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EFFECT OF BIO AND / OR MINERAL NITROGENOUS FERTILIZERS ON MAIZE AND WHEAT CROPS PRODUCTION AND SOIL FERTILITY

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ABSTRACT

This study was conducted during 2003 and 2003 – 2004 seasons at Gemmeiza Agric. Res. Stn., with maize (SC 15 hybrid) and wheat (Gemmeiza 7 var.) , to findout the effect of bio – and / or N- fertilizers on yield production and soil fertility .
The obtained results could be summarized as follows :

The bio-fertilizer Azospirillum proved to be superior than Cyanobacteria one to increase, significant, maize grain and wheat(grain and straw) yields .Azospirillum still better than Cyanobacteria in improving N-uptake, N-use efficiency , % biomass N recovered and available soil N ,for both crops.

Increasing N-rate resulted in significant increases in maize grain and wheat(grain and straw) yields. Nitrogen concentration% of maize (grain and stover) and wheat(grain and straw) were increased significantly as N-rate increased. Nitrogen uptake and available soil N, after harvest, were increased, whereas, N- use efficiency tended to be reduced with increasing N-rate. Biomass-N recovered % for maize crop seemed to be increased with increasing N-rate ,whereas, an opposite trend was observed with wheat crop.

Insignificant interaction effects were obtained due to the adopted biofertilizers and N-rates on the studied characters ,except the available soil N after maize harvest

On conclusion , because of the inisignificant effect of adopted biofertilizers and N-rates , on the most investigated characters , it is recommended to apply the moderate N-rates under Azospirillum in order the reduce the environmental pollution and to reduce, as well, maize and wheat production costs under Gemmeiza soil conditions .

INTRODUCTION

Maize and wheat crops are considered as two of the five most important cereal crops in Egypt with respect to value and area . The maize and wheat yields are a function of many factors including nitrogen , since it is the most commonly deficient nutrient in the Egyptian soils . Nitrogen is well known to be one of the most major elements for plant nutrition and development since it plays an important role in proteins and enzymes synthesis . Thus , optimizing nitrogen management i.e. application time, amount .... etc . well yield an increase in crop yield . El – Douby *et al,* (2001) found that maize grain yield was significantly increased as N – rate increased and the maximum figure was obtained due to the addition of 140 kg N / fad. Moreover, Abo – Soliman *et al.*, (1988) with wheat crop, stated that both grain and straw yields were increased significantly with increasing nitrogen fertilizer level and the optimum level was 70 kg N / fed. Zamber *et al.*, (1984)found that application of N – fertilizer up to 120 Kg N / h increased N – uptake and protein content in the grains of wheat . However , application of such N – mineral fertilizers may harm some microbial groups and lead to upset or change in the ecological balance of soil micoorganisms and consequently disrupt different biological process of the grown plants. So , many research trials amied to minimize such problem through out usage of bio – fertilizers plus mineral N – fertilizers to secure and compensate the plant N – requirements. El – Borolosy *et al.*, (1986) stated that inoculation of maize with Azospirillum or Azotobacter led to a considerable improvement in maize growth and grain yield. Furthermore, Yehia and El–Ghandour (1994) with wheat, illustrated that inoculation with either Rizobium or Azospirllum increased grain and straw yields. The authors also found an increase in N–uptake and grain protein content due to applying such biofertilizers .

Bio fertilizers are also contributed, significantly, in improving soil fertilitly through out nitrogen fixation. Rupple and Merbach (1997) found that the amount of biologically fixed N was enhanced due to inoculation the seeds of wheat by Azosprillum brasilence . Regarding the combination of N – fertilizers and biofertilizers, Saleh *et al.*, (2003) found that the highest maize grain yield was obtained with application of microbin +105 kgN/ fed. Moreover, Reynders and Vlassak (1982) reported that inoculation with Azospirillum or Cyanobacteria in combination with N – fertilizers increased the availability of N and other elements in wheat – cultivated soil .

The objectives of the present study are to determine to what extent the biofertilizers and / or N- fertilizers application affect yield of maize and wheat crops . The consequent effects on N-recovery % , N – use efficiency and soil fertility are considered .

MATERIALS AND METHODS

On achieving the objectives of the herein research work, two field experiments were carried out at Gemmeriza Agricultural Research Station. The first experiment was with maize (SC 15 hybrid) during 2003 season, and the second one was for wheat (Gemmeiza 7 var.) during 2003 – 2004 season . Sowing dates were 20th June and 21st Nov . , respectively , for maize and wheat .The soil of the experimental sites are clay in texture and some of its physcial and chemical characteristics are shown in Tables (1a and 1b) . In both experiments , the split plot design was used. The main plots were conducted for bio – fertilizer i.e. Azospirillum and Cyanobacteria, applied according to the recommendations . Nitogen fertilizer rates were considered as sub plots and including N – addition at the rates of zero, 40, 80 and 120 Kg N / fed . for maize, and 0 , 25 , 50 and 75 Kg N / fed . for the wheat . In the both seasons the treatments were replicated 4 times . The plot area was 3 × 3.5 m, i.e. (1 / 400 fed .) for the two crops under the study . Nitrogen fertilizer was applied in the form of ammonium nitrate (33.5 % N) in three equal portions before the first , second and third irrigation for the two crops . The basel doses of P and K – fertilizers were applied according to recommendations . Normal agricultural practices for growing maize and wheat crops in the region were followed .

At harvest , samples of grain and straw for the two crops were oven – dried , ground and wet digested . Nitrogen was determined using mico – Kjeldahel method according to Hesse (1971) . On determining soil fertility , surface soil samples were collected, to 40cm depth, form each sub-plot, at the end of each growing season, for the maize and wheat ,to determine available soil nitrogen using micro –Kjeldahel method according to A.O.A.C. (1984). Nitrogen Use Efficiency (NUE) was calculated according to Nova and Loomis (1981) . Nitrogen recovery% was calculated as follows .

$$\mathbf{N-recovery\ \% = \frac{N1 - NO \times 100}{N - added}} \quad \text{............ Where}$$

N1= Total N- uptake for the treatment , KgN / fed .
NO = Total N- uptake for the control , KgN / fed .

The statistical analysis of data was done according to the procedure out lined by Snedecor and Cochran (1967) .

Table (1a) : Some physical and chemical properties*of the experimental site before maize planting

Particale size distribution				Soluble cations , meq/100 g soil				Soluble anions, meq/100 g soil				EC Sdm^{-1}	AN ppm
Sand %	Silt %	Clay %	Texture	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	Co_3^{-2}	HCo_3^{-}	Cl^{-1}	So_4^{-2}		
60.9	15.1	18.8	Clay	0.25	0.13	0.62	0.02	—	0.43	0.31	0.28	1.88	30

Table (1b) : Some physical and chemical properties*of the experimental site before wheat planting

Particale size distribution				Soluble cations , meq/100 g soil				Soluble anions , meq/100 g soil				EC Sdm^{-1}	AN ppm
Sand %	Silt %	Clay %	Texture	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	Co_3^{-2}	HCo_3^{-}	Cl^{-1}	So_4^{-2}		
65.18	27.25	6.70	Clay	0.43	0.35	2.35	0.41	—	0.39	1.90	1.16	1.39	35

*** Determined as described by Hesse (1971) and USSLS (1954) .**

RESULTS AND DISCUSSION

Maize grain and stover and wheat grain and straw yields:

Data in Table(2) reveal that maize grain yield insignificantly increased under Azosprillium by 3.45 %, compared to Cyanobacteria. While the increase in stover yield reached the singificant level , since the stover yield with Azosprillium surppased that under Cyanobacteria by 14.95 %. The same trend was observed with wheat crop, since application of Azosprillium significantly influence grain and straw yields with increase percentages comprised 7.82and 9.16%, respectively, (Table 3) .

Data for maize grain and stover yields as affected by different N – rates, reveal highly significant effect ,on maize grain yield only, due to increasing N – rate (Table 2) . The increases % in maize grain yield are 10.25 , 25.05 and 41.81 as N – rate increased from zero to 40, 80,and 120 kg N/fed. The corresponding increase values in stover yield are 10.78 ,27.29 and 37.39 % , respectively.the increase % values in wheat grail rare 42.53, 59.55 and 73.18, while the increase % in straw yield comprised 18.10, 34.29 and 54.92 as N-rate increased from zero to 25.50 and 75 kg n/fed, respectively. Similar results were previously stated by El – Douby *et al.* (2001) with maize crop and Abo – Soliman *et al.*, (1988) with wheat one .

As for combination of bio and N – fertilizer rate , data reveal insignificant effects on maize and wheat either grain yield or stover yield . However , The highest values for grain and stover of maize are recorded under the combination of Azosprillium + 120 Kg N / fad , while the highest ones for wheat ae observed under Azosprillium + 75 Kg N / fed . In this connection , Saleh *et al.,* (2003) found that the highest maize grain yield was obtained due to application of microbin + 105 Kg N/fed .

Interaction data reveal insignificant differences among the figures concerning maize grain and stover yields and wheat grain and straw yields (Tables 2, 3).However, Bhattaria and Hess (1988) mentioned that inoculating with Azosprillium and Cyanobacteria increased the wheat yield under moderate N-fertilization .

Nitrogen concentration percentage:

Nitrogen content % for maize grain and stover under Azosprillium significantly surpassed those under Cyanobacteria with increase % values reached 12.58 and 28.26 % , respectively (Table 2). The same trends were observed with wheat grain and straw yields with corresponding increase % values comprised 9.87 and 67.57 % , respectively (Table 3) .

Data in Table (2) indicate highly significant effects on N-concentration % of maize grain and stover due to the tested N – rates . Increasing N-rate from zero to 40, 80 and 120 Kg N / fed resulted in an increase of N- content % of maize grain reached 7.09 , 20.57 and 29.08 , whereas the increase % in N- content % in stover were 35.29 , 67.65 and 123.53 , respectively . Data also demonstrate an increment increases in N – content % in both wheat grain and straw yields due to increasing N-rate from zero to 25 , 50 and 75 Kg N / fad . ,since the increase % comprised 8.57 , 17.86 and 29.29 in grain and 36.11 , 83.33 and 113.89 in straw , respectively.

Data in (Tables 2 and 3) reveal that the bio – fertilizers i.e, Azosprillium and Cyanobacteria insignificantly interacted with the adopted N-rates , to alter N-content % in maize grain and stover and wheat grain and straw , however , the highest maize grain and stover and wheat grain and straw yields were obtained under combination of Azosprillium + the highest N- rate i.e 120 Kg N/fed with maize and 75 Kg N / fed with wheat .

Nitrogen uptake:

Data in (Table 2) indicate that Azosprillum surpassed Cyanobacteria in increasing N- uptake by maize grain and stover yields, since the increase

% reached 15.88 and 41.08 , respectively. The same trend was observed with wheat grain and straw yields with increase % comprised 18.48 and (Table 3) .

Increasing N-rate was accompanied with increasing value of N-uptake for both maize grain and stover and wheat grain and straw yields . The increases % in N – uptake by maize grain yield are 18.15 ,50.90 and 81.70 and for stover yield are 49.90 ,115.12 and 208.07 under N-rates of 40, 80 and 120 Kg N / fed, comparable to without N- addition, respectively. Similar trend was obtained for N-uptake by wheat crop, since the increase % values were 54.40 ,88.42 and 124.49 for N- uptake by grain and 62.49, 148.71 and 234.67 for N- uptake by straw yield under N- rates of 25,50 and 75 Kg N/ fed , compared to without N- addition, respectively. Similar results were reported by Zamber *et al.*(1984) who found that application of N – fertilization up to 120 Kg N/ ha increased N- uptake and protein content in wheat grains. Moreover , Cherney and Duxbury (1994). stated that availability of inorganic N increased as N – fertilizer level increased .

Data in Tables (2 and 3) indicate that N – uptake by maize and wheat crops was not influenced due to the interaction of the bio fertilizers and N – rates under study . However , the highest N – uptake value for either maize or wheat crops was obtained under the combination of Azosprillium + the highest N- rate i.e 120 and 75 Kg N/fed with maize and wheat crops, respectively .

Bio-mass N–recovery % :

Data in Table (2) reveal that % N – recovered by total maize crop under bio-fertilizer Azosprillium was more by 24.52 % than that under Cyanobacteria one . The same trend was observed with wheat crop since , the corresponding value of % N – recovery reached 25.57 % , (Table 3) .

With respect to N-rate , data indicated that increasing N-rate resulted in increase % N-recovery values by maize crop since the values are 30.77,38.64 and 44.48% under 40, 80 and 120 Kg N/fed., respectively, (Table 2). Similar trend was observed by Abd – El – Razek *et al.* (1999) and Abdel – Maksoud *et al.* (2002), who found slight and gradual increase in % N-recovered by maize plants due to increasing N-rate. Nevertheless, with wheat crop, regular decreases in N-recovered % were obtained, since the values are 72.24, 72.22 and 71.60 % due to increasing N-rate to 25 , 50 and 75 Kg N / fed, respectively, (Table 3). However in this respect , El Awag *et al.* (1996) and Othman, Sanaa (1996) reported that N-recovery % by wheat crop tended to decrease as N-rate increased . The different behaviour in N-recovery % , for maize and wheat crops, may be attributed to different crop growth type and N-requirements besides different irrigation practice and prevailing climate conditions, which enhanced N-losses by volatilization and deep leaching as well . Data also reveal that the highest figures for biomass recovery %,either for maize or wheat crops, were obtained due to the combination of Azospirillum + the highest N-rates.

Nitrogen Use Efficiency (NUE):

In the present study , NUE means Kgs of maize or wheat grains produced due to applying the unit of nitrogen fertilizer . On this basis , the unit of nitrogen yielded more maize grains under Azosprillium than Cyanobacteria by 3.40 % , (Table 2) while the increase with wheat crop was 9.96% (Table 3) .

Regarding NUE values under the different N-rates , it seemed to be reduced as N-rate increased , since the values are 53.56 , 30.32 and 22.92 Kg grains / Kg N applied under 40 , 80 and 120 Kg N / fed rates . These findings were previously reported by Abd El – Razek *et al.*, (1999) and Abdel – Maksoud *et al.*, (2002) with maize crop . The same trend was observed with wheat crop , since NUE values are 89.25 , 50.03 and 36.15 Kg grains / Kg N added under the N-rates of 25 , 50 and 75 N / fed , respectively . Similar results were reported by El – Awag *et al.*, (1996) with wheat crop. The interaction data (Tables 2 and 3) revealed that , the biofertilizer Azosprillium was interacted with the lower N-rate .i.e 40 and 25 Kg N/ fed , for maize and wheat crops , respectively , to produce the highest NUE values .

Available soil nitrogen:

The values of available soil – N , at the season end , determined to great extent the soil fertility and the remainder soil N which can be used in N-fertilization management for the next crop . In this respect , bio – fertilizer Azosprillium proved to be more better than Cyanobacteria one , since the value of the available soil N- under the formar was more by 19.54 and 3.88 % after maize and wheat crops, respectively,than the second (Tables 2 and 3) .

Data also reveal that the available soil N was highly significant influenced by the tested N-rates for maize and wheat crops . The increase % after maize were 23.77 , 52.20 and 81.65 as N- rate increased to 40 , 80 and 120 Kg N/ fed ., compared to control . Abdel – Razek *et al.* (1999) and Abdel – Maksoud *et al.* (2002) found similar trend with maize crop . The corresponding increase % values after wheat crop , are 6.46 , 13.60 and 21.57 under 25 , 50 and 75 Kg N / fed . rates , comparable to without N-addition , respectively.

The same trend was previously observed by Othman , Sanaa (1996) who stated , after wheat crop , that available soil N-tended to increase as N-rate increased . Moreover , Holford and Doyle (1992) found that soil nitrate value , in different depth of soil profile , was increased due to N- fertilization .

Data in (Tables 2 and 3) show that the tested bio – fertilizers i.e Azosprillum and Cyanobacteria were highly significant interacted with the adopted N-rates to affect the available soil – N after maize crop , whereas under wheat crop the differences did not reach the significance level . In addition , the highest value for available soil – N after both maize and wheat crops was obtained due to combination of Azosprillium + the highest N – rate , either for maize or wheat crops .

On conclusion , because of the insignificant interaction effect between the tested bio–fertilizers and the adopted N–rates on most the tested parameters , it is economically recommended to use the moderate N-rate in combination with Azosprillium as bio-fertilizer in order to reduce both eviromental pollution and maize or wheat production costs under the soil conditions of Gemmeiza area .

Table (2) : Maize grain and stover yields , some N-yield relationships and soil fertility as affected by bio and N-fertilizers

	Yield		N-concentration%		N-uptake (Kg N / fed)		Biomass N-recovery %	NUE, KgN / Kg grain	AvailN. In soil (ppm)
	Grain Ardab/fed	Stover Ton/fed	Grain	Stover	Grain	Stover			
A –Main plots Bio–fertilizers									
Azosprillum	16.80	5.46	1.70	0.59	40.42	33.38	42.10	36.19	29.37
Cyanobacteria	16.24	4.75	1.51	0.46	34.88	23.66	33.81	35.00	24.57
F-test	N.S	*	**	**	—	—	—	—	*
B-sub plots N-level Kg/fed									
0	13.85	4.36	1.41	0.34	27.27	14.75	—		19.35
40	15.27	4.83	1.51	0.46	32.22	22.11	30.77	53.56	23.95
80	17.32	5.55	1.70	0.57	41.15	31.73	38.64	30.32	29.45
120	19.64	5.99	1.82	0.76	49.55	45.44	44.48	22.92	35.15
LS $D_{0.05}$	1.43	0.98	0.13	0.08	—	—	—	—	1.86
LS $D_{0.01}$	1.95	NS	0.18	0.11	—	—	—	—	2.55
Interaction (A× B)									
Azospirillum									
0	14.00	4.73	1.50	0.37	29.40	17.50	—	—	20.30
40	15.52	5.12	1 61	0.50	34.98	25.60	34.20	54.32	25.60
80	17.64	5.84	1.78	0.62	43.96	36.21	41.58	30.87	31.70
120	20.05	6.16	1.90	0.88	53.33	54.21	50.53	23.39	39.90
Cyanobacteria									
0	13.71	4.00	1.31	0.30	25.14	12.00	—	—	18.40
40	15.03	4.54	1.40	0.41	29.46	18.61	27.33	52.80	22.30
80	17.01	5.26	1.61	0.52	38.34	27.35	35.69	29.77	27.20
120	19.23	5.82	1.73	0.63	46.57	36.67	38.42	22.44	30.40
LS $D_{0.05}$	NS	NS	NS	NS	—	—	—	—	2.60
LS $D_{0.01}$	NS	NS	NS	NS	—	—	—	—	3.60

Table (3) : Wheat grain and straw yields , some N-yield relationships and soil fertility as affected by bio and N- fertilizers

	Yield		N-concentration%		N-uptake (Kg / fed)		Biomass N-recovery %	NUE, KgN / Kg grain	AvailN. In soil (ppm)
	Grain Ardab/fed	Straw Ton/fed	Grain	Stover	Grain	Stover			
A –Main plots									
Bio–fertilizers									
Azosprillum	15.58	4.17	1.67	0.62	39.68	26.70	81.52	61.25	40.95
Cyanobacteria	14.45	3.82	1.52	0.37	33.49	20.88	64.92	55.70	39.42
F-test	*	*	**	**	—	—	—	—	*
B-sub plots N-level, Kg/fed									
0	10.44	3.15	1.40	0.36	21.93	11.25			36.40
25	14.88	3.72	1.52	.049	33.86	18.28	75.84	89.25	38.75
50	16.68	4.23	1.65	0.66	41.32	27.98	72.22	50.03	41.35
75	18.08	4.88	1.81	0.77	49.23	37.65	71.60	36.15	44.25
LS $D_{0.05}$	0.60	0.41	0.14	0.06	—	—	—	—	1.57
LS $D_{0.01}$	0.83	0.56	0.20	0.09	—	—	—	—	2.15
Interaction (A× B)									
Azospirillum									
0	10.53	3.30	1.45	0.40	22.90	13.2	—	—	36.8
25	15.75	3.82	1.56	0.54	36.85	20.63	85.52	94.5	39.4
50	17.15	4.45	1.71	0.70	43.99	31.15	78.08	51.45	42.1
75	18.90	5.10	1.94	0.82	54.99	41.82	80.95	37.80	45.5
Cyanobactena									
0	10.35	3.00	1.35	0.31	20.96	9.30	—	—	36.0
25	14.00	3.62	1.47	0.44	30.87	15.93	66.16	84.00	38.1
50	16.20	4.00	1.59	0.62	38.64	24.80	66.36	48.60	40.6
75	17.25	4.65	1.68	0.72	43.47	33.48	62.25	34.50	43.0
LS $D_{0.05}$	NS	NS	NS	NS	—	—	—	—	NS

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تأثير إضافة الأسمدة الحيوية و/ أو الأسمدة المعدنية النتروجينية علـــي إنتاجيـــة الأذرة الشامية والقمح وخصوبة التربة .

إبـــراهيم محمــد النجـــار – ســناء عبــد المــنعم عثمـــان – عـــادل متـــري حنـــا و علي محمد مسعود شحاته
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أجري هذا البحث (في تجربة منشقة) علي محصول الأذرة الشامية (هجين فردي ١٥) والقمح (صنف جميزة ٧) بمحطة البحوث الزراعية بالجميزة خلال موسمي ٢٠٠٣ ، ٢٠٠٣ – ٢٠٠٤ علي التوالي وذلك لدراسة تأثير إضافة الأسمدة الحيوية و/ أو الأسمدة النتروجينيـــة علـــي الإنتاجية وخصوبة التربة وأهم النتائج المتحصل عليها هي كالآتي :–

- كان للسماد الحيوي Azospirillum التأثير الأفضل والمعنوي علي محصولى الحبوب والقش للأذرة الشامية والقمح مقارنة بالسماد الحيوي Caynobacteria كذلك تحسنت قيم النتروجين الممتص و % من الاستفادة من النتروجين المضاف وكفاءة استخدام النتـــروجين والنتـــروجين المتبقي الميسر مع إضافة الـــ Azospirillum مقارنة بالـــ Caynobacteria
- زيادة معدل التسميد الأزوتي أدت إلي زيادة معنوية في محصـــول الحبـــوب لـــلأذرة الشـــامية ومحصولي الحبوب والقش للقمح وكذلك محتواهما من النتروجين بالإضافة إلي زيادة النتروجين المتبقي والميسر في التربة بعد الحصاد .
- زادت قيم امتصاص النتروجين و% من الاستفادة من النتروجين بزيادة معدل التسميد الأزوتي ، وعلي العكس نقصت قيم كفاءة استخدام النتروجين لكل من محصولي الأذرة الشامية والقمح .
- أظهرت النتائج عدم معنوية قيم التفاعل لجميع الصفات تحت الدراسة فيما عدا قيم النتـــروجين الميسر والمتبقي بالتربة بعد حصاد الأذرة الشامية فقط .

ومن النتائج السابقة يمكن التزكية باستخدام المعدلات المتوسطة للتسميد الأزوتي مع إضافة السماد الحيوي Azospirillum وذلك لتقليل تلوث البيئة وتخفيض تكاليف إنتـــاج الأذرة الشـــامية والقمح وذلك بمنطقة الجميزة .