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PARTIAL SUBSTITUTION OF MINERAL NITROGEN FERTILIZER BY ORGANIC AND BIO-FERTILIZER ON MAIZE

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ABSTRACT

Two field experiments were conducted to study the effect of bio and organic fertilizer as a partial alternative to mineral-nitrogen fertilizer, on growth, yield and quality of maize plants (c.v. tri- hybrid 324). The study was carried out during the two successive seasons of 2013 and 2014 at El- Gemmeiza Research Station(30º 47′ 22.5″ N- 31° 07′ 34″ E, elev. 10 m), Agricultural Research Center, El-Gharbia Governorate,Egypt. Significant positive influences of 50% of the recommended N rate (120kg N/fed.) +25%of the recommended N rate as organic N +Bio treatment were observed on growth traits after75 days from planting, leaf contents of nitrogen, phosphorus, potassium and yield quality when compared to the other combined treatments. The same treatment, gave the highest grain yield (4450 Kg/fed) which was 9.88 % higher than the (100% mineral N) control (٤٠٥٠Kg/fed) and 51.4% more than the lowest yield of 50% M.N.F. (2940 Kg/fed). Also, results indicated that the treatments comprising 50or 75% mineral N + 4.2 or 2.1 ton/fed. organic N +Bio and/or humic acid significantly increased plant height, weight of 100 grain , grains, straw and biological yields than control. All quality parameters i.e. protein, oil %, total carbohydrate and starch contents under 50% mineral N + 4.2 ton/fed. organic N +Bio and/or humic acid treatments recorded the highest and significant values comparing to the control. Hence, it can be concluded that organic and biofertilizers could be used to minimizing the amount of mineral N fertilizer fot different crops avoiding soil or water pollution.

Keywords: Biofertilizer, humic acid, minerals content, oil, organic manure, protein, Zea mays,

INTRODUCTION

Maize is called “King of cereals” because of its productivity potential compared to any other cereal crop. Being an exhaustive crop, it has very high nutrient requirement and its productivity is closely depends on nutrient management system. Under the present trend of exhaustive agriculture in Egypt, inherent soil fertility can no longer be maintained on the sustainable basis. It is said that nutrient supplying capacity of soil declines steadily under continuous and intensive cropping system. The optimum levels of N, P, K failed to maintain yield levels probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil. Apart from the soil fertility and productivity issues, use of chemical fertilizers is also becoming more and more difficult for the farmers due to their high costs and scarcity during peak season. On thus, increasing awareness is being created on the use of organics including biofertilizers which are the sources of macro, micro and secondary nutrients to sustain the soil fertility and productivity.

Mineral nutrition is one of the most important factors for plant growth and yield. Mineral fertilizers, particularly mineral-nitrogen, are important means of plant nutrition; however, they are also a potential source of environmental pollution (Hartman, 1988). An attention has been therefore focused on alternative fertilizers, including bio-fertilizers in Middle East. Nowadays, there is renewed interest in bio fertilizers for nutrient supply and improve soil fertility and productivity in this region. The integrated use of bio-fertilizers and mineral fertilizers is considered the best option not only to reduce the intensive consumption of chemical fertilizers, but also to sustain the soil with minimum undesirable impacts and to maximize fertilizer use efficiency in soil. Bio-fertilizers are considered as an eco-friendly way to sustainable agriculture. They positively affect plant growth and yield, reduce the negative effects of chemical fertilizers and minimize some chemicals such as NO_3^- and NO_2^- ions in the soil and consequently in plants. Therefore, the way to a healthy agriculture with a minimum pollution requires a conjunctive use of bio-nitrogen and mineral-nitrogen fertilizers.

Bio-fertilizers, microbial inoculants that can promote plant growth and productivity, are internationally accepted as an alternative source of N-fertilizer. In the bio-fertilizer technology, new systems are being developed to increase the biological N_2-fixation with cereals and other non-legumes by establishing N_2-fixing bacteria within the roots (El-Haddad *et al*., 1993).

Organic matter also improves water holding capacity of sandy soil and drainage in clayey soil. Organic manure provides nutrients for the soil micro-organisms, thus increases the activities of microbes in soil, which in turn help to convert unavailable plant nutrients into available form for plant growth promotion.

Humic acid (HA) is a vital constituent and an intimate part of soil organic structure. It has been used by many scientists, agronomists and farmers for improving soil conditions and plant growth. In plants, humic acids have positive effects on enzyme activity, plant nutrients, and growth stimulant and are considered as a “plant food”. Humates are most responsive in high carbohydrate crops like potato, carrot, maize, rice, wheat, etc. (Sharif *et al*., 2003). Humic acid contains 51% to 57% C, 4% to 6% N and 0.2% to 1% P and other micronutrients in minute amounts. Application of 1.0 kg $\cdot ha^{-1}$ to the soil can bring appreciable increase (up to 20%) in yields of wheat, maize, cotton, sugar beet and groundnut and improvement in soil physico-chemical conditions. Application of such minute amounts of HA suggests its enzymatic characteristics. Treating seeds with HA may further increase its beneficial effects to enhance crop yield, (Kaya and Khawar 2005).

Therefore, the objective of this study was to investigate the possibility of using bio and organic fertilization partially instead of recommended N mineral fertilizers on growth, yield and quality of maize.

MATERIALS AND METHODS

Field Experiments

Two field experiments were conducted at El-Gimmeiza Research Station, Agricultural Research Center, El-Gharbia Governorate, Egypt, during the two successive seasons of 2013 and 2014, to study the possibility of using bio and organic fertilization as a partial alternative to mineral-nitrogen fertilizer on growth, yield and quality of maize plants (c.v. tri- hybrid 324).

The experiments included 11 treatments as follows:

T_1. 100%M.N.F. (control represents a recommended rate) =120kgN/fed (Urea source).
T_2. 75%M.N.F. (Mineral N fertilizer)
T_3. 50%M.N.F.
T_4. 50%M.N.F. + 0.1% HA (potassium humate as foliar 0.1%)
T_5. 50%M.N.F. + Bio. (containing10^7 cfu ml^{-1} from each bacterium)
T_6- 50%M.N.F. + 0.1% HA+ Bio
T_7. 50%M.N.F. + 50 % O.N.F. (4.2 ton/fed organic N fertilizer)
T_8. 50%M.N.F. + 25 % O.N.F. (2.1 ton/fed organic N fertilizer) + Bio.
T_9.75%M.N.F + 0.1% HA
T_{10}. 75%M.N.F+ 0.1% HA + Bio
T_{11}. 75%M.N.F. + 25 % O.N.F

The treatments were arranged in a completely randomized block design with three replicates. Randomized samples were taken from the experimental soils before sowing and compost to determine the physical and chemical properties according to Jackson, (1973) as shown in Tables (1 & 2). The organic manure (compost) was thoroughly mixed with 0-20 cm soil surface layer two weeks before sowing.

Super phosphate (15 %P_2O_5) was added as a single dose at the rate of 30 kg P_2O_5 /fed and mixed in the same time with such surface layer. The nitrogen fertilizer (as urea 46%N) was added according to the treatment in three equal portions, i.e. 21, 35 and 50 days after sowing. Also, potassium fertilizer (as potassium sulphate, 48% K_2O) was added at a rate of 24kg K_2O/fed., which was divided into three equal portions applied with N fertilizer. Foliar spray of potassium humate 0.1% was done on 30^{th}, 45^{th} and 60^{th} days after sowing.

The compound of potassium humate granule contained of: 85% potassium humates, 12% potassium oxide, 1% iron, 0.9 organic nitrogen, 1.1% other compounds and with a pH= 7.0. As for bio fertilization, seeds of maize were inoculated with bio-nitrogen fertilizer (*Azotobacter chroococcum* + *Azospirillium brasilense*) (containing10^7 cfu ml^{-1} from each bacterium) were kindly obtained from Microbio. Dept., Soils, Water and Environ. Res. Instit. Agric. Res. Center, Giza, Egypt. Prior to sowing, maize

Table 1. Physical and chemical properties of the experimental soil

Property	Value
Particle size distribution (%)	
Sand	21.5
Silt	31.2
Clay	47.3
Texture grade	clay
pH(1:2.5 soil water suspension)	7.80
ECe (dS/m) (soil paste extract)	1.74
SP	40
Soluble cations (meq/L)	
Ca++	4.50
Mg++	3.50
Na+	8.95
K+	0.42
Soluble anions (meq/L)	
CO_3^{--}	-
HCO_3^-	0.5
Cl^-	9.5
SO_4^{--}	7.37
Organic matter (%)	1.62
Available nutrient (mg/kg)	
N	45.00
P	7. 35
K	375.00
DTPA-extractable ((mg/kg)	
Fe	3.74
Mn	1.94
Zn	0.78

Table 2. Physical and chemical properties of the compost

Properties	Values
EC value (1:10) (dS/m)	7.90
pH value (1:10)	6.70
Moisture content (%)	28.00
Organic matter (%)	44.48
Organic carbon (%)	25.80
Total nitrogen (%)	1.42
C/N ratio	18.20
Soluble ammonia-N (ppm)	615.00
Soluble nitrate-N (ppm)	362.00
P (%)	0.57
K (%)	0.82

Grains were inoculated by soaking in liquid culture of Azospirillum and Azotobacter. Arabic gum was added to liquid culture as adhesive agent. Inoculated grains were air dried by spreading over a plastic sheet for short time before planting. After 75 days from sowing, fresh and dry weights/plant were measured. N, P and K percentages in ear leaf were estimated in the digested plant material. At harvesting, the following characteristics were estimated:

1-Yield and its components:

Plant height (cm), ear characters (i.e., ear length (cm), ear diameter (cm), row number/ear and grain number /row), weight of 100 grain (g), grains, straw, biological yield (kg /fed.) and harvest index were measured.

II- Chemical analysis

- Grains and straw samples were digested with H_2SO_4 + $HClO_4$ mixture for chemical analysis to determine N, P and K contents, according to Chapman and Pratt, (1978).
- Nitrogen content in grains and straw was determined by Keldahl method as described by A.O.A.C (1990). Protein content in the grains was calculated by multiplying N% by 5.75 factor. Phosphorus was determined calorimetrically according to Chapman and Pratt, (1978). Potassium was determined by flam photometer according to Jackson (1973).
- Oil content (%) was determined by soxhelt apparatus using hexane as a solvent as described by A.O.A.C. (1990). Oil and protein yield (kg/fed.) was estimated by multiplying grain yield (kg/fed.) by grain oil and protein percentages respectively.
- Total soluble sugars and total carbohydrates content in the grains were also determined according to Smith *et al.* (1956). Starch content was obtained by calculating the difference between total carbohydrate and total soluble sugar content.

The obtained results were statistically analyzed according to Gomez and Gomez (1984) to define the statistical significance of L.S.D. at 0.05.

RESULTS AND DISCUSSION

Fresh and dry weights /plant and ear leaf NPK contents after 75 days from planting

The effect of mineral N, organic and bio-fertilizers on plant fresh and dry weights and ear leaf mineral content of maize plants after 75 days from planting is variable (Table 3). Data revealed that plants received T_8 (50% mineral N +25% compost N +Bio) recorded the highest values of these parameters followed by T_{10} (75%M.N.F+ 0.1% HA + Bio), T_{11} (75% mineral N +25% compost N) and T_1 (100% mineral N). The promotion of vegetative growth of maize plants after 75 days could be attributed to the effect of organic and non symbiotic N_2-Fixing bacteria *Azotobacter* and *Azospirillum* in exerting a positive effect on plant growth through the synthesis of phytohormones, N_2 fixation, reduction of membrane potential of the root, synthesis of some enzymes (such as ACC deaminase) that modulate the level of plant hormones as well as the solubilization of inorganic phosphate and mineralization of organic phosphate, which make phosphorus available to the plants (Hellal *et al.,* 2011). The increases in fresh and dry weights of maize plants by N application may be attributed to the beneficial effects of N on stimulating the meristmatic activity for producing more tissues and organs, since N plays a major roles in the synthesis of structural proteins and other several macro molecules, in addition to its vital contribution in several biochemical processes in the plant related to growth. In this concern, fertilizing plants with (50% mineral N +25% organic N +Bio) gave the highest leaf N percentage compared with the other treatments followed by (75%M.N.F+ 0.1% HA + Bio), (75% mineral N +25% organic N) and100% mineral N fertilizer (treatments 8, 10, 11 and 1respectively)., Phosphorus and potassium concentrations were also higher in plants fertilized with (M.N.F + 0.1% HA + Bio) or fertilized with M.N.F +organic fertilized compared to those received (M.N.F) alone. These results emphasized that the (M.N.F + 0.1% HA + Bio) or fertilized with M.N.F + Bio +organic fertilized treatments were great enough to reach the highest levels of N, P and K. This could be attributed to the release of organic acids that can either reduce pH of the surrounding soil or directly dissolve the mineral phosphate or due to the chelating property of the organic acids produced by bio such as acetate, lactate, oxalate and citrate. etc. The same trend was observed by Atiyeh *et al*., (2002) who reported that the reason behind the effectiveness of humic acid on plant growth and development is the existence of plant growth regulators such as IAA, GAs and CKs. Moreover, some investigators attributed the positive effects of humic acid to its influence on plants root.

Table 3. Effect of mineral N and some organic accompanied with bio fertilizers on fresh and dry weights of maize plants (g/plant) and ear leaf mineral percentages of maize after 75 days from planting during 2013 and 2014 seasons

Treatments	Fresh weight (g/plant)	dry weight (g/plant)	N%	P%	K%
T_1 100%M.N.F. (control)	484	90	2.75	0.35	1.45
T_2 75%M.N.F.	377	77	2.46	0.33	1.35
T_3 50%M.N.F.	276	58	1.72	0.30	1.25
T_4 50%M.N.F. + 0.1% HA	294	60	1.88	0.42	1.32
T_5 50%M.N.F. + Bio.	369	67	2.46	0.38	1.36
T_6 50%M.N.F. + 0.1% HA+ Bio	394	76	2.65	0.45	1.54
T_7 50%M.N.F. + 50 % O.N.F	433	84	2.59	0.46	1.51
T_8 50%M.N.F. + 25 % O.N.F. + Bio	627	108	2.97	0.48	1.55
T_9 75%M.N.F + 0.1% HA	392	88	2.59	0.35	1.36
T_{10} 75%M.N.F+ 0.1% HA + Bio	531	101	2.95	0.46	1.52
T_{11} 75%M.N.F. + 25 % O.N.F	497	91	2.88	0.45	1.57
L.S.D at 5%	11.43	5.93	0.26	0.08	0.10

Yield and its components

Data in Table (4) show the effect of treatments on yield and yield components of maize (plant height, ear length, ear diameter, No. of row/ear, No. of grain /row, 100-grain weight, grain yield, biological yield and harvest index). The plant height varied significantly among the treatments and maximum plant height (267.33 cm, 265.67 cm, 264.5 cm and 264.33 cm respectively), were recorded by T_8 (50% mineral +25% compost N +Bio),followed by T_{10} (75%M.N.F+ 0.1% HA + Bio), T_{11} (75% mineral +25% compost) and T_1 (100% mineral N) with no significant differences. The lowest value of plant height (226.67 cm) was observed with T_3 (50% mineral N) .This indicates clearly that combined use of organic N, bio and humic acid increased the efficiency of fertilizer, solubilization and transport of nutrients and increased the plant height. The increase in plant height can be attributed to the fact that nitrogen promotes plant growth, increases the number and length of the internodes which results in progressive increase in plant height. Similar results were reported by Abdel Gader, (2007).The superiority of T_8 (50% mineral +25% organic N +Bio), T_{10} (75%M.N.F+ 0.1% HA + Bio) orT_{11} (75% mineral +25% organic) may be referred to the increase in microorganisms activity and increasing adsorbing capacity of essential nutrients against leaching. Moreover, adding mineral + organic fertilizer together improve the mineralization of organic-N. Furthermore, *Azotobacter* and *Azospirillum* could produce IAA and cytokinins which increase the surface area per unit root length and were responsible for root hair branching with an eventual increase in acquisition of nutrients from the soil. Maximum ear length (26.00 cm) was observed with T_8 (50% mineral +25% organic N +Bio), followed by T_{11} (75% mineral +25% organic) and T_{10} (75%M.N.F+ 0.1% HA + Bio respectively). The reason of more ear length may be due to more photosynthetic activities of the plant on the account of adequate supply of nitrogen in these treatments. A typical view of maize cob is that it serves as a temporary storage organ and as a conveyor of nutrients to the developing kernels. Therefore, the better development of cob length will be the index of the better economic yield of maize (Khan *et al.,* 2008). The result in this experiment was in agreement with Rajeshwari *etal.,* (2007). Maximum number of rows per ear (16 rows) and number of grains per row (52 grains) were significantly higher with T_8 (50% mineral N+25% organic N +Bio).These findings may be attributed to the slow and steady supply of N by bio-N and organic, which met the N requirements of plants at different stages of development. N acts as a nutrient reservoir through N_2-fixation and N ions are released slowly over the entire growth period leading to higher yields and yield quality. The data regarding the 100-grain weight in Table (4) showed that all treatments differed significantly from each others. Maximum 100-grain weight 44g, was shown by T_8 (50% mineral +25% organic N +Bio) followed by T_{10} (75%M.N.F+ 0.1% HA + Bio) T_{11} (75% mineral+25% organic) and T_1(100% mineral N) . Similar results were reported by Shah *et al.*, (2009) .The obtained results showed that the beneficial effects of the applied treatments ($T_{8,}$ T_{10} and T_{11}) were positively reflected in the nutritional status of maize plants and consequently reflected in the increased growth, yields and their quality. These results may be explained by the role of *Azotobacter and Azospirillum* in atmospheric nitrogen fixation, better root proliferation and uptake of nutrients and water. The obtained results are also in harmony with those undertaken by Yu *et al.*, (1999).

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Grain Yield (kg fed^{-1}):

The present study showed that, there was a significant and positive effect of different treatments on grain yield of maize (Table 4).The grain yield of maize responded significantly to combined treatments .The highest grain yield (4450 kg/fed) was recorded by treatment T_8 (50% mineral +25% organic N +Bio) which was 51.36% more than the lowest yield of T_3 and 9.88% more than control (4050 kg/fed.) . This might be due to the positive effect of organic and bio fertilizers on better root development which resulted in more nutrient uptake. These microorganisms also produce vitamins and plant growth promoting substances for the betterment of plant growth. Organic manures not only release nutrients slowly but also prevent the losses of leaching (Arshad *et al*., 2004). This might lead to more availability of nutrients from compost and beneficial effects accrued due to *Azotobacter* and *Azospirillum* inoculation which provide nitrogen to plant growth. It may also be due to production of promoting substances like indole acetic acid , gibberellic acid and cytokinins as well as some synthesized vitamins secreted by these introduced beneficial microorganisms which resulted in enhanced nutrient uptake, translocation and synthesis of photosynthetic assimilates which resulted increased plant growth characters and in obtaining economically profitable yield (Suke *et al*., 2011 and Noel *et al*. 1996). These products increase the surface area/unit root length and improved the root hair branching with an ultimate increase on the uptake of nutrients and adsorption of water from the soil that eventually yield larger and in many cases, more productive plants (Dobbelaere *et al*. 2001). The analyzed data revealed that significant differences in harvest index were observed among fertilizer treatments. The comparison of mean showed variation in harvest index ranged from 0.40 to 0.47.The maximum value for harvest index was observed in T_8 (50% mineral +25% organic N +Bio) .The treatmentsT_{10} (75%M.N.F+ 0.1% HA + Bio), T_{11} (75% mineral +25% organic) ,T_1 (100% mineral N) and T_7 (50%M.N.F. + 50 % O.N.F.)was statistically similar for harvest index values 0.46.

Nutrient contents

Nutrient concentrations and contents in both grains and straw of maize plant (Tables 5 and 6) differ significantly amongst all the treatments.

5-6

Grain inoculation with bio-fertilizer in combination with 50%mineral N+ 25% organic N or Bio +50%M.N.F. + 0.1% HA increased nutrient content (NPK) compared to control. T_8 (50% mineral N+25% organic N +Bio) recorded the highest nutrient contents for N, P, and K, followed by T_{10} (75%M.N.F+ 0.1% HA + Bio), T11 (75% mineral +25% organic) and T_1 (100% mineral N). Combined application of inorganic N with biofertilizers as a partial substitute for chemical fertilizers was very effective in stimulating nutrients concentration and contents of maize plant. These findings are in harmony with those obtained by (Wani *et al*., 2007 and Abou-El-Seoud and Abdel-Megeed, 2012). These results might be due to that *Azotobacter* and *Azospirillum* species increased the solubility of soil nutrients as mentioned before. This might be attributed to the increased activity and efficiency of bacteria in reduction of soil pH by secreting organic acid, i.e. acetic, propionic, fumaric and succinic and consequently more solubility and availability of nutrients for plants. It may also be due to production of amino acids, vitamins and growth promoting substances like indole acetic acid and gibberellic acid secreted by these introduced beneficial microorganisms which resulted in enhanced nutrient uptake, translocation and synthesis of photosynthetic assimilates which resulted in increasing plant growth characters and in obtaining economically profitable yield (Singh *et al*., 2006 and Suke *et al*., 2011). The beneficial effects of using organic fertilizers along with mineral -N fertilizer on increasing nutrients concentration and contents of maize plant could be due to their effect on providing plants with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the plants in favors of yield and quality.

Quality parameters

Protein Content and Yield

The protein content and yield of maize grain were significantly affected by different treatments (Table 7).The combination treatments gave the highest values especially T_8 (50% mineral +25% organic N +Bio) which ranked the first in this respect. The treatment T_3 (50% mineral N only) gave the lowest crude protein (٨.٦ %) as compared with the other treatments while the highest crude protein content (١٢.0%) was recorded only with T_8 (50% mineral +25% organic N +Bio) .The maximum protein yield (534 kg/fed) was recorded by treatment T_8 (50% mineral +25% organic N +Bio) which was 17.62 % more than the control. Increasing of protein content may be due to the fact that nitrogen often plays a great role in the synthesis of protein. The increase in protein yield of maize could be attributed to the enhanced nutrient use efficiency in the presence of organic fertilizer. Many research studies have shown that the composted organic materials release nutrients slowly and may reduce the leaching losses, particularly N (Nevens and Reheul, 2003 and Naveed *et al*., 2008).On the other hand, foliar sprays with humic acid(potassium humate) resulted in the highest mean value for protein yield. This result may be due to the role of humic acid as a source of nutrients which consequently increased production of assimilates and results in increased crude protein and protein yield. Free living N-fixing bacteria such as *Azotobacter* and *Azospirillum* have the ability not only to fix nitrogen but also to release certain phytohormones, i.e. GA3, IAA and cytokinins which could stimulate plant growth and increase the availability of nutrients for plant roots by the increase in their dissolutions (Osman, 2007).

Oil Content and Yield

The applied different treatment combinations caused increases in grain oil content and oil yield (Table 7). T_8 (50% mineral +25% organic N +Bio) recorded the highest oil content (9.78%) and oil yield (435 kg fed^{-1}). Increases in grain oil percentage and oil yield (kg fed^{-1}) by *Azospirillum* and *Azotobacter* might be due to their positive effect on nutrients absorption, higher photosynthetic rate, higher dry matter accumulation and higher vegetative growth (Singh and Sinsinwar, 2006).The application of humic acid(potassium humate) in combination with other fertilizers has significant beneficial effect on the growth and yield of maize. Humic acid influences plant growth both in direct and indirect ways. Indirectly, it improves physical, chemical and biological conditions of soil. While directly, it increases chlorophyll content, accelerates plant respiration and hormonal growth responses, increases penetration in plant membranes, etc. Similarly, Chris *et al.* (2005) reported that both the foliar and soil application of humic acid significantly improved seed yield and oil content of mustard. The total carbohydrates content was maximum with T_8 (50% mineral +25% organic N +Bio) (٧٥.٥٤%) followed by T_{10} (75%M.N.F+ 0.1% HA + Bio), T_{11} (75% mineral +25% organic) and T_7 (50%M.N.F. + 50 % O.N.F). The carbohydrate content was 4.90 % increased with application of 50% mineral +25% organic N + bio as compared to the control 100% mineral N. Increase in total carbohydrates content with the use of bio and humic acid might be due to the fact that these substances enhance the nutrients availability to plant nutrients which are associated in sugar synthesis and transport. The promoting effect of humic acid (potassium humate) on the maize quality may be referring to potassium element which is the prevalent action in plant and involved in maintenance of ionic balance in cells and it bounds initially to the enzyme pyruvate kinase which is essential in respiration (Aisha *et al*., 2007). Cangi *et al*. (2006) indicated that foliar spraying of humic acid on asparagus plants increased uptake of macro and micro elements in shoot and rhizome has increased carbohydrates production, chlorophyll and carotenoids in edible stems. Concerning Total soluble sugars (%) and Starch (%) contents, it is noticed that treatments ($T_{8,}$ T_{10} and $T_{11)}$ increased these parameters than the control. These results are agreed with this obtained by Osman, (2007).

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Economic Evaluation:

The Net return of the different treatments was presented in Table (8), which reflects that the most economically beneficial treatment was the application of T_8 (50% mineral +25% organic N +Bio) followed by T_{10} (75%M.N.F+ 0.1% HA + Bio) where the return reached 8714.4 and 8521.5 LE, respectively. This corresponds to an increase in the return reached about 730.7 and 537.8LE, respectively compared to the control.

CONCLUSION

From the abovementioned results, it could be concluded that fertilizing maize plants with organic manure, bio-fertilizers and/or humic acid with 50%or 75% mineral N treatments had a positive effect on maize growth and yields, since applying bio ,OM with 50% or 75% mineral N increased yield than those fertilized with the recommended N rate. Also, adding bio-fertilizer + humic with 50% mineral N highly increased yield than without adding them. This means that maize plants responded mainly to HA application and bio-fertilizer. On the other hand, treatments ($T_{8,}$ T_{10} and T_{11}) increased total carbohydrates, TSS and Starch content than the control. However, it seems that fertilizing maize plants with T_8 (50% mineral +25% organic N +Bio) or T_{10} (75%M.N.F+ 0.1% HA + Bio), are promising treatments under this study conditions.

REFERENCES

Abdel Gader, E.O., (2007). Effect of different nitrogen sources on growth and yield of maize (Zea mays L.). Unpublished M.Sc. Thesis, Omdurman Islamic University, Faculty of Agriculture (inArabic).

Abou-El-Seoud, I.I. and A. Abdel-Megeed, (2012). Impact of rock materials and biofertilizations on P and K availability for maize (*Zea maize*) under calcareous soil conditions. *Saudi J. of Biolo.Sci*. 19: 55–63.

Aisha, A.H., F.A. Rizk, A.M. Shaheen and M.M. Abdel-Mouty,(2007). Onion plant growth, bulbs yield and its physical and chemical properties as affected by organic and natural fertilization. Res. J. Agric. Biol. Sci., 3: 380-388.

Arshad, M., A. Khalid, M. H. Mahmood, and Z.A. Zahir, (2004). Potentiality of nitrogen and L-tryptophan enriched compost for improving growth and yield of hybrid maize. *Pak. J. Agric. Sci.,* 41:16-24.

Atiyeh, R.M., S. Lee and C.A. Edwards. (2002). The influence of humic acids derived from earthwormprocessed organic wastes on plant growth. Bioresearch Technology. 84: 7-14.

A.O.A.C.(1990). Official Methods of Analysis. 15^{th} ed., Association of Official Analytical Chemists, Washington, D.C., USA.

Cangi, R., C. Tarakcioglu and H. Yasar. (2006). Effect of humic acid applications on yield, fruit characteristics and nutrient uptake in Ercis grape (*Vitis vinifera* L.) cultivar. Asian J. Chemi.. 18: 1493-1499.

Chapman, H.D. and R.T. Pratt, (1978). " Methods of Analysis for Soils, Plants and Water" Univ. of California, Div. Agric. Sci. Priced Publication 4030, pp: 12-19.
Chris, W., N. Anderson and R. B. Stewart. (2005). Soil and foliar application of humic acid for mustard production. Environ. Pollution, pp. 254-257.
Dobbelaere, S., A. Croonenborghs, A. Thys, D. Ptacek and J. Vanderleyden (2001). Responses of agrinomically important crops to inoculation with *Azospirillum*. Aust. J. Plant Physiol., 28: 871-879.
El-Haddad, M.E., Y.Z. Ishac and M.I. Mostafa, (1993). The role of biofertilizers in reducing agriculture costs, decreasing environmental pollution and raising crop yield. Arab. Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 1(1): 147-195.
Gomez, K.A. and A.A. Gomez (1984). “Statistical Procedures for Agriculture Research”. 2nd ed. Willey Inter Science Publisher, pp. 357-423.
Hartman, A. (1988) “Ecophysiological aspects of growth and nitrogen fixation in Azospirillium species”. Plant Soil, vol. 110, pp. 225–238.
Hellal, F. A., S. A. Mahfouz and F. A. S. Hassan (2011). Partial substitution of mineral nitrogen fertilizer by bio-fertilizer on (*Anethum graveolens* L.) plant. Agric. Biol. J. N. Am., 2011, 2(4): 652-660
Jakson, M.L., (1973). “Soil and Chemical Analysis”. Prentice-Hall of India Private Limited, New Delhi.
Kaya, M. and Khawar, K.M. (2005) Effect of pre-sowing seed treatment with zinc and foliar spray of humic acids on yield of common bean. *International J. of Agric. and Biology*, 7, 875-878.
Khan H, M. Malik, M. Saleem, H .Khan, M. Malik and M .Saleem. (2008). Effect of rate and source of organic material on the production potential of spring maize (Zea mays L.). Pak. J. Agric. Sci .45: 40-43
Naveed, M., M Khalid, D.L Jones, R. Ahmad, and Z.A., Zahir, (2008). Relative efficacy of *Pseudomonas* spp., containing ACC-deaminase for improving growth and yield of maize (*Zea mays* L.) in the presence of organic fertilizer.*Pak. J. Bot*., 40(3): 1243-1251.
Nevens, F. and D.Reheul. (2003). The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use. *Europ. J. Agron*., 19: 189-203.
Noel, T.C., C. Sheng, C.K. Kost, R.P. Phris and M.E. Hymes,(1996). *Rhizobium lequminosaium* as a plant growth-promoting rhizobacterium: Direct growth promoting of canola and lettuce. Can. J. Microbiol., 42: 279-283.
Osman, A. Sh. (2007) “Effect of partial substitution of mineral-N by biofertilization on growth, yield and yield components of potato”. The 3rd Conf. Sustain. Agric. Develop., Fac. Agric., Fayoum Univ., 12–14 Nov., pp. 381–396.
Rajeshwari, R.S.; N.S. Hebsur ; H.M. Pradeep, and T.D. Bharamagoudar, (2007).Effect of integrated nutrient management on the growth and yield of maize. Karnataka J. Agric.Sci., 20: 399-400.

Shah, S.T.H., M.S.I Zamir, M. Waseem, A. Ali, M. Tahir, W.B. Khalid, (2009). Growth and yield response of Maize (Zea mays L.) to organic and inorganic sources of nitrogen. Pak. J. Life. Soc. Sci. 7: 108-111

Sharif, M., R.A. Khattak, and M.S. Sarir, (2003). Residual effect of humic acid and chemical fertilizers on maize yield and nutrient accumulation. *Sarhad J. of Agric.*, 19, 543-550.

Singh, Y., C.S. Singh, T.K. Singh, and J.P. Singh (2006). Effect of fortified and unfortified rice-straw compost with NPK fertilizers on productivity, nutrient uptake and economics of rice (*Oryza sativa*). *Indian J. Agron.,* 51(4):297–300.

Singh, R. and B.S. Sinsinwar, (2006). Effect of integrated nutrient of brinjal (*Solanam melongana* L.) to different sources management of growth,
yield, oil content and nutrient of nitrogen. Veg. Sci., 29(1): 9-11.

Smith, F.; M. Dubois,; K.A. Gilles ; J. K. Hamilton, and L.N. Kebers, (1956).Colorimetric methods for determination of sugars and related substances. Anal. Chem., 28:350-354.

Suke, S.N., R.D. Deotale, H. Priyanka, D .Mitali and S.N. Sorte (2011). Effect of nutrients and biofertilizers of chemical and biochemical parameters of maize (*Zea mays* L.).*J. Soil and Crops,* 21(1):107-112

Yu, L.; B.Chen,; S. Yu,; Z. Li, and Z. Min, (1999). Effects of organic and chemical complex fertilizers treated with EM. Sixth International Conference on Kyusei. Nature Farming Pretoria, South Africa, 28-31.

Wani, P.A., M.S. Khan, and A. Zaidi (2007). Synergistic effects of the inoculation with nitrogen-fixing and phosphate-solubilizing rhizobacteria on the performance of field-grown chickpea.*J. Plant Nut. Soil Sci*., 170: 283–287.

الاستبدال الجزئى للنيتروجين المعدنى بالتسميد العضوى والحيوى على الذرة

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أجريت تجربتان حقليتان لدراسة تأثير استخدام الاسمدة البيولوجية والعضوية كبديل جزئى عن الازوت المعدنى على نمو محصول الذرة وجودته (صنف هجين ثلاثى٣٢٤). وقد اجريت الدراسة خلال موسمى ٢٠١٣ و ٢٠١٤ فى محطة بحوث الجميزة-محافظة الغربية-مركز البحوث الزراعية-الجيزة.تم تصميم التجربة فى قطاعات كاملة العشوائية بثلاث مكرارات.

اظهرت نتائج التجربة:

إن المعاملة رقم (٨) (٥٠% نتروجين معدنى + ٢٥% نتروجين عضوى+ حيوى) اثرت ايجابيا على صفات النمو ومحتوى الورقة من العناصر الغذائية (النتروجين والفوسفور والبوتاسيوم) مقارنة مع المعاملات الاخرى وذلك بعد ٧٥ يوم من الزراعة.

أدى استخدام الاسمدة البيولوجية والعضوية وحامض الهيوميك مع ٥٠ أو ٧٥% من التسميد الازوتى المعدنى إلى إعطاء أفضل المواصفات للنمو مثل ارتفاع النبات –وزن ١٠٠حبة-محصول الحبوب والمحصول البيولوجى (كجم للفدان) مقارنة بالنباتات التى استخدم فيها المعدل الموصى به من التسميد النيتروجينى.

وتم الحصول على النتيجة نفسها لجميع قياسات الجودة مثل محتوى البروتين والزيت(%) ومحصول البروتين والزيت (كجم للفدان) وكذالك الكربوهيدرات الكلية والنشا عند استخدام نفس المعاملات التى تحتوى على الاسمدة البيولوجية والعضويةمع ٥٠ أو ٧٥%من التسميد الازوتى المعدنى مقارنة بالمعدل الموصى به من الازوت المعدنى.

أعطت المعاملة رقم (٨) والتى تحتوى على ٥٠% نتروجين معدنى + ٢٥% نتروجين عضوى+ حيوى أعلى محصول حبوب (٤٤٥٠كجم للفدان) والذى زادت انتاجيتها بمقدار ٨٨. ٩ %مقارنة بالكنترول (٤٠٥٠كجم للفدان) وبزيادة مقدرها ٥١.٤ %عن اقل محصول فى معاملة(٣) ٢٩٤٠ كجم للفدان .

وجد أن أفضل عائد أقتصادى عند معاملة ٨ والتى تحتوى على ٥٠% نتروجين معدنى + ٢٥%نتروجين عضوى+حيوى ويليها معاملة ١٠ والتى تحتوى على ٧٥% نيتروجين معدنى + الرش بحمض الهيوميك + حيوى مقارنة بمعاملة الكنترول

ومن هنا يمكن استنتاج أن إستخدام الاسمدة البيولوجية والعضوية كبديل جزئى للاسمدة النتروجينية المعدنية ربما يكون الطريقة المناسبة للحصول على أعلى محصول حبوب ذات جودة عالية وأفضل عائد أقتصادى والحد من تلوث التربة والمياة الناتجة عن الاستخدام الزائد من هذه الاسمدة ..

Table 4. Effect of mineral N and organic accompanied with bio fertilizers on yield and yield component kg/fed of maize during 2013 and 2014 season

Treatments	Ear characters						Total yield kg/fed		
	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	No .of row /ear	No. grain /row	100-grain weight (g)	Grain Yield (kg/fed)	Biological Yield (kg/fed)	Harvest index
T_1 100%M.N.F. (control)	264.33	24.67	5.09	15	51.00	39.0	٤٠٥٠	٨٨٠٤	0.46
T_2 75%M.N.F.	248.00	23.67	4.77	14	44.00	35.0	3651	٨٢٩٨	0.44
T_3 50%M.N.F.	226.67	21.00	4.45	12	36.33	32.0	2940	٧٣٥٠	0.40
T_4 50%M.N.F. + 0.1% HA	230.33	23.00	4.45	13	39.33	35.0	٣٢٦8	٧٧٨١	0.42
T_5 50%M.N.F. + Bio.	239.00	23.50	4.56	14	44.00	36.0	٣٤٠٦	٧٧٤١	0.44
T_6 50%M.N.F. + 0.1% HA+ Bio	257.33	24.00	4.77	14	48.50	38.0	٣٨٩٣	٨٤٦٣	0.46
T_7 50%M.N.F. + 50 % O.N.F	262.33	24.50	4.88	14	49.00	38.5	٣٩٧٦	٨٦٤٣	0.46
T_8 50%M.N.F. + 25 % O.N.F. + Bio	267.33	26.00	5.09	16	52.00	44.0	4450	٩٤٦٨	0.47
T_9 75%M.N.F + 0.1% HA	260.00	23.33	4.77	14	47.00	35.5	٣٧١٧	٨٤٤٨	0.44
T_{10} 75%M.N.F+ 0.1% HA + Bio	265.67	25.67	4.94	15	50.00	42.0	4250	٩٢٣٩	0.46
T_{11} 75%M.N.F. + 25 % O.N.F	264.50	25.00	5.10	15	48.50	41.0	4081	٨٨٧٢	0.46
L.S.D at 5%	14.27	2.34	n.s	2.14	5.88	3.72	190.06	344.72	0.02

Table 5. Effect of mineral N and some accompanied organic with bio fertilizers on N, P and K contents of maize grains of during 2013 and2014 seasons.

Treatments	Grains					
	Nitrogen		Phosphorus		Potassium	
	%	Content (Kg/fed.)	%	Content (Kg/fed.)	%	Content (Kg/fed.)
T_1 100%M.N.F. (control)	1.93	78	0.47	19	0.77	31
T_2 75%M.N.F.	1.70	62	0.38	14	0.64	23
T_3 50%M.N.F.	1.50	44	0.35	10	0.58	17
T_4 50%M.N.F. + 0.1% HA	1.60	52	0.37	12	0.60	20
T_5 50%M.N.F. + Bio.	1.75	60	0.42	14	0.64	22
T_6 50%M.N.F. + 0.1% HA+ Bio	1.85	72	0.44	17	0.64	25
T_7 50%M.N.F. + 50 % O.N.F	1.88	75	0.51	20	0.81	32
T_8 50%M.N.F. + 25 % O.N.F. + Bio	2.08	93	0.48	21	0.79	35
T_9 75%M.N.F + 0.1% HA	1.83	68	0.39	14	0.69	26
T_{10} 75%M.N.F+ 0.1% HA + Bio	1.98	84	0.44	19	0.71	30
T_{11} 75%M.N.F. + 25 % O.N.F	1.95	80	0.49	20	0.78	32
L.S.D at 5%	0.17	7.68	n.s.	3.99	n.s.	6.42

Table 6. Effect of mineral N and some organic accompanied with bio fertilizers on N, P and K content in straw of maize during 2013 and2014 seasons

Treatments	Straw					
	Nitrogen		Phosphorus		Potassium	
	%	Content (Kg/fed.)	%	Content (Kg/fed.)	%	Content (Kg/fed.)
T_1 100%M.N.F. (control)	0.82	39	0.20	10	2.2	105
T_2 75%M.N.F.	0.70	33	0.18	8	1.7	79
T_3 50%M.N.F.	0.52	23	0.15	7	1.3	57
T_4 50%M.N.F. + 0.1% HA	0.60	27	0.17	8	1.5	68
T_5 50%M.N.F. + Bio.	0.65	28	0.19	8	1.5	65
T_6 50%M.N.F. + 0.1% HA+ Bio	0.75	34	0.20	9	1.8	82
T_7 50%M.N.F. + 50 % O.N.F	0.74	35	0.24	11	2.4	112
T_8 50%M.N.F. + 25 % O.N.F. + Bio	0.85	43	0.23	12	2.8	141
T_9 75%M.N.F + 0.1% HA	0.72	34	0.18	9	1.9	90
T_{10} 75%M.N.F+ 0.1% HA + Bio	0.84	42	0.22	11	2.3	115
T_{11} 75%M.N.F. + 25 % O.N.F	0.80	38	0.22	11	2.4	115
L.S.D at 5%	0.09	4.67	0.03	1.80	0.52	24.45

Table 7. Effect of mineral N and some organic accompanied with bio fertilizers on quality parameters of maize during 2013 and 2014 season

Treatments	Protein (%)	Protein yield (kg/fed)	Oil %	Oil yield (kg/fed)	Total soluble Sugars (%)	Starch (%)	Carbohydrate %
T_1 100%M.N.F. (control)	١١.2	454	8.53	345	4.87	67.14	٧٢.٠١
T_2 75%M.N.F.	9. 8	358	7.68	280	4.38	67.2	٧١.٥٨
T_3 50%M.N.F.	٨.٦	253	5.77	170	3.99	63.80	٦٧.٧٩
T_4 50%M.N.F. + 0.1% HA	٩.٢	301	6.42	210	4.15	65.65	٦٩.٨0
T_5 50%M.N.F. + Bio.	١٠.1	344	6.98	238	4.60	64.30	٦٨.٩0
T_6 50%M.N.F. + 0.1% HA+ Bio	١٠.6	413	7.50	292	4.65	67.19	٧١.٨٤
T_7 50%M.N.F. + 50 % O.N.F	١٠.٨	429	7.95	316	4.97	67.92	٧٢.٨٩
T_8 50%M.N.F. + 25 % O.N.F. + Bio	١٢.0	534	9.78	435	5.62	69.92	٧٥.٥٤
T_9 75%M.N.F + 0.1% HA	١٠.5	390	7.44	277	4.78	67.4	٧٢.١٨
T_{10} 75%M.N.F+ 0.1% HA + Bio	11.4	485	8.75	372	4.95	69.01	٧٣.٩٦
T_{11} 75%M.N.F. + 25 % O.N.F	١١.2	457	8.93	364	4.90	68.67	٧٣.٥٧
L.S.D at 5%	1.25	45.29	0.67	26.40	n.s.	0.60	1.53

Table 8: Economic Study

Treatment	Yield/fed.		Income (LE)/fed.			Cost (LE)/fed.						Net Return (LE)/fed.
	Grain (ard. /fed.)	Straw (ton/fed.)	Grain (LE)	Straw (LE)	Total (LE)	Compost	N	HA	Bio	others	total	
T_1 100%M.N.F. (control)	28.9	4.754	8678.6	713.1	9391. 7	-	408	-	-	1000	1408	7983.7
T_2 75%M.N.F.	26.1	4.647	7823.6	697.05	8520.6	-	306	-	-	1000	1306	7214.6
T_3 50%M.N.F.	21.0	4.41	6300	661.5	6961.5	-	204	-	-	1000	1204	5757.5
T_4 50%M.N.F. + 0.1% HA	23.3	4.513	7002.9	676.95	7679.8	-	204	18	-	1000	1222	6457.8
T_5 50%M.N.F. + Bio.	24.3	4.335	7298.6	650.25	7948.8	-	204	-	10	1000	1214	6734.8
T_6 50%M.N.F. + 0.1% HA+ Bio	27.8	4.57	8342.1	685.5	9027.6	-	204	18	10	1000	1232	7795.6
T_7 50%M.N.F. + 50 % O.N.F	28.4	4.667	8520	700.05	9220.1	720	204	-	-	1000	1924	7296.1
T_8 50%M.N.F. + 25 % O.N.F. + Bio	31.8	5.018	9535.7	752.7	10288.4	360	204	-	10	1000	1574	8714.4
T_9 75%M.N.F + 0.1% HA	26.6	4.731	7965	709.65	8674.7	-	306	18	-	1000	1324	7350.7
T_{10} 75%M.N.F+ 0.1% HA + Bio	30.4	4.989	9107.1	748.35	9855.5	-	306	18	10	1000	1334	8521.5
T_{11} 75%M.N.F. + 25 % O.N.F	29.2	4.791	8745	718.65	9463.7	360	306	-	-	1000	1666	7797.7

Ardab of maize = 140 kg **Price of grain (Ard.) =LE 300**
Price of straw (ton) =LE 150 **price of compost (ton) =LE180**
Price of N (50kg) =LE170 **Price of HA (L) =LE 15** **price of bio = LE 10** **Another cost =LE 1000**