{-1}.

4-6-3- Effect of Cerealin and Rhizobacterin biofertilizers on soil microbiological activity (sub-sub-plots):

Data in Table (28 and Fig 7) show the effect of the above-mentioned biofertilizers on microbial activity at the depth of 0 to 15 cm and 15 to 30 cm in soil rhizosphere and at 0, 50, 70 and 120 DAS. The results revealed that both biofertilizers were significantly effective on dehydrogenase activity in soil rhizosphere at 50 and 70 DAS. However, both biofertilizers were significantly indifferent at 50 DAS at depths of 0 to 15 cm and 15 to 30 cm. At 0 to 15 cm and 70 DAS Rhizobacterin was significantly more effective than Cerealin but at 15 to 30cm Cerealin was insignificantly effective on DHA in soil rhizosphere. The significant positive effect of biofertilizers via measuring DHA had previously been recorded by **Fayez *et al.* (1983) and Sutton *et al.* (1991)**. These results could be attributed to the enrichment of microorganism in rhizosphere by inoculum of biofertilizers with the result that microbial activity and multiplication increased as illustrated by **Shahaby *et al.* (2000).**

4-6-1-1- Effect of interaction of the involved treatments on soil microbiological activity as per soil depth and time of soil sampling:

4-6-1-2- Effect of maize cultivar x N-level interaction on soil microbiological activity as per soil depth and time of soil sampling:

Data in Table (29) represent the effect of interaction of maize cultivars with N-levels at the depth of 0 to 15 cm and 15 to 30 cm and at times of soil sampling 0, 50, 70 and 120 DAS. The results indicated that this interaction had insignificant effect on DHA at the depth of 0 to 15 cm and at all times of soil sampling. However, at the depth of 15 to 30 cm and at 50 DAS, this interaction was significantly effective on DHA. The microbial activity recorded the best value when both cultivars were supplied with 100 kg N fed^{-1}. In this concern, this interaction in question was insignificantly effective on DHA at sampling times of 70 and 120 DAS.

4-6-1-3- Effect of maize cultivar x biofertilizer on soil microbiological activity as per soil depth and time of soil sampling:

Data in Table (30) identify the effect of interaction of maize cultivars with Cerealin and Rhizobacterin biofertilizers on microbial activity as measured via DHA at the depth of 0 to 15 cm and 15 to 30 cm and at times of soil sampling. The results concluded that at the depth of 0 to 15 cm of soil rhizosphere the interaction of SWC 10 with Rhizobacterin significantly recorded better effect on DHA at 50 and 70 DAS. However, TWC 322

Table (29):Effect of maize cultivar **x** N-level interaction on soil dehydrogenase activity as per soil depth and soil sampling time.

Soil depth (cm)	Maize cultivar	N-level (kg fed^{-1})	Dehydrogenase activity TPF*g^{-1} dry soil day^{-1}			
			Soil sampling time (DAS)			
			0	50	70	120
0 to 15	SWC10**	80	2.43	29..22	45.50	8.59
		100	2.56	34.24	51.80	6.83
		120	2.18	26.32	46.70	7.53
		140	2.07	24.86	38.10	7.12
	TWC322***	80	2.07	25.88	43.30	7.73
		100	2.11	32.00	49.60	7.30
		120	2.15	28.43	33.50	7.09
		140	2.29	27.41	30.70	8.82
	LSD .05		N.S	N.S	N.S	N.S
15 to 30	SWC10	80	3.98	20.33	10.96	9.45
		100	3.88	23.33	13.74	8.02
		120	4.15	20.27	9.03	7.99
		140	3.71	17.89	10.62	8.54
	TWC322	80	2.54	18.14	10.45	7.85
		100	3.67	21.58	11.05	6.99
		120	2.55	18.25	8.54	8.74
		140	3.15	21.29	9.44	11.02
	LSD .05		0.19	0.71	N.S	N.S

* Triphenyl formazan
** Single way cross 10
*** Three way cross 322

Table (30) : Effect of maize cultivar **x** biofertilizer interaction on soil dehydrogenase activity as per soil depth and soil sampling time.

soil depth (cm)	Maize cultivar	Biofertilizer	Dehydrogenase activity µg TPF*g^{-1} dry soil day^{-1}			
			Soil sampling time (DAS)			
			0	50	70	120
0 to 15	SWC10**	Cerealin	3.09	36.27	63.20	9.86
		Rhizobacterin	3.14	45.00	69.80	10.17
		Uninoculated	3.01	33.37	49.00	10.04
	TWC322***	Cerealin	2.79	42.44	48.40	10.75
		Rhizobacterin	3.00	36.06	59.60	9.49
		Uninoculated	2.83	35.22	49.00	10.75
	L.S.D .05		N.S	1.38	1.95	N.S
15 to 30	SWC10	Cerealin	4.16	30.12	15.51	12.67
		Rhizobacterin	6.71	28.18	17.58	10.55
		Uninoculated	4.76	23.52	11.25	10.78
	TWC322	Cerealin	3.90	30.06	11.00	10.99
		Rhizobacterin	4.52	26.91	16.21	11.30
		Uninoculated	3.49	22.27	12.26	12.31
	L.S.D .05		N.S	0.71	0.55	N.S

* Triphenyl formazan
** Single way cross 10
*** Three way cross 322

Table (32): Effect of maize cultivar **x** N-level **x** biofertilizer interaction on soil dehydrogenase activity as per soil depth and soil sampling time.

soil depth (cm)	Maize cultivar	N-Level (kg fed^{-1})	Biofertilizer	Dehydrogenase activity µg TPF* g^{-1} dry soil day^{-1}			
				Soil sampling time (DAS)			
				0	50	70	120
0 to 15	SWC10**	80	Cerealin	1.01	8.96	14.80	3.35
			Rhizobacterin	0.55	10.81	18.10	2.50
			Uninoculated	0.87	9.64	12.60	2.74
		100	Cerealin	0.90	10.43	15.70	2.00
			Rhizobacterin	1.05	16.19	23.90	2.51
			Uninoculated	0.61	7.62	12.20	2.32
		120	Cerealin	0.49	7.12	19.30	2.83
			Rhizobacterin	0.80	10.24	11.70	2.57
			Uninoculated	0.89	8.96	15.70	2.14
		140	Cerealin	0.69	9.76	13.40	1.69
			Rhizobacterin	0.74	7.76	16.20	2.59
			Uninoculated	0.64	7.34	8.50	2.84
	TWC322***	80	Cerealin	0.67	10.55	9.00	2.53
			Rhizobacterin	0.69	5.26	22.50	2.41
			Uninoculated	0.71	10.07	11.80	2.79
		100	Cerealin	0.66	10.67	17.40	2.46
			Rhizobacterin	0.82	11.36	20.00	2.82
			Uninoculated	0.63	9.98	12.20	2.03
		120	Cerealin	0.77	10.00	7.00	2.68
			Rhizobacterin	0.60	8.28	9.80	1.54
			Uninoculated	0.78	10.15	16.70	2.86
		140	Cerealin	0.69	11.22	15.00	3.08
			Rhizobacterin	0.89	11.16	7.40	2.72
			Uninoculated	0.71	5.03	8.30	3.02
		L.S.D .05		0.20	2.76	3.91	N.S

* Triphenylformazan
** Single way cross 10
*** Three way cross 322

Table (33) : Effect of maize cultivar **x** N-level **x** biofertilizer interaction on soil dehydrogenase activity as per soil depth and soil sampling time.

soil depth (cm)	Maize cultivar	N-level (kg fed^{-1})	Biofertilizer	Dehydrogenase activity µg TPF*g^{-1} dry soil day^{-1}			
				Soil sampling time (DAS)			
				0	50	70	120
15 to 30	SWC10**	80	Cerealin	0.84	6.99	4.65	2.51
			Rhizobacterin	2.07	6.67	3.38	2.90
			Uninoculated	0.98	6.67	2.93	4.04
		100	Cerealin	1.17	8.76	4.59	3.57
			Rhizobacterin	1.04	9.46	5.71	2.36
			Uninoculated	1.67	5.11	3.44	2.09
		120	Cerealin	1.11	7.31	3.13	3.09
			Rhizobacterin	1.88	7.75	3.82	2.32
			Uninoculated	1.16	5.21	2.08	2.58
		140	Cerealin	1.04	7.05	3.14	3.50
			Rhizobacterin	1.72	4.29	4.67	2.97
			Uninoculated	0.95	6.54	2.81	2.07
	TWC322***	80	Cerealin	0.95	6.63	3.26	2.84
			Rhizobacterin	0.90	4.79	4.08	2.64
			Uninoculated	0.69	6.72	3.10	2.37
		100	Cerealin	1.00	8.42	3.38	2.39
			Rhizobacterin	1.46	8.61	4.23	1.57
			Uninoculated	1.21	4.53	3.44	3.03
		120	Cerealin	1.05	7.26	2.32	2.73
			Rhizobacterin	0.76	6.15	3.58	2.49
			Uninoculated	0.74	4.84	2.64	3.52
		140	Cerealin	0.90	7.75	2.04	3.02
			Rhizobacterin	1.40	7.36	4.32	4.60
			Uninoculated	0.85	6.19	3.08	3.40
		L.S.D .05		N.S	N.S	N.S	N.S

* Triphenyl formazan
** Single way cross 10
*** Three way cross 322

7- Cerealin or Rhizobacterin inoculation had significant effect on grain content of N. However, Cerealin was significantly more effective than Rhizobacterin on grain content of N. Regarding P and K in grain, Cerealin nor Rhizobacterin has significant effect.

8- Interaction of either SWC 10 or TWC 322 with N-level of 100 kg N fed^{-1} was significantly effective on N content in grain. N content in grains of SWC 10 significantly surpassed that of TWC322. Meanwhile, this interaction insignificantly affected P and K content in grains of both cultivars.

9- Cerealin as well as Rhizobacterin plays an important role in enhancing soil fertility by improving soil concentration of NH_4 and NO_3 significantly after 50 and 70 DAS at the depth of 0 to 15 cm and 15 to 30 cm. Both biofertilizers are statistically indifferent and their effect on the two soil parameters is insignificant at 120 DAS and at both depths.

10-Both biofertilizers are significantly effective on microbiological activity in soil rhizosphere at 50 and 70 DAS. However, both biofertilizers are significantly indifferent at 50 DAS at depths of 0 to 15 cm and 15 to 30 cm. At 0 to 15 cm and 70 DAS Rhizobacterin is significantly more effective than Cerealin but at 15 to 30 cm Cerealin is insignificantly effective on microbiological activity in soil rhizosphere.

11-Maize seeds inoculated with Rhizobacterin and received 100 kg N fed^{-1} recorded the highest significant effect on microbiological activity in both outlined depths of soil rhizosphere at 50 and 70 DAS. However, this interaction has insignificant effect on microbiological activity at 120 DAS in both depths.