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INTEGRATED EFFECT OF BIO-ORGANIC AND/OR NITROGEN FERTILIZER ON GROWTH AND YIELD OF MAIZE (*Zea maize* L.)

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ABSTRACT

A field experiment was carried out in 2013 and 2014 seasons at Etay El-Baroud Agricultural Research Station, to investigate the effect of biofertilizer (cerealin), organic fertilizer (cattle manure) at 20, 15, 10 and 5 m^3/faddan and mineral nitrogen fertilizer at 100 (control), 75 and 50% of the recommended dose on growth, Net Assimilation Rate (NAR), Crop Growth Rate (CGR), chlorophyll content in leaves, yield components and chemical constituent (total carbohydrates, oil and protein content) of maize grains. Significant differences were detected among different treatments where, addition of organic manure in combination with 50 or 75% mineral nitrogen increased most growth parameters (stalk dry weight, leaf area, leaf area index and specific leaf weight), yield attributes (ear length, grain weight/ ear and grain yield/ faddan and chlorophyll content (a+ b in first season) compared with 100% mineral nitrogen (control). Also, total carbohydrates, oil and protein content in grains, significantly increased in the treatments included 75% mineral nitrogen plus 5 m^3 cattle manure/faddan. Crop growth rate (CGR) significantly affected by different treatments at growth stage 45-60 days in the second season. Generally, inoculation of biofertilizer (cerealin) combined with 75% mineral nitrogen increased, equal or decrease slightly the growth and yield components of maize compared with 100% mineral nitrogen (control). So, it seems that growth, yield and grain quality could be greatly improved through fertilizing maize plants with biofertilizer or organic manure combined with 50 or 75% of the recommended mineral nitrogen.

Key words: Maize, biofertilizer, organic manure, nitrogen, growth, NAR, CGR, yield, chemical constitutes.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in Egypt and it ranks the third important cereal crop after wheat and rice. Maize production decreased due to various reasons but the most important reason is low fertility of the soil (Hussain *et al*., 2007).For optimum plant growth, nutrients must be available in sufficient and balanced quantities (Chen, 2006).

Chemical nitrogen fertilizers are used worldwide to sustain and increase the crop yield. Nitrogen is required in large quantities for plants to grow, since it is the basic constituent of proteins, and nucleic acids. Farmers use chemical fertilizers to increase production to meet their needs, but the excessive use of fertilizers leads to contamination of soil, groundwater and reduce soil fertility (Baral and Adhikari, 2013). Also, its continuous use is causing hazards for human health and microbial population problem in the soil (Nain *et al*., 2009) besides being quite expensive and making the cost of production high.

Saikia and Jain (2007) found that 25% of the applied nitrogen fertilizer is lost from the soil through leaching, volatilization and denitrification. Current trends in agriculture are focused on the reduction of the use of inorganic fertilizers, forcing the search for alternative ways to improve crop yield in sustainable agriculture (Smit *et al*., 2001).

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Usage of organic manure and biofertilizers are the suitable, safe and environment friend alternative to use of chemical fertilizers.

The use of animal waste in maintaining soil organic matter is a popular practice in all over the world. It is not only a safe and effective way of recovery for lost plant nutrients like nitrogen and phosphorous, but also improves the physical and chemical attributes of the soil (Azeez *et al*., 2010). Organic fertilizers in comparison with the chemical fertilizers, have lower nutrient content and are slow release but they are as effective as chemical fertilizers over longer periods of use (Naguib, 2011).

Biofertilizers are products containing living cells of different types of microorganisms which when, applied to seed, plant surface or soil, colonize the rhizosphere or the interior of the plant and promotes growth by converting nutritionally important elements (nitrogen, phosphorus) from unavailable to available form through biological process such as nitrogen fixation and solubilization of rock phosphate (Rokhzadi *et al*., 2008). Also, use of biofertilizers on Egyptian soils has decreased the pH, which had led to increase availability of trace elements that enhance plant growth (Abd El-Lattief, 2013). The applications of biofertilizers in agriculture are suggested as a sustainable way of increasing crop yields and economize their production as well (Wali Asal, 2010). Bio-fertilization is very safe for human, animal and environment to get lower pollution and saving fertilization cost. In addition, their application in soil improves soil biota and minimizes the sole use of chemical fertilizers (Sabashini *et al*., 2007). Moreover, it has been reported that biofertilizers not only provides nitrogen, but also produce indole acetic acid, gibberellins, cytokinine and vitamins B (Mohamed and Medani, 2005).

Tolessa and Friesen (2001) reported that the inclusion of organic sources of nutrients in the fertilization program, besides nutrient supply, improves the nutrient use efficiency of the added synthetic fertilizers by reducing their loss and enhancing their availability to the associated crop.

Kumar and Puri (2001) and Chan *et al*. (2007) also verified the results of Tolessa and Friesen (2001) by reporting increased crop production through application of organic manure at different rates along with different rates of inorganic fertilizers. This showed that the role of organic sources of nutrient application is well established in enhancing soil fertility and crop productivity. Also, the mixture of biofertilizers with organic matter showed effectiveness in biological nitrogen fixation (Lima *et al*., 2010). This process may be important to increment soil fertility and crop yield.

Inoculation of seeds with biofertilizers in the presence of chemical fertilizers resulted in improving both growth and yield. Many workers recorded that inoculation of maize plants with biofertilizer showed an appreciable increase in plant growth (Gomaa, 2008).

Cerealin is a commercial biofertilizer (a nitrogenous biofertilizer containing nitrogen fixing bacteria) which contains Azotobacter and Azospirilium bacteria (produced by Ministry of Agriculture, Egypt).

Cocking (2003) indicated that nitrogen-fixing bacteria is able to enter into roots from the rhizosphere, particular at the base of emerging lateral roots. Nitrogen fixing bacteria (NFB) that function transform inert atmospheric N_2 to organic compound (Bakulin *et al*., 2007).

Many attempts have been tried to replace a part of those harmful chemical fertilizers by biofertilizers in maize to get yield of a good quality without loss in its quantity (El-Kholy *et al*., 2005). Inoculation of plants with biofertilizers could result significant changes in various growth parameters, such as crop biomass, nutrient uptake, plant height, leaf area and root length of cereals (Cakmake *et al*., 2006).

The objective of this study was to determine the growth, yield attributes and chemical constituents of maize plant as influenced by the application of bio, organic and mineral nitrogen fertilizers to minimize inorganic fertilizer usage.

MATERIALS AND METHODES

A field experiment was carried out at Etay El-Baroud Agric. Res. Station during two successive summer seasons 2013 and 2014, to

study the effect of bio, organic and mineral fertilizers on some growth parameters, (NAR), (CGR), photosynthetic pigments content, yield and its attributes as well as crude protein, total carbohydrates and oil content of maize grains.

The experiment was laid out in a randomized complete block design with four replicates in both seasons. Plot area was 16.8 m^2 (5.6 x 3m) included 8 rows, 70 cm apart, 3 m long.

Maize was sown in hills, spaced 30 cm and plants were thinned to one per hill. Grains of maize (yellow single hybrid 173) were sown on 15 and 18 of June in the two growing seasons, respectively.

Treatments of fertilization regimes were as follow:

1. 100% chemical nitrogen fertilizer (CNF) (120 Kg nitrogen/fad.) as control treatment.
2. 20 m^3/fad., organic fertilizer (OF)
3. 75% CNF (90 Kg nitrogen/fad.)+ biofertilizer (BF)
4. 15 m^3/ fad., OF+ BF
5. 75% CNF (90 Kg nitrogen/ fad.)+ 5 m^3/ fad., (OF)
6. 50% CNF (60 Kg nitrogen/ fad.)+ BF
7. 10 m^3/ fad. OF+ BF
8. 50% CNF (60 Kg nitrogen/ fad.) + 10 m^3/fad. OF

CNF (Chemical Nitrogen fertilizer), in the form of ammonium nitrate (33.5%N) was added in two equal doses before the first and second irrigation. OF (Organic fertilizer), in the form of cattle manure was applied to the soil. BF (Biofertilizer cerealin), maize grains were inoculated with biofertilizer cerealin before planting.

Pre-sowing, 100 kg/faddan of calcium super phosphate (15.5%P_20_5) were applied to the soil. Potassium fertilizer at the rate of 50 Kg/ faddan as potassium sulphate (48% K_20) was added before the first irrigation. All other cultural practices were carried out as recommended.

Harvest was done on October 20 and 23 in the first and second seasons, respectively.

Physical and chemical properties of the experimental soil are presented in Table 1. Chemical analysis of cattle manure used during the experiment are presented in Table 2.

Growth Parameters

Five plants were randomly taken at 45, 60 and 75 days after planting to determine stalk dry weight, leaf area according to (Bremner and Taha, 1966), leaf area index (LAI) (Watson, 1952), specific leaf weight (SLW) by (Pearce *et al*., 1969), crop growth rate (CGR) BY (Abd El-Gawad *et al*., 1980) and net assimilation rate (NAR) as given by (Watson, 1958).

Yield and its Attributes

At harvest five plants from each plot were taken randomly to determine plant height, ear length, ear diameter, row number/ear, grain number/row, grain weight/ear, 100-grain weight and harvest index.

At harvest, plants were harvested and adjusted to 15.5% moisture to estimate grain yield/ faddan (ardab) from the whole plot area.

Chlorophyll Content

Chlorophyll a and b were calorimetrically determined in fresh leaves of plants at 60 days old according to the method described by Moran and Porath (1980) and calculated as mg/g fresh weight.

Chemical Analyses of Grains

At harvest, grains were collected to determine percentage of:

Total carbohydrates

Total carbohydrates were determined in the dried grains using phenol sulphuric method (Dubois *et al*., 1956).

Oil content

Maize grains were taken from each treatment for determination of oil content by Soxhlet apparatus according to (AOAC, 1990).

Protein content

Protein content was calculated by multiplying nitrogen content by 6.25 (AOAC, 1988).

Table 1. Physical and chemical properties of the experimental soil

Soil properties	Clay (%)	Silt (%)	Sand (%)	Soil texture	pH	Organic matter (%)	Available N ppm	Available P ppm	Available K ppm
Values	55.10	33.81	11.09	Clay	8.20	1.79	51	32	325

Table 2. Chemical analysis of cattle manure used in the experiment

pH	8.2
EC ds/ m	13.81
Organic matter	22.32
Total N (%)	1.1
Total P (%)	0.89
Total K (%)	1.08
Fe ppm	851
Zn ppm	97
Mn ppm	155
Cu ppm	88
C/N ratio	18.55

Statistical Analysis

Data were statistically analysed according to Snedecor and Cochran (1980) and the values of the least significant differences (LSD at 5% level) was calculated to compare the means of different treatments.

RESULTS AND DISCUSSION

Growth Characters

Stalk dry weight, leaf area, leaf area index and specific leaf weight

Results presented in Table 3 show that there were significant effects due to different fertilization treatments on all studied growth characters (stalk dry weight, leaf area/ plant, leaf area index and specific leaf weight) at 45, 60 and 75 days after sowing (DAS) in both seasons. Stalk dry weight increased with increasing plant age up to 75 days. Fertilizing maize plants with 100% mineral nitrogen (control) increased stalk dry weight compared with the other treatments only at 45 and 60 days after sowing in the second season. These results are in agreement with those obtained by Abo- Baker and Mostafa (2011) who reported that chemical fertilizers promote plant growth through the role of nitrogen in protein synthesis and increasing the meristmatic activity.

The maximum stalk dry weight was obtained in treatment receiving 50% of recommended mineral nitrogen fertilizer combined with organic fertilization at 10 m^3/ faddan at 45 and 60 days after sowing (161.18 and 282.09) in the first season and at 75 days (461.09) in the second season. Addition of organic fertilizers with the chemical fertilizer improved physical and chemical properties of the soil and consequently affects the growth and development of plant roots and shoots (El-Ashry *et al*., 2008).

Table 3. Effect of bio, organic and nitrogen fertilizer on growth parameters of maize during two seasons

Treatment	Stalk dry weight (g)			Leaf area (cm^2)			Leaf area index			Specific leaf weight (g)		
	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS
	First season (2013)											
100% NF (control)	156.11	272.0	482.0	6598	11443	11862	3.14	5.45	5.65	5.60	8.36	9.18
20 m^3/fad., OF	144.15	214.0	405.0	5300	10164	10305	2.52	4.84	4.91	5.00	7.89	8.78
75% NF+ BF	146.60	253.0	415.0	5759	10394	11104	2.74	4.95	5.29	5.56	8.29	9.18
15 m^3/ fad., OF+ BF	139.73	225.0	442.0	5141	9395	10491	2.45	4.47	5.00	4.84	7.47	9.00
75% NF+ 5 m^3/fad., OF	157.73	267.0	481.0	6814	11428	11830	3.26	5.44	5.63	5.78	8.38	9.06
50% NF+ BF	150.15	200.0	423.0	5214	9753	10086	2.48	4.65	4.81	4.97	8.09	8.31
10 m^3/fad., OF+ BF	139.06	211.0	410.0	5706	10585	10752	2.72	5.04	5.08	4.88	7.82	8.82
50% NF+10 m^3/fad., OF	161.18	282.0	430.0	6171	10750	11333	2.94	5.12	5.40	5.95	8.28	9.17
LSD at 0.05	10.40	54.80	55.70	642.43	1373.4	1257.1	0.31	0.65	0.60	0.76	0.58	0.56
	Second season (204)											
100% NF (control)	163.61	278.0	459.0	6734	10765	11440	3.21	5.13	5.45	5.54	8.11	9.26
20 m^3/fad., OF	138.17	208.0	395.0	5277	9636	10421	2.51	4.59	4.96	5.18	7.80	8.63
75% NF+ BF	149.13	260.0	425.0	6378	10477	11112	2.94	4.99	5.29	5.30	8.07	8.95
15 m^3/ fad., OF+ BF	140.85	232.0	409.0	5958	9355	10158	2.84	4.46	4.84	4.62	7.88	8.72
75% NF+ 5 m^3/fad., OF	154.70	262.0	437.0	6677	10818	11295	3.18	5.15	5.38	5.50	8.28	9.10
50% NF+ BF	148.44	228.0	417.0	5787	9810	10084	2.75	4.67	4.80	4.56	7.98	8.49
10 m^3/fed. OF+ BF	143.46	202.0	411.0	5853	10178	10413	2.79	4.85	4.96	4.87	7.30	8.80
50% NF+10 m^3/fad., OF	157.56	266.0	461.0	6695	10837	11265	3.19	5.16	5.36	5.46	8.03	9.21
LSD at 0.05	12.13	43.33	39.83	634.7	1046.7	1012.8	0.34	0.50	0.48	0.63	0.54	0.48

NF Nitrogen fertilizer OF Organic fertilizer BF Biofertilizer (Cerealin)

It is observed that, applying biofertilizer (cerealin) combined with 75% of the recommended dose of chemical nitrogen fertilizer increased stalk dry weight in both seasons compared with the other treatments which contain biofertilizers except at 75 days after sowing in the first season, stalk dry weight increased by addition of biofertilizer to organic manure (10 m^3/ faddan). The combination of biofertilizer with organic or chemical fertilizers further enhanced the biomass and grain yield of crops (Yasari *et al*., 2008; Azzan *et al*., 2009).

Inoculation of biofertilizer with chemical fertilizer increased fertility of the soil rhizosphere and resulted in more efficient uptake of soil nutrients by maize plants (Zahir *et al*., 2012). Also, biofertilizers and nitrogen fertilizers are activator of some enzymatic systems and also play a key role in cell division and cell elongation, these factors led to increased plant development (Ojaghloo, 2007).

Data in Table 3 show that, in both studied seasons, leaf area, leaf area index and specific leaf weight increased with age advanced from 45 to 75 days. Rasheed *et al*. (2003) found that leaf area index of maize increased progressively with the advancement of the growth period and reached the maximum value at 75 days and thereafter declined at 90 days.

In general, the higher values were recorded with 50 and 75% of the recommended rate of

mineral nitrogen fertilizer plus organic fertilizers or 100% mineral nitrogen fertilizer. The positive effect of most treatments could be attributed to the beneficial effect of the tested materials (mineral nitrogen combined with organic manure) on improving all studied growth parameters at different stages of growth. It may be due to the fact that prolonged release of nutrient from organic manure increases the efficiency and favorable conditions.

Compost not only slowly releases nutrients but also, prevents the losses of chemical fertilizers through dentrification, volatilization waste may improve the efficiency of chemical fertilizers (Abedi *et al*., 2010).

It is noticed that, fertilizing with 75% of mineral nitrogen with biofertilizer, increased leaf area, leaf area index and specific leaf weight compared with the other treatments contained biofertilizer in both studied season with exception these parameters increased at 60 days in the first season by application of organic with biofertilizer. These results supported by other researchers (Nezarat and Gholami, 2009; Abbas, 2013) who evaluated that the effect of biofertilizer with chemical fertilizers have a major impact on maize growth and development. Also, Gholami *et al*. (2009) observed that maize leaf number, shoot dry weight and leaf surface area were increased significantly by bacterial inoculation in both sterile and non sterile soil.

Adding of 50% of the recommended dose of chemical fertilizers to the biofertlizers improved the plant growth. This improvement may be due to the direct effect of chemical fertilizers or indirect through the microbial propagation activation (Abo- Baker and Mostafa, 2011). Also, El-Naggar *et al*. (2015) reported that the highest values of vegetative growth (plant height, leaf area and leaves dry weight) were obtained by adding cattle manure combined with biofertilizer on sweet basil plants.

Net assimilation rate (NAR) and crop growth rate (CGR)

Results in Table 4, Figs. 1 and 2 clear that crop growth rate at 45-60 days was significant in the second season whereas, net assimilation rate (NAR) and crop growth rate (CGR) were not significantly affected in both studied seasons although, addition of organic manure at 10 m^3/ faddan combined with 50% mineral nitrogen increased net assimilation rate and crop growth rate at 45-60 days in the first season, also, inoculation of biofertilizer with organic manure at 15 or 10 m^3/faddan tended to increase these parameters at 60-75 days in both studied seasons compared with 100% mineral nitrogen (control). More or less the same trend obtained by addition of biofertilizer plus 75% of mineral nitrogen.

Addo-Quaye *et al*. (2011) found that increasing leaf area index, which was able to capture more photosynthetic active radiation (PAR) for greater photosynthesis leading to greater rate of dry matter accumulation. Haghighi and Yarmahmodi (2011) found that integrated application of fertilizers (bio-chemical fertilizers) increased crop growth rate, net assimilation rate and leaf area index of maize plant. Also, Soleymanifard *et al*. (2013) reported that high levels of nitrogen fertilizer and biofertilizer increased leaf area index (LAI), crop growth rate (CGR) and finally biomass production was increased, also net assimilation rate (NAR) is a good criterion for telling plant's growth properties, so, some physiological indices such as LAI, CGR and NAR show their effectiveness by increasing maize grain yield.

Plant height at harvest

Data in Table 5 clear that plant height of maize plant was significantly affected by different treatments in both studied seasons. In general the higher values were recorded with 100% mineral in both seasons or organic fertilizer at 20 m^3/faddan in the first season. Similar results were reported by Mishra *et al*. (2010) on mineral fertilizer and Ahmed *et al*. (2011) on organic fertilizer.

Inoculation of biofertilizer (cerealin) combined with 50 and 75% of recommended mineral nitrogen tented to increase plant height. The relative positive effect of biofertilizer may be attributed to the production of plant growth promoting substances such as indole acetic acid, gibberellins and cytokinine stimulating effect on plant growth (Suzan, 2007).

Inoculation of biofertilizer stimulated the relative elongation rate of shoot system and improving plant height (Shehata *et al*., 2010 on wheat ; Yadav *et al*., 2011 on maize).

Table 4. Effect of bio, organic and nitrogen fertilizer on net assimilation rate (NAR) and crop growth rate (CGR) of maize during two seasons

Treatment	Net assimilation rate (mg/cm^2/day)				Crop growth rate (mg/cm^2/day)			
	45-60 DAS		60-75 DAS		45-60 DAS		60-75 DAS	
	2013	2014	2013	2014	2013	2014	2013	2014
100% NF (control)	0.37	0.39	O.56	0.48	3.68	3.63	6.67	5.75
20 m^3/fad., OF	0.27	0.27	0.55	0.53	2.22	2.22	6.06	5.94
75% NF+ BF	0.40	0.39	0.45	0.48	3.38	3.52	5.14	5.24
15 m^3/ fad., OF+ BF	0.35	0.37	0.64	0.52	2.70	2.89	6.89	5.62
75% NF+ 5 m^3/fad., OF	0.35	0.36	0.58	0.47	3.47	3.41	6.79	5.56
50% NF+ BF	0.21	0.30	0.63	O.56	1.84	2.53	6.82	6.00
10 m^3/fad., OF+ BF	0.27	0.22	O.54	0.60	2.29	1.86	6.32	6.63
50% NF+10 m^3/fad., OF	0.43	0.37	0.38	0.51	3.84	3.44	4.70	6.19
LSD at 0.05	NS	NS	NS	NS	NS	1.25	NS	NS

NF Nitrogen fertilizer OF Organic fertilizer BF Biofertilizer (Cerealin)

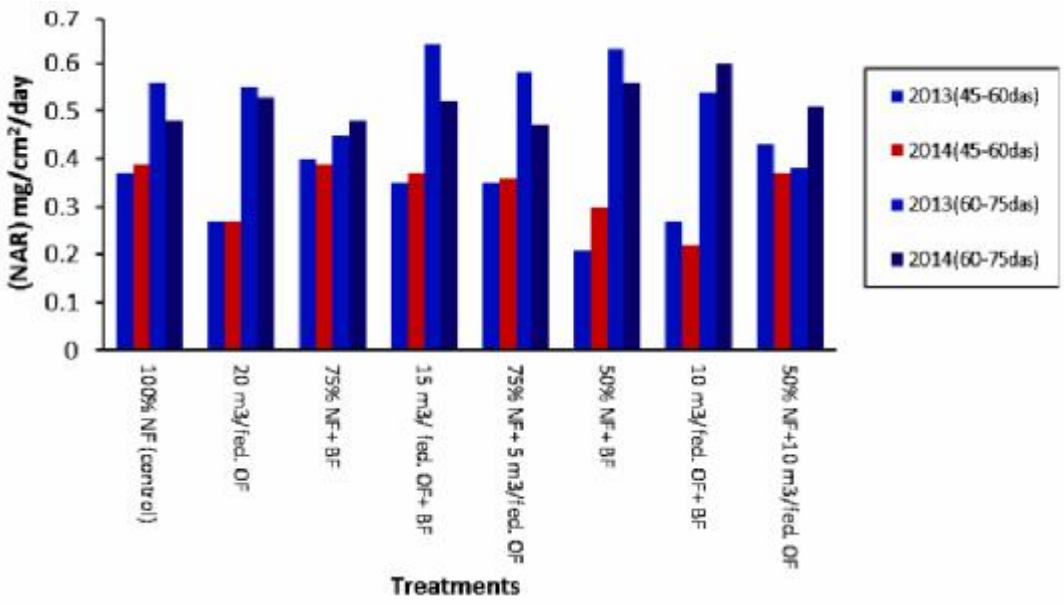

Fig. 1. Effect of bio-organic and nitrogen fertilizers on net assimilation rate (NAR) of maize during two seasons

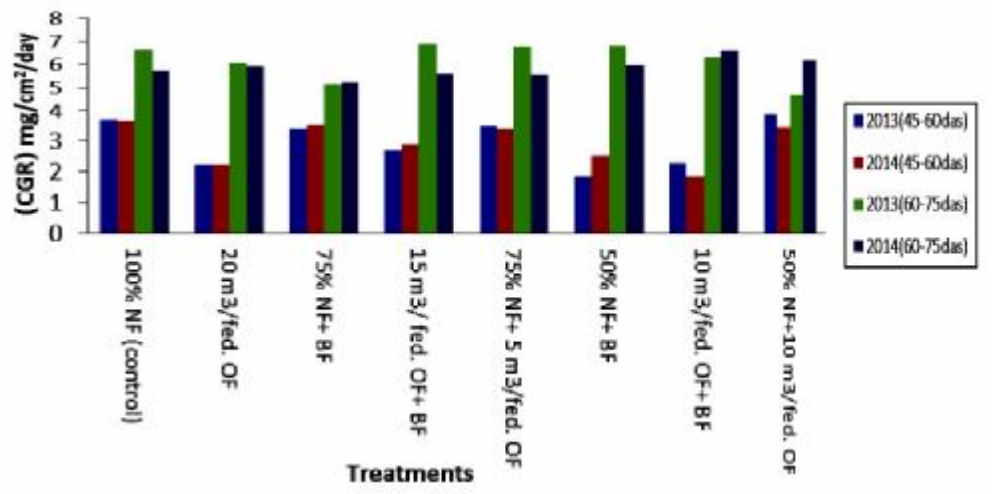

Fig. 2. Effect of bio-organic and nitrogen fertilizers on crop growth rate (CGR) of maize during two seasons

Table 5. Effect of bio-organic and nitrogen fertilizer on yield and yield attributes of maize during two seasons

Treatment	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	Row number/ ear	Grain number / row	Grain weight/ ear (g)	100 -grain weight (g)	Grain yield/fad., (ardab)	Harvest index
					First season (2013)				
100% NF (control)	365.4	24.6	4.30	14.4	48.94	272.0	42.05	28.90	0.49
20 m^3/fad., OF	363.6	22.3	4.05	12.8	45.48	244.0	39.14	26.36	0.41
75% NF+ BF	361.6	24.1	4.20	13.6	45.62	244.0	42.12	27.14	0.42
15 m^3/ fad., OF+ BF	343.6	23.2	4.10	14.0	45.87	233.0	38.59	25.92	0.41
75% NF+ 5 m^3/ fad., OF	357.6	24.0	4.15	14.4	46.81	260.0	41.45	29.01	0.48
50% NF+ BF	355.8	23.0	4.05	13.2	46.69	230.0	40.36	26.45	0.40
10 m^3/fad., OF+ BF	350.6	22.8	4.15	13.2	47.87	237.0	38.39	26.16	0.42
50% NF+10 m^3/ fad., OF	362.8	24.4	4.10	14.8	48.37	268.0	41.50	28.08	0.46
LSD at 0.05	11.74	1.53	NS	NS	NS	30.26	2.84	2.24	0.06
					Second season (2014)				
100% NF (control)	366.0	24.4	4.35	14.8	48.01	269.0	41.43	28.79	0.49
20 m^3/fed. OF	348.0	23.4	4.20	12.4	45.99	245.0	37.98	25.63	0.42
75% NF+ BF	356.2	23.8	4.35	13.6	48.72	266.0	40.51	28.38	0.46
15 m^3/fad., OF+ BF	349.6	22.9	4.15	12.8	46.34	242.0	38.21	26.70	0.42
75% NF+ 5 m^3/fad., OF	359.8	24.8	4.40	14.4	49.11	273.0	39.96	28.73	0.48
50% NF+ BF	355.6	23.6	4.15	12.4	46.59	238.0	37.27	27.20	0.46
10 m^3/fad., OF+ BF	351.6	23.2	4.05	12.8	47.56	235.0	37.78	27.31	0.43
50% NF+10 m^3/fad., OF	361.8	24.4	4.35	14.0	48.74	259.0	40.37	28.53	0.47
LSD at 0.05	10.40	1.19	NS	1.75	NS	28.35	2.89	2.15	0.04

NF Nitrogen fertilizez OF Organic fertilizer BF Biofertilizer (Cerealin)

Yield and its attributes

Data presented in Table 5 show that some yield traits of maize were significantly affected by different treatments in the two seasons, including ear length, grain weight/ear, grain yield/faddan and harvest index. Previous results indicate that these attributes exhibited maximum values in treatments included 50 or 75% of recommended rate of mineral plus organic fertilizers (cattle manure), these values were most equal to that produced with 100% mineral nitrogen fertilization (control). However, the beneficial effects of adding 50 or 75% of recommended mineral nitrogen to organic fertilizers are in harmony with the findings of (Ahmed *et al*., 2013).

Enhanced yield in treatment treated with organic fertilizers along with half of the recommended NPK mineral fertilizer might be attributed to the vigorous root and shoot growth due to increased soil organic matter that subsequently improved soil physical conditions, water holding capacity and enhanced soil fertility leading to good crop stand till maturity (Eqtidar *et al*., 2006). Also, some yield attributes, *i.e.,* ear diameter and grain number/row were insignificant in both seasons, as well row number/ ear in the first season.

Data in Table 5 reveal that inoculation of biofertilizer (cerealin) plus 75% of the recommended mineral nitrogen increased all yield attributes compared with these treatments contained biofertilizer. 100 grain weight was significantly affected by different treatments. The highest value of 100 grain weight was obtained by the treatment included 75% of the recommended mineral nitrogen fertilizer plus biofertilizer compared with 100% mineral nitrogen (control). The results of biofertilizers go in line with the findings of (Ahmed *et al*., 2013; Ibrahim *et al*., 2015) on maize.

The better utilization of readily available fertilizer nitrogen or nitrogen from biological nitrogen fixation which made plants more efficient in photosynthetic activity. Grain becomes a dominant sink of plant nutrients are deposited in the grains as compared to other parts of the plant (Ali and Jan, 2005). Also, Abo- Baker and Mostafa (2011) showed that, using biofertilizers combined with 50 or 100% chemical fertilizers improved, in most cases, growth characters and increased yield or at least did not differ significantly from the control (full recommended dose of NPK fertilizers alone).

Abd El-Latteif (2013) indicated that using biofertilizers caused significant increase in harvest index due to effect on dry weight and allocating more photosynthetic matter to wheat grain.

Oliveira *et al*. (2015) found that at harvest the plant height, dry biomass and yield were determined; the results showed that the biofertilizers increased sugarcane productivity.

In general, the previous results showed that application of organic fertilizer alone decreased almost growth parameters and yield components of maize plants. This could be attributed to deficiency of mineral nitrogen in the early plant development and nitrogen use by microbes to break down organic material. These results agree with those of (Bashir *et al*., 2009; Habibi *et al*., 2011).

Chlorophyll content

Results in Table 6 reveal that chlorophyll b in both seasons and chlorophyll a+ b in the first season were significantly affected by different treatments. Addition of organic fertilizers (cattle manure) or biofertilizers (cerealin) plus 75% of mineral nitrogen fertilizer gave maximum increase in chlorophyll b and chlorophyll a+ b in the first season compared with control (100% mineral nitrogen).

Generally, previous results indicated that addition of biofertilizers or organic manure combined with 75% of mineral nitrogen fertilizers increased chlorophyll content in maize leaves. In this connection, chlorophyll content in maize leaves was the greatest, when plants not only biofertilized, but also fertilized with mineral nitrogen (Kouchebagh *et al*., 2012 ; Abbas *et al*., 2013).

The beneficial effects of biofertilizers inoculation on increased chlorophyll content might have been due to the supply of higher amount of nitrogen to the growing tissue and organs supplied by nitrogen fixing bacteria (Chandrasekar *et al*., 2005). Also, application of organic fertilizers improved shoot length, leaf area and leaf chlorophyll content (Kohler *et al*., 2007).

Table 6. Effect of bio, organic and nitrogen fertilizer on chlorophyll content in leaves during two seasons and chemical constituents of maize grains in the second season only

Treatment	Chl.a (mg/g.f.wt)		Chl.b (mg/g.f.wt)		Chl.(a+b) (mg/g.f.wt)		Total carbohydrates (%)	Oil content (%)	Protein content (%)
	2013	2014	2013	2014	2013	2014	2014	2014	2014
100% NF (control)	1.65	1.58	0.66	0.63	2.31	2.21	71.99	6.36	9.92
20 m^3/fad., OF	1.55	1.48	0.60	0.59	2.14	2.06	71.35	6.27	9.96
75% NF+ BF	1.56	1.55	0.73	0.60	2.29	2.15	71.82	5.82	9.82
15 m^3/ fed. OF+ BF	1.52	1.50	0.59	0.54	2.11	2.04	69.57	5.10	9.68
75% NF+ 5 m^3/fad. OF	1.64	1.55	0.68	0.62	2.33	2.17	72.06	7.02	10.12
50% NF+ BF	1.53	1.53	0.58	0.57	2.11	2.10	69.36	5.74	9.60
10 m^3/fad., OF+ BF	1.45	1.51	0.61	0.58	2.06	2.09	69.54	5.78	9.16
50% NF+10 m^3/fed. OF	1.62	1.57	0.63	0.61	2.24	2.18	71.90	6.25	10.03
LSD at 0.05	NS	NS	0.09	0.05	0.17	NS	1.18	0.83	0.42

NF Nitrogen fertilizer OF Organic fertilizer BF Biofertilizer (Cerealin)

Chemical constituents of maize grains

The following traits were determined in the second season only.

Total carbohydrates, oil and protein content

Data given in Table 6 show that total carbohydrates, oil and protein content were significantly affected by different treatments. Results clear that fertilizing maize plants with 75% of mineral nitrogen combined with cattle manure at 5 m^3/faddan gave higher values compared with 100% mineral nitrogen fertilizers. It is observed that addition of 75% of mineral nitrogen plus biofertilizer (cerealin) gave almost equal results to that gained with 100% mineral nitrogen fertilizer.

In general, biofertilizer or organic manure combined with 75% mineral nitrogen increased or were the same results as those obtained by 100% mineral nitrogen. These results can be explained in the light of facts that, using organic manure, led to increase organic matter, availability of nutrients, nitrogen fixation by (biofertilizer), nitrogen is the basic matter in forming protein and rhizosphere microorganisms that release phytohormones and substances which lead to increasing growth and dry matter accumulation which in turn increases the concentration of oil (Edris *et al*.,2003; Jung *et al*., 2004) and protein content (Shehata and El-Khawas, 2003).

Application of biofertilizer plus chemical fertilizer increased protein content in maize grains (Naserirad *et al*., 2011) and Gomaa, 2013, on quinoa seeds. Also, addition of organic manure increased oil content in sweet basil and fennel seed (Mohamed and Abdu, 2004; El-Naggar *et al*., 2015).

Chandraskar *et al*. (2005) found that fertilizing with biofertilizer plus urea increased leaf area, it is well known that the leaf area index is released to primary productivity, which exhibit maximum efficiency in CO_2 assimilation and $C_6H_{12}O_6$ production. Total carbohydrates and protein content were increased by addition of biofertilizer (Eleiwa *et al*., 2012) or organic manure (Atia, 2005).

Conclusion

From the previous results, it could be concluded that inoculation of biofertilizer (cerealin) combined with 75% mineral nitrogen fertilizer or addition organic fertilizer (cattle manure) plus 50 or 75% mineral nitrogen

fertilizer improved, in most cases, growth characters, yield components and increased chemical constituents of maize grains or at least did not differ significantly from the control (100% recommended dose of mineral nitrogen fertilizer) and can be used in maize production without reducing the productivity. So, applying biofertilizer or organic manure can save the quantity of mineral nitrogen fertilizer, decrease the production cost and reduce the negative effects on the environment.

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تأثير التسميد الحيوى والعضوى والنيتروجينى علي نمو وإنتاجية الذرة الشامية

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أجريت هذه التجربة خلال الموسمين ٢١٠٣-٢١٠٤ بمحطة البحوث الزراعية بايتاى البارود لدراسة تأثير السماد الحيوى (سيريالين) والسماد العضوى (سماد المواشى) بمعدلات ٢٠ ، ١٥، ١٠ و٥ متر مكعب/ الفدان والسماد المعدني النيتروجينى بمعدلات ١٠٠، ٧٥ و٥٠% من الموصى به على نمو وصافى معدل التمثيل الضوئي (NAR) ومعدل نمو المحصول (CGR) وإنتاجيه نبات الذرة وكذلك المحتوى الكلوروفيلى للأوراق ومحتوى الحبوب من الكربوهيدرات والزيوت والبروتين، وقد وجدت اختلافات معنوية بين المعاملات عند إضافة نسب من السماد العضوي مع نسب مختلفة من السماد المعدنى فى معظم الحالات أدت إلى زيادة قياسات النمو (الوزن الجاف للمجموع الخضري ومساحة الأوراق ودليل مساحة الورقة وكذلك الوزن النوعي للورقة) وكذلك الإنتاجية (طول الكوز ووزن الحبوب فى النبات ووزن الحبوب للفدان بالمقارنة بالموصى به في السماد المعدني (كنترول)،عند إضافة السماد العضوي (٥ متر^{٣}/الفدان) مع السماد المعدني (٧٥%) زاد محتوى الحبوب من الكربوهيدرات والزيت والبروتين، المعاملات المختلفة كان لها تأ ثيرمعنوي على معدل نمو المحصول (CGR) عند فترة النمو من ٤٥-٦٠ يوم من الزراعة في موسم الزراعة الثاني، تشير النتائج بصفة عامة أنه عند إضافة السماد الحيوي مع السماد المعدني (٧٥%) فإنه يعمل على تحسين نمو وإنتاجية نبات الذرة حيث تزيد أو تتساوى أو تقل قليلا عن النباتات المعاملة بالسماد المعدني الموصى به (كنترول)، لذلك يبدو تحسن في نمو وإنتاجية وصفات الحبوب لنبات الذرة عند إضافة السماد الحيوي أو العضوي مع ٥٠ أو ٧٥% من كميات الســـماد المعدني الموصى بها.

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