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RESPONSE OF COTTON TO BIOFERTILIZER INOCULATION AND FARMYARD MANURE UNDER DIFFERENT LEVELS OF INORGANIC NITROGEN

Metwally, S.G.
Soil , Water and Environment Res. Inst. ARC, Giza Egypt .

ABSTRACT

Two field experiments were conducted at El-Serw Agricultural Research Station, Damietta Governorate during the two seasons (2001and 2002) to investigate the influence of farmyard manure, mineral and bio nitrogen fertilizer and their interactions on cotton seed yield, its components and nutrients contents of cotton leaves. Split split plot design with four replicates was used. The most important results could be summarized as follows.

Adding $20m^3$/fed. of farmyard manure induced significant increases in boll weight, seed index, seed cotton yield, oil content, oil yield and lint yield. Also N,P and K contents of leaves were significantly increased in both seasons.

Raising mineral nitrogen fertilizer level from 45 to 60 and 75 kg N/fed . resulted significant increases in boll weight, seed index, seed cotton yield, oil content, oil yield and lint yield . Also N,P and K contents of cotton leaves in both seasons.

Inoculation of seed cotton with biofertilizer Nitrobien resulted significant increases in boll weight, seed index, seed cotton yield, oil contents, lint yield and N,P and K contents of cotton leaves compared with uninoculation treatments in both seasons.

The interaction between farmyard manure and nitrogen fertilizer showed that , the highest seed cotton yield was obtained with adding $20m^3$/fed farmyard manure and 75 kg N/fed in both seasons. The interaction between mineral nitrogen and bio fertilization had significant effect on boll weight, seed index, seed cotton yield, seed yield, and oil yield in both seasons.

Although the maximum seed cotton yield and its components were recorded with using 75 kg N/fed. and adding $20m^3$ farmyard manure or using nitrogen biofertilization. However, using rate of 60 kg N/fed. with application of $20m^3$/fed. farmyard manure or inoculation with biofertilization were most compatible, since it has the highest seed cotton yield over control.

Finally, it could be recommended that, using $20m^3$ farmyard manure or inoculation seed cotton by nitrogen biofertilization under using 80% of N recommended dose of mineral nitrogen fertilizer (i.e 60 kg N/fed). achieve the maximum cotton yield as well as reducing mineral fertilization and soil pollution under the conditions of the current study.

INTRODUCTION

Cotton (*Gosypium barbadensel* L.) consider one of the most important agricultural crops in Egypt, it is an economically cash crop in Egypt. We should recognize all the factors that effect cotton yield in order to maximize the yield per unit area. This could be achieved by applying recommended cultural practices such as using farmyard manure, biofertilizer and chemical fertilizers.

Nitrogen is considered as one of limiting factors to achieve the yield of cotton crop. Nitrogen was found to increase seed cotton yield, boll weight, lint percentage oil percentage and (N,P and K) contents in cotton leaves

(Abido *et al.*, 2000, El-Akabawy *et al.*, 2000, Abd El-Magid, 2002 and Sabik *et al.*, 2002).

Chemical nitrogen fertilizer is not only so expensive but also so hazard to agroecosystem . Thus, there is a global need for reducing the dependence on chemical fertilizers of agricultural production. In this respect, considerable saving in nitrogen fertilizer can be made by using farmyard manure, which can supply both macro and micronutrients in quantities nearly as much as in chemical fertilizer in addition to its good effect on soil conditions. Some investigators i.e. Pimpini *et al.* (1992) and Abido *et al.* (2000), reported that organic manure is an important and save source of plant nutrients for both increasing crops production and decreasing environmental hazards caused by intensive mineral fertilization .

Nowdays, on the way of clear agriculture with minimum pollution effects and saving in chemical nitrogen requirements can be gained by using biofertilization by certain free living N2 – fixing bacteria such as Nitrobien . The use of biofertilizer was recommended by several investigators to substitute the chemical fertilizers (Abd El-Magid, 2002) .

Therefore, the aim of the present investigation was to study the ability of farmyard manure and biofertilizer alone or in combination with chemical nitrogen fertilizer application for covering the nitrogen requirements of cotton yield production and saving the environment against pollution by extra chemical fertilizer application.

MATERIALS AND METHODES

Two field experiments were performed at El-Serw Agricultural Research Station , Damietta Governorate during the two successive seasons 2001and 2002 using cotton variety Giza 86 . Cotton seeds of Giza 86 cultivar were sown on March 19th and 30th in 2001 and 2002 seasons respectively .
The investigation was amid to study

1- The effect of microbial inoculation , using free living N – fixing bacteria and farmyard manure on yield and yield components as will as N,P and K contents in cotton leaves at peak of flowering
2- The optimum level of mineral nitrogen fertilizer to obtain the maximum seed cotton yield under the influence of microbial inoculation and farmyard manure .

Soil samples were taken from surface layer (0-30 cm depth) and analyzed for physical – chemical properties (Table 1) as described by page (1982) .

Table (1): Some physical and chemical properties of the experimental soil in 2001 and 2002 seasons .

Soil properties	1st season	2nd season
Soil texture	Clayey	Clayey
Soil pH (1:2.5) soil - water susp.	8.2	8.1
EC (soil paste at 25 C°) dS/m.	3.6	3.2
O.M %	0.9	0.8
$CaCo_3$ %	1.5	1.3
Available – N ppm	28	34
Available – P ppm	9.8	10.40

The experimental design was split split plot with four replicates, the plot area was 10.5m^2, which contained five rows, 3.5 meters long and 60 cm apart. The main plot were occupied by farmyard manure treatments (0 and 20 m^3/fed), while the sub plot were assigned to nitrogen levels (45, 60 and 75 kg N/fed) and the sub – sub plots were arranged to biofertilizer treatments . Farmyard manure was applied at 15 days before ploughing . The chemical analyses of farmyard manure is given in Table 2.

Table (2): Chemical analysis of farmyard manure (FYM) in 2001 and 2002 seasons .

Analysis	2001 season	2002 season
OM %	9.60	10.40
Total N %	0.41	0.46
Total P_2O_5%	0.32	0.36
Total K_2O %	1.31	1.40

Phosphorus fertilizer was applied to all experimental plots in one dose preplanting in the form of monocalcium superphosphate (15 % P_2O_5) at the rate of 15 kg P_2O_5/fed.

Seed inoculation was carried out using Nitrobien obtained from General Organization Equalization fund, Ministry of Agriculture Egypt. Inoculation was performed by coating the calculated weight of cotton seeds with the certain biofertilizer, then the coated seeds air dried and sown immediately. Nitrogen fertilizer in the form of ammonium nitrate (33% N) was applied in two equal doses, one dose being applied after thinning while the remaining dose was applied before the second irrigation. The other agronomic practices of cotton cultivation were done as recommended.

A sample of the youngest fourth fully matured leaf on the main stem were taken of full flowering to determine nutrients concentration (N.P.K) as described by Jackson (1973). Boll weight, seed index, lint percentage, oil percentage and seed cotton yield were determined.

All obtained data were subjected to statistical analysis according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Seed cotton yield and its components

A – Effect of farmyard manure (FYM)

Data in Tables 3 and 4 show clearly that boll weight, seed index, lint yield, seed yield, oil yield and seed cotton yield were significantly increased with application of farmyard manure in both seasons. Applying 20 m^3/fed. farmyard manure increased the seed cotton yields/fed. by 11.59% and 10.72 % compared with the control treatments in 2001 and 2002 seasons respectively. The beneficial effect of farmyard manure to seed cotton yield could be attributed to available NPK in the soil over initial as will as increasing activity of a symbiotic nitrogen fixation as a result of increasing the available carbon and energy source. Also application of farmyard manure influence the physical and chemical properties of soil and subsequently increased fertility , available water and productivity of the soil. Such results are in accordance

with those obtained by Bassal and Zahran (2002), Abido *et al.*, (2002) and Keshta, and El-Kholy (1999).

Table (3): Boll weight (gm) seed index (gm), seed cotton yield (kg/fed) and seed yield (kg/fed) as affected by farmyard manure (FYM) and nitrogen fertilizer (bio and mineral) in the two seasons

Treatments	Boll weight		Seed index		Seed cotton yield		Seed yield	
A-FYM (m^3/fed)	2001	2002	2001	2002	2001	2002	2001	2002
Control	2.95	3.09	10.50	10.60	1151.40	1119.3	715.3	691.6
20m^3/fed	3.18	3.35	11.20	11.40	1281.40	1239.2	793.2	819.0
LSD at 5%	0.02	0.01	0.17	0.04	6.43	2.39	11.77	12.58
B-N-rate (kg/fed)								
45	2.87	3.02	10.20	10.40	1078.8	1155.7	674.8	717.1
60	3.19	3.32	11.10	11.33	1223.3	1321.4	757.1	813.3
75	3.14	3.31	11.20	11.32	1287.1	1355.7	795.2	844.8
LSD at 5%	0.01	0.01	0.01	0.02	7.97	3.02	9.05	3.7
C-Inoculation								
Control	2.99	3.14	10.50	10.70	1143.8	1226.4	711.20	757.10
Nitrobien	3.13	3.29	11.20	11.30	1249.1	1324.15	773.5	815.60
LSD at 5%	0.04	0.04	0.08	0.1	15.45	18.97	10.80	12.01
A×B	xx	xx	xx	xx	xx	xx	xx	xx
A×C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B×C	xx	xx	xx	xx	xx	xx	xx	xx
A×B×C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N.S.= Not significant X = Significant XX = High significant

Table (4): Oil percentage, oil yield (kg/fed.), lint percentage and lint yield (kg/fed) as affected by farmyard manure (FYM)_ and nitrogen fertilizer (bio and mineral) in the two seasons.

Treatments	Oil percentage		oil yield		Lint percentage		Lint yield	
A-FYM(m^3/fed)								
Control	18.19	18.21	130.10	125.9	37.7	38.2	436.2	427.4
20m^3/fed	18.18	18.15	143.9	148.6	38.1	38.5	488.2	473.5
LSD at 5%	0.01	0.04	0.68	0.87	0.01	0.01	706.1	1.7
B-N-rate(kg/fed)								
45	18.27	18.28	123.3	131.1	37.4	37.9	404.0	438.2
60	18.17	18.17	137.5	147.9	38.1	38.4	466.3	508.1
75	18.08	18.07	143.5	152.1	38.2	38.6	493.5	532.3
LSD at 5%	0.01	0.02	1.53	0.65	0.12	0.05	3.39	2.06
C-Inoculation								
Control	18.19	18.19	129.1	137.6	37.80	38.2	433.6	469.0
Nitrobien	18.16	18.17	140.40	148.11	37.90	38.4	475.5	508.5
LSD at 5%	N.S.	N.S.	1.58	2.17	0.16	0.20	5.99	7.95
A×B	xx	xx	N.S.	xx	N.S.	N.S.	N.S.	xx
A×C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B×C	N.S.	N.S.	xx	xx	N.S.	N.S.	xx	xx
A×B×C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

B- Effect of nitrogen fertilizers levels

Data presented in Tables 3 and 4 reveal significant increases in boll weight, seed index, lint yield, seed yield, oil yield and seed cotton yield with increasing nitrogen fertilizer rate up to 75 kg/fed. In both seasons, when compared with addition of 45 or 60 k g/fed. The increases in seed cotton yield might be due to nitrogen as one of the most important components of

cytoplasm, nucleic acids and chlorophylls , therefore increasing nitrogen levels increased multiplication of cells , which enhance amount of metabolites necessary for building plant organs and ended in seed cotton yield. These results are in accordance with those obtained by Ali and El-Sayed (2001), El-Sayed and El-Manshawi (2001) and Abd El-Hadi *et al.* (1997).

C- Seed inoculation effect

The same data listed in Tables 3 and 4 show that, seed cotton yield was significantly increased which inoculation as compared with uninoculation treatment. The average seed cotton yield was increased with seed inoculation by 9.2 % and 7.9 % respectively over control treatment. These results may be attributed to nitrogen fixation by non–symbiotic bacteria presents in the biofertilizer Nitrobien, which produce growth regulators substances such as indol acetic acid, gibberellins and others which stimulate plant growth and subsequently affected seed cotton yield and its attributes . These results are in agreement with those obtained by Keshta and El-Kholy (1999) and Abd El-Magid, (2002). The results of boll weight, seed index, lint yield, seed yield and oil yield (Table 3 and 4) show the same trend of seed cotton yield .

N,P and K concentration

A- Farmyard manure effect

Data in Table 5 indicated that applying 20m^3/fed. farmyard manure significantly increased N,P and K concentration in leaves in both seasons. These increases of N,P and K concentration due to Farmyard manure may be attributed to that farmyard manure improves soils structure and leads to increases in the availability of nutrients concentration. These findings had been supported by Abido *et al.* (2000).

Table (5): N,P and K concentration in cotton leaves at peak of flowering as affected by farmyard manure (FYM) and nitrogen fertilizer (bio and mineral) in two seasons.

Treatments	N %		P %		K %	
A-FYM(m^3/fed)	2001	2002	2001	2002	2001	2002
Control	2.59	2.62	0.331	0.326	3.08	3.04
20m^3/fed	2.73	2.77	0.349	0.345	3.22	3.19
LSD at 5%	0.03	0.03	0.001	0.002	0.03	0.02
B-N-rate(kg/fed)						
45	2.52	2.57	0.326	0.321	3.03	3.01
60	2.67	2.72	0.340	0.335	3.16	3.12
75	2.79	2.80	0 354	0.350	3.26	3.21
LSD at 5%	0.004	0.005	0.002	0.001	0.02	0.02
C-Inoculation						
Control	2.63	2.67	0.335	0.331	3.12	3.08
Nitrobien	2 69	2.73	0.345	0.340	3.18	3.15
LSD at 5%	0.03	0.03	0.002	0.002	0.03	0.03
A×B	xx	xx	xx	xx	xx	xx
A×B	N.S	N.S	N.S	N.S	N.S	N.S
B×C	N.S	N.S	N.S	N S	N.S	N.S
A×B×C	N.S	N.S	xx	xx	N.S	N.S

B- Nitrogen fertilizers levels effect

Data in Table 5 indicat that there were a significant increases N,P and K concentration in leaves with increasing of nitrogen up to 75 kg N/ fed., this might be attributed to the role of nitrogen nutrient in increasing the root surface per unite of soil volume and subsequently increases the nutrients intake the roots. These results are in agreement with those obtained by Abd El-Magid, (2002).

C- Seed inoculation effect

Concerning the seed inoculation influence on nutrients concentration in leaves, data in Table 5 indicat that seed inoculation with Nitrobien significantly increased all values of N,P and K concentrations in leaves of cotton. This positive effect of inoculation upon nutrients concentration could be attributed to high efficiency of bacteria presence in biofertilizer **N**itrobien to fix atmospheric N as well as produce some biological active substances, which help in increasing the root biomass and thus indirectly help in increasing nutrients absorption by roots from surrounding environment. Such results are in accordance with those obtained by Abd El-Magid (2002).

Interaction effect

Concerning the interaction between farmyard manure and nitrogen fertilizer rate data in Tables 6 and 7 reveal, significant effects on seed yield , lint yield, boll weight, seed index, oil content and NPK contents of leaves on both seasons, while seed yield and oil yield had significant effect in the 2nd season. Maximum seed cotton yield was obtained with application 20m^3 / fed. farmyard manure and 75 kg N/fed. In addition, it could be noticed that , treat cotton plants with nitrogen fertilizer at the rate of 60 kg N/fed. and 20m^3 farmyard manure gave results generally similar to/or more than applying 75 kg N /fed. without 20 m^3 Farmyard manure. In addition Farmyard manure considered a source of nutrients for few next years.

Table (6):N,P and K concentration in cotton leaves at peak of flowering as affected by interaction between farmyard manure (FYM) and nitrogen fertilizer rates in the two seasons.

Treatments		Characters					
		N%		P%		K%	
FYM(m^3/fed).	N rates kg/fed	2001	2002	2001	2002	2001	2002
Control	45	2.45	2.49	0.316	0.309	2.89	2.94
	60	2.61	2.64	0.329	0.325	3.06	3.09
	75	2.71	2.74	0.348	0.343	3.18	3.22
20 m^3 / fed.	45	2.60	2.65	0.335	0.333	3.14	3.13
	60	2.27	2.80	0.351	0.344	3.18	3.23
	75	2.84	2.86	0.361	0.358	3.24	3.29
F. Test		xx	xx	xx	xx	xx	xx
LSD(5%)		0.05	0.06	0.004	0.004	0.05	0.04

Concerning the interaction among inoculation and nitrogen fertilizer rates, data in Table 8 demonstrat that, adding 60 kg N/fed. under the treatment of inoculation with **N**itrobein gave results generally more than those of the treatment of application of 75 kg **N**/fed. without inoculation.

Table (7): Boll weight (gm), seed index (gm), seed cotton yield (kg/fed.), lint yield (kg/fed.), seed yield (kg/fed.), oil yield (kg/fed.) and oil percentage as affected by the interaction between farmyard manure (FYM) and nitrogen fertilizer rate during the two seasons.

Treatments		Characters													
		Boll weight		Seed index		Seed cotton yield		Lint yield		Seed yield		Oil yield		Oil percentage	
FYM (m^3/fed)	N rate Kg/ fed.	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	45	2.74	2.87	9.70	9.90	1025.2	1098.8	381.1	414.4	00	683.6	00	125.3	18.30	18.33
Control	60	3.05	3.21	10.80	10.90	1178.0	1279.2	448.7	490.2	00	789.0	00	143.8	18.20	18.23
	75	3.05	3.19	11.09	11.10	1251.2	1339.7	478.8	515.8	00	820.9	00	148.3	18.08	18.07
	45	3.00	3.17	10.60	10.80	1132.5	1212.5	427.0	461.9	00	750.7	00	148.4	18.24	18.23
20 m^3/ fed.	60	3.33	3.45	11.43	11.70	1268.1	1363.7	483.9	526.0	00	837.7	00	151.9	18.19	18.14
	75	3.32	3.43	11.39	11.60	1323.0	1417.7	508.1	548.9	00	868.7	00	157.0	18.09	18.07
F. Test		xx	xx	xx	xx	xx	xx	xx	xx		xx		xx	xx	xx
LSD(5%)		0.07	0.07	0.14	0.13	26.77	32.86	10.37	13.77	N.S	20.79	N.S	3.75	0.08	0.07

Table (8): Boll weight (gm), seed index (gm) , seed cotton yield (kg/fed.), seed yield (kg/fed.), lint yield (kg/fed.) and oil yield (kg/fed.) as affected by the interaction between nitrogen fertilizer rate and boifertilizer in two seasons .

Treatments		Characters											
		Boll weight		Seed index		Seed cotton yield		Seed yield		Lint yield		Oil yield	
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
N 45	B_0	2.76	2.90	9.70	9.90	1015	1084	636	674	00	410	116	123
	B_1	2.98	3.13	10.60	10.80	1142	1267	714	760	00	466	130	139
N 60	B_0	3.10	3.25	10.80	11.00	1158	1250	719	771	00	479	131	141
	B_1	3.27	3.41	11.50	11.70	1288	1393	794	885	00	532	144	155
N 75	B_0	3.12	3.27	11.00	11.20	1257	1344	778	826	00	517	140	149
	B_1	3.15	3.34	11.40	11.50	1316	1413	812	863	00	547	146	156
F. Test		xx	xx	xx	xx	xx	xx	xx	xx	N.S	xx	xx	xx
LSD(5%)		0.07	0.07	0.10	0.13	26.77	32.86	18.71	20.19		13.77	3.2	3.75

B_0 = Without inoculation B_1 =Inoculation with Nitrobien

There fore , it seems from this treatment that saving 15 kg N / fed. by using biofertilizer technique could be minimizes production costs and environmental pollution.

Finally, these clearly confirmed that the farmyard manure and the biofertilizer treatments could be used under the Egyptian conditions as effective tool compensate the quantities of used the chemical fertilizers and consequently reduce the consumption of these fertilizers which turn minimizing agricultural costs as will as Egyptian environmental pollution.

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استجابة القطن للتسميد الحيوي والعضوي تحت مستويات مختلفة من التسميد النتروجيني المعدني

سمير غريب متولي
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – جيزة – مصر

أقيمت تجربتان حقليتان في محطة البحوث الزراعية بالسرو – محافظة دمياط خلال موسمين متتاليين ٢٠٠١ ، ٢٠٠٢ لدراسة تأثير مستويات مختلفة من التسميد النتروجيني المعدني وكذلك التسميد الحيوي والعضوي وكذلك التفاعل بينهما على إنتاج محصول القطن ومكوناته ٠ استخدم تصميم القطع المنشقة مرتين في أربع مكررات٠
كانت النتائج المتحصل عليها كالتالي :

١- أدت إضافة السماد العضوي بمعدل ٢٠ م^{٣} / فدان إلى زيادة معنوية في وزن اللوزة – وزن المائة بذرة – محصول القطن الزهر – نسبة الزيت – محصول الزيت – نسبة تصافي الحليج و محصول الحليج – وكذلك زيادة تركيز عناصر النتروجين والفوسفور والبوتاسيوم في الأوراق٠
٢- أدت زيادة التسميد الأزوتي من ٤٥ إلى ٦٠ و ٧٥ كجم / فدان إلى زيادة معنوية في وزن اللوزة – وزن المائة بذرة – محصول القطن الزهر – نسبة الزيت ومحصول الزيت – نسبة تصافي الحليج ومحصول الحليج وكذلك تركيز النتروجين والفوسفور والبوتاسيوم في الأوراق٠
٣- أدى التلقيح بالمخصب الحيوي (النتروبين) إلى الحصول على أعلى القيم بينما أعطت معاملة الكنترول (بدون تلقيح) أقل القيم في كل الصفات المدروسة ٠
٤- كان التفاعل بين معدلات التسميد النتروجيني المعدني ومعاملات التسميد العضوي معنويا على الإنتاج والصفات المدروسة وكذلك تركيز عناصر النتروجين والفوسفور والبوتاسيوم في أوراق النبات في مرحلة التزهير٠
٥- كان التفاعل بين معدلات التسميد النتروجيني المعدني ومعاملات التسميد الحيوي معنويا على وزن اللوزة – وزن المائة بذرة – محصول القطن الزهر – محصول البذور والزيت ٠
٦- رغم أن استخدام التسميد النتروجيني بمعدل ٧٥ كجم نتروجين / فدان مع التسميد العضوي أو التسميد الحيوي أعطى أعلى القيم في إنتاج محصول القطن الزهر نجد أن استخدام ٦٠ كجم نتروجين / فدان مع التسميد العضوي أو الحيوي يحقق أعلى عائد مما يؤدي إلى توفير حوالي ١٥ كجم نتروجين / فدان.

- لذلك يوصى باستخدام ٦٠ كجم نتروجين / فدان مع استخدام التسميد العضوي أو الحيوي وهذا يؤدي إلى تقليل تكاليف الإنتاج وكذلك تقليل التلوث البيئي تحت ظروف الدراسة الحالية٠