Effect of different fertilizers on maize (*Zea mays* L.)

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الملخص:

أجريت تجربتان حقليتان في مزرعة خاصة في كوم حمادة محافظة البحيرة–مصر خلال موسمي الزراعة 2017، 2018 لدراسة تأثير التسميد النيتروجيني، العضوي والحيوي علي نبات الذرة الشامية. وقد أستخدم في هذه التجربة تصميم القطاعات كاملة العشوائية مع ثلاث مكرارات. صنف الذرة هجين فردي كورس 1100، تم خلط البذور ب 1% هيبوكلوريت الصوديوم لمدة خمس دقائق ثم تغسل بالماء وبعدها تلقح بالميكوريزا قبل الزراعة. المعاملات كانت النيتروجين بثلاث معدلات (50، 100، 150 كجم/فدان)، حمض الهيوميكبثلاث معدلات (5، 10، 15 كجم/فدان)، التلقيح بالميكوريزا. أظهرت النتائجأن التلقيحبالميكوريزا مع 100 كجم نيتروجين /فدان اعطت أعلي متوسط لقيم وزن الكوز، طول الكوز، عدد الصفوف/كوز، وزن100 بذرة مقارنة مع المعاملات الآخري. من ناحية آخري، سجلت معاملة حمض الهيوميك بمعدل15 كجم/فدان **مع** 50 كجم نيتروجين /فدان أعلي القيم لمحتوي البروتين و النسب المئوية لكل من الكربوهيدرات والنشا، يتبعها معاملة التلقيحبالميكوريزا مع 150 كجم نيتروجين /فدان، مقارنة مع المعاملات الآخري، خلال كلا الموسمين تحت هذه الدراسة.

ABSTRACT:

Two filed experiments were carried out in a private Farm at KomHamda - Beheira, Governorate, Egypt during the two successive growing seasons of 2017 and 2018 to study the response of maize to nitrogen, organic and bio-fertilization on yield and quality of maize. The used experimental design was randomized complete block design (RCBD) with three replicates. The used maize hybrid (Single Cross 1100), thereafter, the seeds were surface sterilized with 1% sodium hypochlorite for 5 min, washed with sterilized water, and then treated with the microbial inoculants before planting. The treatments were nitrogen at three levels (50, 100, 150 kgN/fed), humic acid (5, 10, 15 kg/fed) and inoculation with mycorrihzae. The obtained results showed that inoculation with mycorrihzae mixed with 100 kgN/fed. gave the highest mean values of ear weight, ear length,number of row/ear and 100-grain weight, as compared with the other treatments. In addition, the treatment of humic acid at 15 kg/fed. plus 50kg/fed N recorded the maximum content of protein, carbohydrates and starch percentages, followed by mycorrihzae mixed with 150 kgN/fed., as compared with the other treatments, during both seasons under this study.

Keywords:maize, nitrogen, biofertiliztion, humic acid, yield components, chemical composition.

INTRODUCTION:

Maize (*Zea mays*, L.) is one of the most important cereal crops in the world both as food and feed. Its total world production ranks third, following wheat and rice, and it is consider a staple food in many countries, especially those in the tropics and sub-tropics **(Mohammadi*et al.,* 2017 and Abdoulaye *et al.,* 2019).** Maize protein belongs to prolamines which are the most abundant type of proteins stored in cereal seeds, like wheat, maize, sorghum, rice, and barley **(Holding, 2014)**. Sugar-rich varieties called sweet corn are usually grown for fresh consumption, while field-corn varieties are used for animal feed and as chemical feedstocks. Moreover, maize is also a major source of oil, gluten, and starch, which can be hydrolyzed and enzymatically treated to produce syrups, particularly high fructose corn syrup. The corn steep liquor, a plentiful watery byproduct of the maize wet milling process, is widely used in the biochemical industry and research purposes as a culture medium to grow many kinds of microorganisms (**Krenz *et al.,* 1999)**. Recently, high consumption of the nitrogen fertilizers by new cultivars of maize plant has significantly increased by 59.60% in the last few years, which causes serious environmental problems (**Abdel Monem*et al.,* 2000)**.

In order to maximize the use of fertilizers economically and reduce the traces of chemical fertilizers in the environment, biofertilizers are considered as a promising alternative approach for maize and other crop species production. Bio-fertilizers can promote plant growth through nitrogen fixation, phytohormone, phosphate (P), and potassium solubilization**(Wu *et al.,* 2005 and Bashan and de-Bashan (2005).**

Bio-fertilizer is a substance contains living microorganisms which applied to seeds, plant surfaces, or soil increase growth by increasing the availability of nutrients to the plant. The using of bio-fertilizers increasing the biological nitrogen fixation, growth hormone and plant antibiotics which improve the evolution of root systems of corn and this method is very important for the environment protection from pollution **(Garg *et al.,* 2005)**. Through the use of bio-fertilizers the healthy plants can be grown while enhancing the sustainability and the health of the soil. The bio-fertilizers play several roles for activates the beneficial bacteria and improve the soil fertility by increase the plant nutrient requirements. Bio-fertilizers do not contain any chemicals which are harmful to the living microorganisms soil.

These biofertilizers are mainly based on beneficial microorganisms in a viable state applied to seed or soil aiming to increase soil fertility and plant growth by increasing the number and biological activity of desired microorganisms in the rhizosphere**(Roa, 1999).**improving such beneficial microbial communities in the soil is an important factor in the biogeochemical cycling of both inorganic and organic nutrients, specifically, in the rhizosphere zone which can increase the availability of nutrients to plants and also improve the soil quality **(Jeffries *et al.,* 2003)**. influence plant community development, nutrient uptake, water relations, and above-ground productivity, and can also act as bio-protectants against pathogens and toxic stresses **(Jeffries*et al.,* 2003)**. Moreover, AMF can improve the plant growth by enhancing the photosynthetic rate and gas exchangerelated traits (**Birhane *et al.,* 2012)** or by increasing the availability and translocation of various nutrients (**Rouphael *et al.,* 2015)**.

In addition to the biofertilizers, the use of organic fertilizers can also reduce the application of chemical fertilizers to a great extent. With the increasing interest in using renewable energy, the production and subsequent use of biomass energy is an important organic source (**Zheng *et al.,* 2015)**.Humicacid (HA) are usually used as a kind of hormone that promotes plant growth rather than improving the chemical or the physical conditions of the soil. Moreover, HA has an important function for improving plant growth via increasing the plant nutrient uptake, transport, and availability of micronutrients. In addition, HA may have an important role for inducing the metabolic activity-related enzymes of soil microorganisms **(Abou-Aly and Mady 2009)**

A recent study has shown that seed germination, seedling growth, soluble protein, sugar, and starch contents were significantly improved by HA priming. Moreover, HA priming has the potential to maintain the balance between the ABA and GA biosynthesis and catabolism **(Sheteiwy *et al.,* 2017)**. Several studies have reported that HA increased the activities of superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase **(Moghadam, 2013)**, and reduced the transpiration rate and water use efficiency of the roots **Asli and Neumann (2010)**.

The current study aimed to evaluate the effect of nitrogen, organic and biofetilizers application on maize hybrid.

MATERIALS AND METHODS:

Two field Experiments were conducted at in a private Farm at KomHamda - Beheira, Governorate, Egypt during the two successive growing seasons of 2017 and 2018 to study the response of maize to nitrogen, organic and bio-fertilization on yield and quality of maize.

The used experimentaldesignwas randomized complete block design (RCBD) with three replicates. The used maize hybrid (Single Cross 1100), thereafter, the seeds were surface sterilized with 1% sodium hypochlorite for 5 min, washed with sterilized water, and then treated with the microbial inoculants before planting. Then, seeds were sowed on15 May 2019 and 2020 in hills, the distance between hills was 25 cm, and 2–3 grains were applied per hill on one side of the ridge. Three weeks and before the first irrigation, the plants were thinned to a one healthy plant per hill.Nitrogenfertilizer in the form of urea (46%N) at three rates(150-100-50 Kg urea/fed was applied in two equal doses, in which the first dose was applied after thinning and before the first irrigation, whereas the second dose was applied before the second irrigation, the bio-fertilization used as arbuscularmycorrhizalfungi.Prior to the transplantation, AM fungi pots were inoculatedwith 200 g of *Acaulosporatuberculata, Gigaspora margarita* and *Glomusintraradices*(1-1-1) mixture containing approximately 100 spores per type. Non AM pots received the same quantity of autoclaved inoculum. The inoculums were placed adjacent to each seeding root.

Samples of soil were collectedat depth 0-30 from the experimental orchard for all treatments, some physical and chemical properties of the experimental soil in**2018chapman and pratt(1978)** as shown **Table (1).**

Table (1): Some Physical and chemical properties of the experimental soil in 2017 and 2018 seasons

Parameter	Value	Unit
Mechanical Analysis		
Sand	68.30	%
Silt	12.02	%
Clay	19.68	%
Textural class	**Sandy loam**	
pH (1:1)	7.46	-
Ca co_3	3.0	%
EC(1:1, water extract)	0.61	dS/m
O.M	0.21	
Soluble cations		
Ca^{2+}	2.0	meq/l
Mg^{2+}	1.0	meq/l
Na^{+}	2.7	meq/l
K^{+}	0.4	meq/l
Soluble anions		
$HCO3^{-}$	3.8	meq/l
Cl^{-}	1.8	meq/l
SO_4^{2-}	1.5	meq/l
Available nutrients		

Nitrogen (N)	210	mg/l
Phosphorus (P)	67.25	mg/kg
Potassium (K)	750	mg/kg

The preceding crop wasEgyptian clover (berseem) in the first season and barley (*Hordiumvulgare*, L.) in the second season, respectively.

At harvest the three inner rows were used for grain yield estimation. The following data were recorded:

Yield and its components

Ear weight (g), ear length (cm), number of rows/ear, 100-grain weight (g).

1. Chemical characters:

- Grain protein content according of seeds protein percentage to**A.O. A.C. (1990).**
- Starch percentage (%) was determined using a sample of 0.1 g of the residue by hydrolysis with concentrated HCl for 3h under reflux condenser **(AOAC, 1985).**
- Total carbohydrates were determined, quantitatively, in corn seeds by Anthron method according to **Mahadevan and Sridhar (1986)** as follows:

  Extraction was carried out by grinding dry matter in Mahadavan buffer (sodium citrate buffer, pH 6.8). Extracts were homogenized for 3 minutes and centrifuged at 4000 rpm for 15 min. the supernatant was then used to determine total carbohydrates.

All data obtained were statistical according to procedures described by **Gomez and Gomez (1984).**

RESULTS AND DISCUSSIONS

A) Yield and its components

- Ear weight (g)

The results tabulated in **Table (2)** revealed thatresponse maize to nitrogen, humic acid and mycorrihae on ear weight during 2017 and 2018 seasons. Results showed that the height mean values of ear weight (227.51 and 237.00 g) recorded by mixed AM+100kg/fed N, followed by mixed AM+50kg/fed N (219.83 and 233.45 g), while nitrogen fertilizer at rate 50kg/fed gave the lowest mean values of ear weight (43.44 and 50.31 g), during both seasons under this study.

- Ear length (cm)

Results in **Table (2)** showed that the higher ear length recorded by AM+100kg/fed. N (20.55 cm) in the first season, while mixed AM+50kg/fed N gave the higher ear length (26.09 cm) in the second season, while nitrogen fertilizer at rate 50kg/fed recorded the shortest ear length (12.21 and 13.65 cm), during both seasons.

This result agrees with the result of **Mahdi and Ismail (2015)**who reported that cob length increased with increasing nitrogen level. A similar result wasconfirmed by **Saha*et al.* (1994)**who reported that cob length tended to decline withincreasing plant population.

- Number of row/ear

Results as shown in **Table (2)** indicated that AM+ nitrogen fertilizer concentrations significant effect on number of row/ ear during both seasons. However, the maximum number of row/ ear was recorded by mixed AM+150kg/fed N (13.60 and 14.66), followed by mixed AM+100kg/fed N (13.31 and 14.31), as compared with nitrogen fertilizer at rate 50kg/fed which gave the lowest mean values of number of row/ ear (9.66 and 10.30), during both seasons.

- 100-grain weight

Results presented in **Table (2),** show the effect of nitrogen, humic acid and mycorrihae application on 100-grain weight of maize. The results showed significant differences among all treatments in 2017 and 2018 seasons. It is clear that 100-grain weight increments were more pronounced with mixed AM+100kg/fed N (35.48 and 31.90 g), followed by mixed AM+150kg/fed N (33.73g) in the first season and mixed 15 kg/fed Humic acid +50kg/fed N (31.40g), while nitrogen fertilizer at rate 50kg/fed recorded the lowest mean values of 100-grain weight (19.72 and 20.11 g), during both seasons under this study.

The favorable effect of humic acid treatments might have been due to the effective role in improvement early maize growth more dry matter accumulation and stimulated the building of metabolic products that translocate to grains. Moreover, the describable effects in improvement in plant growth characters such as plant height and ear leaf area which reflected in turn increase in the different yield components such as ear length number of kernels/ear and 100- grains weight. These findings are in coincidence with those recorded by **Chen *et al*. (1999), Bakry*et al.* (2009), Attia*et al*. (2013) and Balbaa and Awad (2013).**

Table(2). Ear weight (g), ear length (cm), number of row/ear, 100- grain weight as affected by nitrogen, organic and biofertili
during 2017/2018 seasons.

Treatments	Ear weight (g)		Ear length (g)		No. of row/ear		10
	2017	2018	2017	2018	2017	2018	20
150kg/fed. N	71.33gh	78.80g	14.03c-h	17.33de	11.33e-h	12.60a-f	22.
100kg/fed. N	61.50hi	72.90gh	14.73f-h	17.40c-f	11.13gh	12.32b-g	25.8
50kg/fed. N	43.44j	50.31ij	12.21i	13.65hi	9.66h	10.30gh	19.
5 kg/fed Humic acid −50kg/fed N	78.00g	85.11g	14.93f-h	17.48c-e	11.30e-h	12.63a-f	25.
10 kg/fed Humic acid +50kg/fed N	126.22f	140.92e	15.55fg	18.75b-d	11.35e-h	13.38a-e	26.3
15 kg/fed Humic acid +50kg/fed N	162.10d	167.00d	16.13ef	18.66 b-d	11.62d-h	14.00a-c	33.4
AM+50kg/fed N	219.83b	233.45a	20.51a	26.09a	13.31a	14.31ab	33.0
AM+100kg/fed N	227.51a	237.00a	20.55a	22.03 a	13.60a	14.66a	35.
AM+150kg/fed N	211.16c	224.66b	18.56b-d	19.18a-c	12.0c-g	13.60a-d	33.7

B) Chemical composition

- Protein (mg/g f.w.)

Results in **Table (3)** demonstrated that all treatment significant affected on protein content in maize seeds during 2017 and 2018 seasons. However, the highest mean values of protein content was recorded by mixed 15 kg/fed Humic acid +50kg/fed N (342.61 and 360.71mg/g f.w.),followed by mixed AM+150kg/fed N (282.72 and 288.56 mg/g f.w.), as compared with nitrogen fertilizer at rate 50kg/fed which gave the lowest mean values of protein content (85.84and 94.44 mg/g f.w.), during both seasons.

- Carbohydrate (%)

Results in **Table (3)** indicated that all treatment significant affected on carbohydrate percentage in maize seeds during 2017 and 2018 seasons. However, the highest mean values of carbohydrate percentage was recorded by mixed 15 kg/fed humic acid +50kg/fed N (53.44 and 64.43 %), followed by mixed AM+150kg/fed N (46.48 and 55.58%), as compared with nitrogen fertilizer at rate 50kg/fed which gave the lowest mean values of carbohydrate percentage (22.88 and 29.11%), during both seasons.

- Starch (%)

Results as shown in **Table (3)** detected thatall treatment significant increased on starch percentage in maize seeds during 2017 and 2018 seasons. However, the highest mean values of starch percentage was recorded by mixed 15 kg/fed Humic acid +50kg/fed N (35.58 and 47.64 %), followed bymixed 10 kg/fed humic acid +50kg/fed N (32.35 and 40.95 %), as compared with nitrogen fertilizer at rate 50kg/fed which gave the lowest mean values of starch percentage (14.50 and 17.92 %), during both seasons.

Table (3). Protein content (mg/g f.w.), carbohydrate (%) and starch (%) as affected by nitrogen, organic and biofertilization on maize during 2017/2018 seasons.

Treatments	Protein (mg/g f.w.)		Carbohydrate (%)		Starch (%)	
	2017	2018	2017	2018	2017	2018
150kg/fed. N	114.08ij	128.11hi	32.08	37.44gh	19.13k	23.15i
100kg/fed. N	107.10jk	110.42jk	25.36l	33.72hi	16.35l	20.90j
50kg/fed. N	94.44kl	85.84l	22.88m	29.11k	14.50l	17.92k
5 kg/fed Humic acid +50kg/fed N	113.93ij	130.77hi	32.80	40.33f	19.50jk	23.44i
10 kg/fed Humic acid +50kg/fed N	133.25h	138.75hi	39.83ij	46.40d	32.35h	40.95b
15 kg/fed Humic acid +50kg/fed N	342.61a	360.71a	53.44a	64.43a	35.58a	47.64a
AM+50kg/fed N	190.53f	197.71g	39.52fg	51.48c	27.26gh	29.00fg
AM+100kg/fed N	243.11d	247.11cd	43.45e	53.93c	30.86e	33.22d
AM+150kg/fed N	282.72b	288.56b	46.48b	55.58b	30.49ef	35.73c

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