Minufiya J. Agric. Res. Vol.38 No. 2(1): 385 - 394 (2013) **"http://www.mujar.net"**

USING HUMIC ACID AS A PARTIAL REPLACEMENT OF MINERAL N FERTILIZER IN CORN (*ZEA MAYS*) GROWN IN SANDY SOIL

N. E. M. Mohamed
Agronomy Dept. Fac. of Agric. Souhag Univ., Egypt.

(Received: Jan. 9, 2013)

ABSTRACT: *Two field experiments were carried out during 2010 and 2011 seasons to investigate the effect of using humic acid at 1.0 to 3.0 kg/ fed as a partial replacement of mineral N fertilizer on growth, yield, yield components and chemical composition of seeds and leaves of corn cv. S.C 101.*

The growth characters, yield, yield components, proteins % as well as N, P, K and Mg in the leaves (except number of rows/ ear and shelling %) were considerably affected by varying percentages of mineral N as well as humic acid levels. Using mineral N (90 kg/ fed) through 75 % mineral + 2.0 kg humic acid/ fed gave the best results in most cases. Reducing percentages of mineral N from 75 to 50 % even with the application of humic acid gave the lowest results of yield and its components.

Supplying corn cv. S.C 101 plants with N at 90 kg/ fed through 75 % mineral N plus 2.0 kg humic acid/ fed was responsible for improving yield and its components.

Key words : *Corn – zea mays – mineral fertilizer – humic acid – yield.*

INTRODUCTION

In Egypt, large areas of desert lands are sandy soil, which is low in organic matter content as well as low in macro and micro nutrients. So, organic fertilizer is one of the limiting factor for horizontal agricultural expansion especially under Egyptian conditions of arid and semi arid areas (Saleh *et al.*, 1997) and should be added to enhance organic matter and N content in the soil (Kannaiyan, 2002).

Increasing population resulted in broad demand for food at last two decades. To meet this demand might be difficult because current fields are not accountable and yield loss clearly appears. Under these conditions, agriculture could not supply growing global requirement to food. Corn is one of the high yielding cereals that ranked as third cereal crop after wheat and rice to supply global population consumption (FAO, 2011).

Corn (*Zea mays*) follows family Gramineae. In Egypt it is considered one of the most important crops and the principal source of feeding for many people of the world, particularly the third world and Egypt admits.

Humic substances exert an influence on soil fertility and biological activity of soil and consequently, they indirectly affect the growth and development of plants. They have positive action on plant metabolism, photosynthesis and cell division. Using them at various developmental stages stimulates rooting as well as the growth of aboveground parts. They can also have a positive effect on nutrients uptake (Fernandez- Escobar *et al.*, 1996; Nardi *et al.*, 2002; Canellas *et al.*, 2002; Muscolo *et al.*, 2007; Marino *et al.*, 2008 as well as Verlinden *et al.*, 2009 and 2010).

Using humic substances and organic manures as a partial replacement of mineral N was found by many authors to enhance growth, uptake of nutrients, yield and yield components of many field crops especially cereals (Ayuso *et al.*, 1996; Saleh *et al.*, 1997; Zahran *et al.*, 1997; El- Beshbeshy, 2000; Abdel- Aziz *et al.*, 2000; Ali 2001; El-Douby *et al.*, 2001; Sheriff, 2002; El- Douby, 2002; Jones *et al.*, 2004; Chen, 2006; Ulukan, 2002 and 2008; Asik *et al.*, 2009; Verlinden *et al.*, 2009 and 2010; Szczepanck and Wilczewski, 2011 and Babaogh *et al.*, 2012).

This study aimed to study the effect of using humic acid partially instead of mineral N fertilizer on growth, nutrient uptake, yield and its components of corn cv. S.C 101 grown under sandy soil.

MATERIALS AND METHODS

Two field experiments were preformed during 2010 and 2011 seasons in the newly reclaimed sandy soil of New Farm of Fac. of Agric. Souhag Univ., El- Kawthar, Souhag district, Souhag Governorate. The soil had an average pH value of 7.5, 3.39 ds m^{-1} EC, 0.64 % organic matter, 12 % $CaCO_3$, 0.95 % total N, 13 ppm available P and 232 ppm available K for the upper 30 cm of soil depth (according to the procedures outlined in Cottenie *et al*., 1982). Corn plants were preceded by wheat in the two seasons. Each experiment included nine treatments . A randomized complete blocks design with three replicates was adopted . The area of each plot was 10.5 m^2 (1 / 400 fed.), consisted of five ridges, 3m. long and 70 cm apart . Hills in ridges were 25 cm apart. The two outer rows were left to guard against compatibility from adjacent plots, where the other three rows were used for yield and yield component measurements.

Seeds of corn cv. S.C 101 were sown on the second week of May, two kernels per hill (12 kg. seeds/ fed.). After complete germination, the hills were thinned to one plant per hill. Other cultural practices were carried out as recommended for Souhag region.

This study involved the following nine treatment from mineral N and humic acid applications.

1- Application of 100% the mineral N (90 kg/ fed.) .
2- Application of 87.5 % of the mineral N plus 1.0 kg humic acid/ fed.
3- Application of 87.5 % of the mineral N plus 1.5 kg powdered potassium humate (85 % humic acid)/ fed.
4- Application of 75 % of the mineral N plus 1.5 kg humic acid/ fed.
5- Application of 75 % of the mineral N plus 2.0 kg powdered potassium humate/ fed.
6- Application of 62.5 % of the mineral N plus 2.0 kg humic acid/ fed.
7- Application of 62.5 % of the mineral N plus 2.5 kg powdered potassium humate/ fed.
8- Application of 50 % of the mineral N plus 2.5 kg humic acid/ fed.
9- Application of 50 % of the mineral N plus 3.0 kg powdered potassium humate/ fed.

The amount of mineral N was splitted into two equal doses, side dressed after thinning before the first irrigation and the rest before the second irrigation. The amount of powdered potassium humate was put in hills before sowing according to the previous amounts.

Data were collected from each plot basis, for measuring the following characters:-

1- Growth characters:-

Ten guarded plants from each plot were selected randomly in the two seasons, to recorded the following traits :

1- Plant height (cm.) (the distance between the ground surface till the base of tassel).
2- Stem diameter (mm) .
3- Number of green leaves per plant.
4- Leaf area of topmost ear (cm^2) was calculated according to the following equation reported by Alessi and Power (1975) and Radford (1967).

Leaf area= leaf length × maximum width × 0.75

5- First ear height (cm.).
6- Barren plants %.
7- Lodged and broken plants % was calculated by dividing the number of plants having angles more than 30 ْC in addition to the broken plants by total number of normal plants and multiplying the product by 100.
8- Plants carried two ears %.

At harvesting time (1st week of Sept. during both seasons), the following characters were recorded as the average of ten plants randomly chosen from each plot.

1. Number of ears per plant.
2. Ear weight (g.).

3. Ear dimensions (length, in cm and diameter in mm).
4. Number of rows/ ear and number of kernels/ row.
5. Number of kernels / row .
6. Weight of 100 kernels (g.).
7. Weight of kernels/ ear (g.).
8. Shelling % was calculated by dividing kernel weight per ten ears by weight of ten ears and multiplying the product by 100.
9. Grain yield / plant (gm) .
10. Grain yield / fed.
11. Proteins % in the dry seeds (according to A.O.A.C., 1995).
12. Percentages of N, P, K and Mg were determined in the leaves lateral bearing ears at the start of silking stage according to Mengel and Kirkby (1987) and Wilde *et al.*, (1985).

Data were subjected to the proper statistical analysis of variance according to the procedure outlined by Mead *et al.*, (1993). The treatment means in both seasons were compared using new L.S.D at 0.05.

RESULTS AND DISCUSSION

1- Growth characters:-

It is clear from the data in Table (1) that application of the mineral N (90 kg N/ fed) through 75 % to 87.5 % mineral N plus humic acid at 1.0 to 2.0 kg/ fed. significantly improved the five growth characters namely plant height, stem diameter, number of green leaves/ plant, leaf area and ear height in relative to using N via mineral N at percentages ranged from 50.0 to 62.5 % with humic acid or when N applied via mineral N at 100 %. Reducing mineral N from 75 to 50 % even with the application of higher amounts of humic acid (2.0 to 3.0 kg/ fed.) significantly was followed by a great reduction on theses growth characters. Using the mineral N completely via inorganic N was significantly superior than using N via mineral source at percentages lower than 75 % even with the application of humic acid. As a general increasing levels of humic acid from 0.0 to 2.0 kg/ fed, regardless the amount of mineral N had a significant and gradual promotion on these growth characters. The maximum values were recorded from the plants which received N through 75 % mineral N + 2.0 kg humic acid/ fed. Treating the plants with N via 50 % mineral N + 2.5 kg humic acid per fed. gave the lowest values. These results were true during both seasons.

The promoting effect of humic acid on growth characters might be attributed to its positive action on enhancing soil fertility, cell division, photosynthesis (Verlinden, 2009 and 2010). The negative action of higher mineral N on increasing plant lodging as well as the great tendency to pest incidence and producing broken plants could explain the present results.

These results are in agreement with those obtained by Asik *et al.*, (2009); Verlinden *et al.*, (2010); Szczepanek and Witczewski (2011) and Babaogh *et al.*, (2012).

2- Percentages of barren plants, lodged and broken plants and plants carried two ears:-

It is clear from the data in Table (1) that supplying the plants with the suitable N via 75 to 87.5 % mineral N plus humic acid at 1.0 to 2.0 kg/ fed. significantly was accompanied with enhancing the percentage of plants carried two ears and at the same time reducing percentages of barren plants and lodged and broken plants rather than using N through 50 to 62.5 % N + humic acid at 2.0 to 3.0 kg/ fed. as well as when N was applied at 100 % mineral N. The reduction or the promotion was significantly associated with increasing humic acid levels from 1.0 to 2.0 kg/ fed. Reducing the percentages of mineral N from 75 to 50 % as well as increasing humic acid levels from 2 to 3.0 kg/ fed. significantly increased the percentages of barren plants and lodged and broken plants, while it was responsible for reducing percentage of plants carried out two comparing with the other treatments. Using the suitable N through 100 % mineral significantly was responsible for reducing barren plants % as well as lodged , broken plants % and increasing the percentage of plants that

Table 1

carried two ears in relative to using mineral N at percentages lower than 75 %. The minimum percentages of barren plants as well as lodged and broken plants % and the maximum percentage of plants that gave two ears were recorded on the treatment that included the application of N through 75 % mineral N plus 2.0 kg. humic acid/ fed. Supplying the plants with N via 50 % mineral N + humic acid at 3.0 kg/ fed. gave the highest values of barren plants as well as lodged and broken plants percentages as well as the lowest percentage of plants that carried out two ears. These results were true during both seasons.

The beneficial effect of the optimum rate of mineral N as well as humic acid on reducing barren, lodged and broken plants as well as increasing the percentage of plants which carried two ears might be attributed to the production of health and vigour plants.

These results are in agreement with those obtained by Asik *et al*., (2009); Verlinden *et al*., (2010); Szczepanek and Witczewski (2011) and Babaogh *et al*., (2012).

3- Yield and yield components:-

Data in Tables (2 & 3) obviously reveal that varying N management treatments had significant effect on yield per plant and per fed. and yield components namely, number of ears per plant; weight and dimensions of ear, number of kernels per row, 100 kernel weight and kernel weight/ ear. Number of rows per ear and shelling % did not alter significantly with mentioned treatments. Using N through 75.0 to 87.5 % plus humic acid at 1.0 to 2.0 kg/ fed. significantly succeeded in improving the yield and its components in relative to using N completely via mineral N or when mineral N was applied at percentages lower than 75 % even the application of humic acid. There was a gradual promotion on yield and its components with increasing levels of humic acid from 1.0 to 2.0 kg/ fed. As a general increasing rates of humic acid under the same level of mineral N significantly enhanced yield and its components. A great and significant decline on yield and its components was observed when mineral N was added at percentages lower than 75 % as well as when N was applied completely via mineral source. The best results with regard to yield and its component of corn plants were obtained with using N through 75 % mineral N + 2.0 kg humic acid/ fed. Yield per fed. under such promised treatment reached 4.92 and 4.71 tons grain in relative to 3.59 and 3.51 tons per fed produced in plants treated with N completely via mineral N. The lowest yield (2.10 and 2.21 tons) was recorded when the plants were fertilized with N through 50 % mineral N + 2.5 kg humic acid. The results were announced during both seasons.

The beneficial effect of humic acid and application of the optimum mineral N rate on the yield and yield components was mainly attributed to their positive action on enhancing nutritional status of the plants and the biosynthesis of organic foods (Marino *et al*., 2008).

These results are in concordance with those obtained by El- Douby *et al*., (2001); Sheriff (2002); El- Douby (2002) and Ulukan (2008).

4- Chemical composition of seeds and leaves:-

Table (3) shows that amending corn plants with N through 75 to 87.5 % mineral N plus humic acid at 1.0 to 2.0 kg/ fed significantly was accompanied with enhancing the percentage of proteins in the seeds and the percentage of N in the leaves in relative to using N completely via mineral source as well as when N was applied at percentages lower than 75 % even with humic acid application. However, there was a gradual and significant promotion on P, K and Mg percentages in the leaves with reducing percentages of mineral N from 100 to 50 % and at the same time increasing humic acid levels from 1.0 to 3.0 kg/ fed. There was a significant reduction on proteins % in the seed and leaf N content with reducing mineral N percentages from 75 to 50 % + using humic acid at 2.0 to 3.0 kg/ fed. The maximum proteins and N % was presented with using N via 75 % mineral N plus 2.0 kg humic acid/ fed. The

Table 2

Table 3

highest P, K and Mg in the levels were recorded on the plants that fertilized with N via 50 % mineral N plus 3.0 kg humic acid/ fed. These results were true during both seasons.

The positive action of humic acid on improving soil fertility and uptake of different nutrients could explain the present results. The antagonism on the uptake of N from one side and P, K and Mg uptake on the other side could explain the present results.

These results are in concordance with those obtained by El- Douby *et al.*, (2001); Sheriff (2002); El- Douby (2002) and Ulukan (2008).

From the foregoing results, it could be concluded that the highest corn grain yield/ fed could be obtained by supplying S.C 101 corn plants with N (90 kg/ fed.) through 75 % mineral N plus 2.0 kg humic acid/ fed.

REFERENCES

Abdel- Aziz, S. M., N. Kh. Kandel, I. A. Hussein and S. M. M. Aliam (2000). Soil conditions and their role in plantavailable nutrients status in sandy soil. Fayoum J. Agric. Res. & Dev. 14 (1): 46 – 53.

Alessi, J. and J. F. Power (1975). Effect of plant spacing on phonological development of early and mid season corn hybrids in arid region. Crop Sci., 15: 179 – 182.

Ali, L. K (2001). Use improved organic fertilizers as nutrients sources. Ph. D. Thesis, Fac. of Agric. Ain Shams Univ., Egypt.

Association of Official Agricultural Chemists (1995). Official Methods of Analysis (A.O.A.C). 14th Ed. A.O.A.C Benjamin Franklin Station Washington, D.C, U.S.A. pp 490 – 550.

Asik, B., M. Turan, H. Celik and A. Katkat (2009). Effect of humic substances on plant growth and mineral nutrients uptake of wheat (*Triticum durum* cv. *salihli*) under conditions of salinity. Asian J. Crop. Sci. 1 (2): 87 – 95.

Ayuso, M., T. Hernandes, C. Garcia and J. Pascual (1996). Stimulation of barley growth and nutrient absorption by humic substances originating from various organic materials. Biores. Technol 57: 251 – 257.

Babaogh, F., F. R. Khoeal and Y. Mehrdad (2012). Effect of biological fertilizer on yield and yield components of corn (*Zea mays*) cv. S.C. 504 in drought conditions J. Appl. Environ. Biol. Sci. 2 (3): 117 – 122.

Canellas, L., F. Olivares and Okorokova-Facanha, A. (2002). Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence and plasma membrane H^+- ATPase activity in maize roots. Plant Physiol. 130, 1951 – 1957.

Chen, J. (2006). The combined use of chemical and organic fertilizers and/ or biofertilizer for crop growth and soil fertility. Inter. Workshop on Sust. Mana. of the soil- Rhizosphere system for Efficient Crop Produvtion and Fertilizer Use, Thailand 11 pp 16 – 20 .

Cottenie, A., M. Verloo, M. Velghe and R. Camerlynck (1982). Chemical Analysis of Plant and Soil. Laboratory of Analytical and Agro chemistry. State Univ. Ghent, Belgium.

El- Beshbeshy, T. R. A. (2000). Partial substitution of chemical fertilization by composted plant residues in the nutrient of wheat growth on sandy soil. Minia J. of Agric. Res. and Dev. 20 (3): 412 – 418.

El- Douby, K. A. (2002). Effect of preceding crops and bio- mineral nitrogen fertilizer on growth and yield maize. Annals of Agric. Sci. Moshtohor, 40 (1): 27 – 37.

El- Douby, K. A., E. A. Ali, S. E. A. Toaima and A. M. Abdel- Aziz (2001). Effect of nitrogen fertilizer, defoliation and plant density on maize grain yield. Egypt. J. Agric. Res. 79 (3): 965 – 982.

Fernadez- Escobar, R., M. Benlloch, D. Barranco, A. Duenas and J. Ganan (1996). Response of olive trees to foliar application of humic substances extracted leonardite. Sci. Hortic. 66, 191 – 200.

Food Agriculture Organization (F.A.O.) (2011). Quarterly Bulletin of Statistics Vol. 14 No. (1), Year Book Annuairo Production , 45 : 154 – 156 .

Jones, C. A., J. S. Jacobsem and A. Mugaas (2004). Effect of humic acid on phosphorus availability and spring wheat yield. Fac. Ann. of Agric. Sci. Moshtohor, 32 (2): 645 –656.

Kannaiyan, S. (2002). Biotechnology of Biofertilizers. Alpha Sci. Inter. Ltd., P.O. Box 4067 Pangbourne R. 68 U.K pp 1 – 275.

Marino, G., O. Francioso, P. Carletti, S. Nardi and C. Gessa (2008). Mineral content and root respiration of in vitro grown kiwifruit plantlets treated with two humic fractions. J. Plant Nutr. 31, 1074 – 1090.

Mead, R., R. N. Currow and A. M. Harted (1993). Statistical Methods in Agricultural and Experimental Biology. Second Ed. Chapman & Hall London. pp 10 - 44.

Mengel, K. and E.A. Kirkby (1987). Principles of Plant Nutrition. 4th ed.. International Potash. Institute, Warblaufen, Bern Switzerland.

Muscolo, A., M. Sidari, E. Attina, O. Francioso, V. Tugnoli and S. Nardi (2007). Biological activity of humic substances is related to their chemical structure. Soil Sci. Soc. Am. J. 71 (1), 75 – 85.

Nardi, S., D. Pizzeghello, A. Muscolo and A. Vianello (2002). Physiological effects of humic substances on higher plants. Soil Biol. Biochem. 34, 1527 – 1536.

Radford, J. (1967). Growth analysis formula, Their use and abuse (Crop Sci. 7: 171 – 175).

Saleh, A. L., R. A. Youssef and F. L. Header (1997). Influence of sewage sludge and bentonite application on yield and chemical composition of carrot (*Davcus carotal*). J. Agric. Sci. Mansora Univ. 22 (2): 599 – 607.

Sheriff, M. (2002). Effect of lignite coal derived humic substances on growth and yield of wheat and maize in alkaline soil. Ph. D. Thesis NW FD. Agric. Univ. Peshawar, Pakistan.

Szczepanek, M. and E. Wilczewski (2011). Effect of humic substances on germination of wheat and barley under laboratory conditions. Acta Sci. Pol., Agricultural 10 (1): 79 – 86.

Ulukan, H. (2007). Humic acid application into field crops. Cultivations Sci. Eng. 11 (2): 110 – 115.

Ulukan, H. (2008). Effect of soil applied humic acid at different sowing times on some yield components in wheat hybrids. Inter. J. of Botany 4 (10): 164 – 175.

Verlinden, G., T. Coussens, A. Vilegher, G. Baert and G. Haesaert (2010). Effect of humic substances on nutrients uptake by herbage on production and nutritive value of herbage from sown grass pastures. Grass Forage Sci. 65, 133 – 144.

Verlinden, G., B. Pycke, J. Metens, F. Debersaques, K. Verheyen, G. Baert, J. Bries and G. Haesaert (2009). Application of humic substances results in consistent increases in crop field and nutrient uptake. J. Plant Nutr. 32 (9), 1407 – 1426.

Wilde, S.A., R.B. Corey, J.G. Lyer and G.K. Voigh (1985). Soils and Plants Analysis for Tree Cultures . Published by Mohan Primalans , Oxford , IBH , Publishing Co., New Delhi , India , pp. 1 – 142 .

Zahran, F. A., E. M. El- Mersawy and Abd El- Ghany- Haifaa, S. (1997). Effect of nitrogenous and biofertilizers on late wilt, downy diseases and yield of maize. Ann. of Agric. Sci. Moshtohor, 35 (4): 2641 – 2652.

استخدام حامض الهيوميك كبديل جزئي للسماد النيتروجيني المعدني للذرة الشامية النامي في التربة الرملية

نحيف إبراهيم محمد محمد

قسم المحاصيل – كلية الزراعة – جامعة سوهاج – مصر.

الملخص العربي

تم تنفيذ تجربتان حقليتان خلال موسمي ٢٠١٠ ، ٢٠١١ لدراسة تأثير استخدام حامض الهيوميك بمعدل ١ الي ٣ كجم للفدان كبديل جزئي للسماد النيتروجيني المعدني علي النمو والمحصول ومكوناته والتركيب الكيماوي للبذور والأوراق للذرة الشامية (صنف هجين فردي ١٠١) .

تأثرت جميع صفات النمو الخضري ، المحصول ومكوناته والنسبة المئوية للبروتين وعناصر النيتروجين والفوسفور والبوتاسيوم والماغنيسيوم (ما عدا صفتي عدد صفوف الكوز ونسبة التفريط) باختلاف النسب المئوية المستخدمة للسماد النيتروجيني المعدني وكذلك المعدلات المستخدمة من حامض الهيوميك . وأعطي استخدام (٩٠ كيلو جرام نيتروجين) في صورة ٧٥ % سماد نيتروجين معدني + ٢ كجم حامض الهيوميك للفدان أفضل النتائج في معظم الحالات أما أقل النتائج لصفات المحصول ومكوناته فقد تم الحصول عليها عند تقليل النسبة المئوية للسماد النيتروجيني المعدني من ٧٥ الي ٥٠ % حتي مع استخدام حامض الهيوميك (٢ كجم للفدان / السنة) .

إن تسميد نباتات الذرة الشامية صنف هجين فردي ١٠١ بالنيتروجين بمعدل ٩٠ كجم للفدان من خلال ٧٥ % سماد نيتروجيني معدني بالإضافة إلى إستخدام حامض الهيوميك بمعدل ٢ كجم للفدان كان فعالا لتحسين المحصول ومكوناته .

Table (1): Effect of mineral N and humic acid treatments on some growth and agronomic characters of corn plants during 2010 and 2011 seasons.

Mineral N and humic acid treatments	Plant height (cm.)		Seem diameter (mm)		No. of green leaves/ plant		Leaf area of topmost ear (cm^2)		1st Ear height (cm.)		Barren plants %		Lodged and broken plants %		Plants carried two ears %	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
100 % mineral N	262.0	252.0	18.11	18.00	17.5	18.0	611.1	641.0	144.1	139.0	5.55	5.44	12.21	11.97	16.12	16.20
87.5 % mineral N + 1.0 kg humic	271.0	261.2	18.61	18.50	18.0	18.6	641.2	664.0	149.0	144.1	5.20	5.09	11.44	11.20	17.50	17.61
87.5 % mineral N + 1.5 kg humic	277.0	267.0	19.00	18.92	18.8	19.5	661.3	690.2	152.4	146.9	4.81	4.69	10.58	10.32	18.92	18.94
75 % mineral N + 1.5 kg humic	282.0	271.0	19.30	19.20	19.0	19.5	681.0	711.0	155.1	149.1	4.42	4.31	9.72	9.48	20.11	20.00
75 % mineral N + 2.0 kg humic	284.0	275.0	19.17	19.61	19.5	20.0	701.2	750.0	156.2	151.3	4.00	3.91	8.81	8.62	21.50	21.40
62.5 % mineral N + 2.0 kg humic	246.9	237.0	17.22	17.11	16.5	17.0	591.0	585.1	135.9	130.0	6.41	6.31	14.10	13.90	13.52	13.50
62.5 % mineral N + 2.5 kg humic	254.0	244.0	17.60	17.50	17.0	17.5	599.2	611.1	140.0	134.0	5.94	5.83	13.00	12.83	14.71	14.70
50 % mineral N + 2.5 kg humic	231.0	222.0	16.21	16.11	15.0	15.5	551.1	531.0	127.1	122.9	7.11	6.99	15.64	15.37	11.22	11.21
50 % mineral N + 3.0 kg humic	241.0	231.0	16.61	16.50	15.5	16.0	581.0	561.0	133.0	127.1	6.75	6.63	14.85	14.58	12.35	12.30
New L.S.D at 0.05	5.1	5.2	0.27	0.30	1.0	1.0	20.1	21.1	2.9	3.0	0.33	0.29	0.35	0.36	1.11	1.21

Table (2): Effect of mineral N and humic acid treatments on some yield components of corn plants during 2010 and 2011 seasons.

Mineral N and humic acid treatments	No. of ears/ plant		Ear weight (g.)		Ear length (cm.)		Ear diameter (mm)		No. of rows per ear		No. of kernels per row		100 Kernel weight (g.)		Kernel weight (g.)/ ear	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
100 % mineral N	1.46	1.45	201.9	203.0	17.4	17.5	39.11	39.15	12.70	12.75	38.2	38.5	33.77	33.50	163.8	164.4
87.5 % mineral N + 1.0 kg humic	1.52	1.50	217.8	218.8	17.8	17.9	40.12	40.16	12.80	12.84	40.5	40.8	34.10	33.83	176.8	177.2
87.5 % mineral N + 1.5 kg humic	1.60	1.59	227.2	228.6	18.2	18.3	41.90	41.95	12.86	12.90	42.0	42.4	34.30	34.03	185.3	186.1
75 % mineral N + 1.5 kg humic	1.67	1.66	234.9	236.3	18.7	18.8	42.95	43.00	12.90	12.97	43.1	43.4	34.55	34.28	192.1	193.0
75 % mineral N + 2.0 kg humic	1.70	1.69	243.2	244.0	19.1	19.2	43.11	43.12	12.95	12.99	44.2	44.5	34.77	34.50	199.0	199.4
62.5 % mineral N + 2.0 kg humic	1.33	1.32	185.5	185.6	16.6	16.6	38.11	38.20	12.62	12.65	35.9	36.1	33.00	32.71	149.5	149.4
62.5 % mineral N + 2.5 kg humic	1.40	1.40	194.4	194.9	17.0	17.1	38.91	93.00	12.66	12.71	37.0	37.2	33.50	33.23	156.9	157.1
50 % mineral N + 2.5 kg humic	1.13	1.12	164.0	166.2	16.0	16.0	36.60	36.70	12.50	12.55	33.0	33.3	32.11	31.84	132.5	133.1
50 % mineral N + 3.0 kg humic	1.20	1.15	171.7	173.0	16.3	16.4	37.11	37.20	12.55	12.60	34.1	34.5	32.50	32.22	139.1	140.1
New L.S.D at 0.05	0.23	0.21	5.0	4.9	0.3	0.3	0.51	0.51	NS	NS	0.60	0.62	0.16	0.15	5.1	5.0

Table (3): Effect of mineral N and humic acid treatments on shelling %, yield, yield components as well as proteins in seeds and leaf N, P, K and Mg in the leaves of corn plants during 2010 and 2011 seasons.

Mineral N and humic acid treatments	Shelling %		Grain yield/ plant (g.)		Grain yield/ fed (ton)		Seed proteins %		Leaf N %		Leaf P %		Leaf K %		Leaf Mg %	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
100 % mineral N	81.11	81.00	239.1	238.4	3.59	3.51	6.91	6.80	1.61	1.50	0.11	0.12	1.09	1.10	0.45	0.44
87.5 % mineral N + 1.0 kg humic	81.18	81.11	268.7	265.8	4.09	4.04	7.11	7.00	1.68	1.56	0.14	0.14	1.17	1.11	0.44	0.49
87.5 % mineral N + 1.5 kg humic	81.55	81.41	296.5	295.9	4.31	4.25	7.25	7.14	1.75	1.65	0.17	0.18	1.25	1.19	0.52	0.51
75 % mineral N + 1.5 kg humic	81.79	81.69	320.8	320.4	4.71	4.51	7.36	7.25	1.81	1.71	0.20	0.21	1.34	1.28	0.55	0.54
75 % mineral N + 2.0 kg humic	81.81	81.71	338.4	337.0	4.92	4.71	7.50	7.39	1.88	1.76	0.23	0.24	1.40	1.34	0.60	0.59
62.5 % mineral N + 2.0 kg humic	80.61	80.51	198.8	197.2	2.88	2.84	6.11	6.00	1.41	1.31	0.26	0.25	1.46	1.40	0.63	0.62
62.5 % mineral N + 2.5 kg humic	80.71	80.60	219.7	219.9	3.26	3.27	6.40	6.29	1.50	1.40	0.30	0.31	1.52	1.46	0.67	0.66
50 % mineral N + 2.5 kg humic	80.80	80.31	149.7	149.7	2.10	2.21	5.80	5.70	1.25	1.14	0.34	0.33	1.60	1.54	0.71	0.70
50 % mineral N + 3.0 kg humic	81.00	80.99	166.9	165.3	2.38	2.35	5.91	5.85	1.33	1.23	0.36	0.37	1.65	1.60	0.75	0.74
New L.S.D at 0.05	NS	NS	11.2	12.2	0.21	0.25	0.11	0.11	0.06	0.07	0.02	0.02	0.05	0.05	0.03	0.03