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EFFECT OF DOSES OF HUMIC ACID ON DRY MATTER PRODUCTION AND NUTRIENTS USE EFFICIENCY OF MAIZE (*Zea mays* L.)

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ABSTRACT

Research was conducted to determine the effects of soil application of humic acid on dry matter production and nutrients use efficiency of Maize plant under calcareous soil conditions. Humic acid was used to obtain four humic acid doses (0, 20, 40 and 80 kg ha^{-1}) were applied to soil. Although the dry weight and N, P, K, Mn, Cu, Fe and Zn uptake of the plant parts were affected negatively, especially at 80 $kgha^{-1}$ of humic acid level. The highest mean of dry weight, N, P, K, Mn, Cu, Fe and Zn uptake were obtained from 80 $kgha^{-1}$ of humic acid treatment. In contrast, the highest mean of N, P, K, Mn, Cu, Fe and Zn % contents by plant parts were determined at 80 $kgha^{-1}$ of humic acid treatment.

KEYWORDS: calcareous soil; humic acid; maize; nutrients; dry weight

INTRODUCTION

Maize is an important cereal crops in the world. It provides staple food to many populations and it is the third most important cereal crop in the world after wheat and rice (Bijanzadeh et al., 2019, Balbaa and Awad (2013) and Shah *et al.,* 2009). Maize is a multipurpose crop in the world (Khaliq *et al.,* 2004) with great nutritional values and contains about 72% starch, 10.4% proteins, and 4.5% fats, minerals, and non-cholesterol oil (Aslam *et al.,* 2011). Iraqi Kurdistan region as a semi-arid region, there is an increasing interest for field crop production and recommended farmers to grow grain crops and vegetables, the maize cultivation in the Kurdistan region–Iraq has got more attention in last year's. The cultivated area in Kurdistan region roughly is about (1824 ha) with average production about (5138 kg ha^{-1}) (Maruf and Mam Rasul, 2019). However, the yield potential of corn in developing countries is low due to poor-quality seed and imbalanced nutrients application (Bijanzadeh *et al.,* 2019). An increasing the number of human population continuously increases their demands for food and energy, which require to incorporate the new areas in agricultural as well as increase the crop yield-per unit of area with healthy quality with good nutritional or healthy quality. Generally, the average yield of maize is greater than (4 ton ha^{-1}) (Farnham *et al.,* 2003).

In terms of nutrient acquisition efficiency by the plant, Maize may have different strategies in response to nutrient deficiency (Hogir, 2016). In addition to that the strategy of Maize cultivation is recently had been introduced to the Kurdistan Iraqi region, and every year new high-yielding maize varieties are continually being evolved and introduced by the breeder to be grown by farmers in the area. However, the properties such as economic, quality and grain yield potential of this new Maize not fully aware by the farmers. Therefore, intensive efforts of the researchers were focused on how to maximize the productivity of this crop through highly nutrient efficient, especially for humic acids. In order to obtain high yields from the corn plant, which is in need of nutrients in high amounts, the soil fertility must also be high. Due to the chemical fertilizers used in agriculture, the chemical, physical and biological properties of the soil have been degraded and especially the level of organic matter has fallen below 1% (Gong *et al.,* 2009). One of the most economical and rapid solutions to the problem of organic matter in modern agriculture is direct application of humic acid to the soil or plant (Gollenbeek and Van Der Weide, 2020 and Yang *et al.,* 2021).

Humic acid improves soil's physical structure. Application of humic acid increases soil aeration and water holding capacity of the soil. Humic acid maximizes the cation exchange capacity of the soil and regulates soil pH. It will also help to lower the pH of the soil to a more neutral level and will flush high levels of salts out of the root zone, all of which will help to promote better plant health and growth. Humic acid is considered to increase the permeability of plant membranes and enhance the uptake of nutrients (Liu *et al.,* 2019 and Sharif *et al.,* 2002). Humic acid increases the uptake of nitrogen, phosphorus, potassium, iron, zinc and trace elements in the soil by the plant. Humic acid increases the amount and activity of microorganisms in the soil. Humic acid also increases the tolerance of the plant against to stress conditions of plants such as cold, hot and physical effects and resistance to disease (Pilanal and Kaplan, 2003, Necmi and Mustafa, 2003 and Muhamad

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and Ghafoor 2019). Many researchers (Chen and Aviad 1990, Padem and Ocal 1999, Kolsarici *et al.*, 2005, Ertan 2007 and Akram *et al.*, 2019) reported that humic acids have an impact on plant growth and development, and that when applied in low quantities they affect development positively. Nevertheless, they stated that when applied in excessive amounts, they have ineffective or negative effects on development. It has been reported that humic acid application promotes germination by increasing enzyme activities in seeds and increases germination rate, root and shoot growth (Mahdieh and Elham 2016 and Nikoletta *et al.*, 2020). The objectives of the study were to: (1) determine the effect of humic acids on dry matter production of Maize, and (2) determine the macronutrients use efficiency under calcareous soil conditions.

MATERIALS AND METHODS

To determine the effect of humic acid on dry matter production and nutrients use efficiency of maize (*Zea mays* L.) cv. Gloria, grown under calcareous soil, the experiment was conducted at Kanipanka Agricultural Research Farm (45.7161 E, 35.3822 N 578 m above sea level) in Sulaimani governorate, Iraq as shown in Fig. 1 during spring growing season of 11th April 2022 to 27th July 2022. The experiment includes four levels of humic acid as humate potassium (Humic 85%), obtained from AFICO factory in Jordan were incorporated into the soil in deep by 5 cm at sowing time. Average of the rainfall and air temperature climatic data of the experiment field location (Kanipanka) in 2022 showing in table 2.

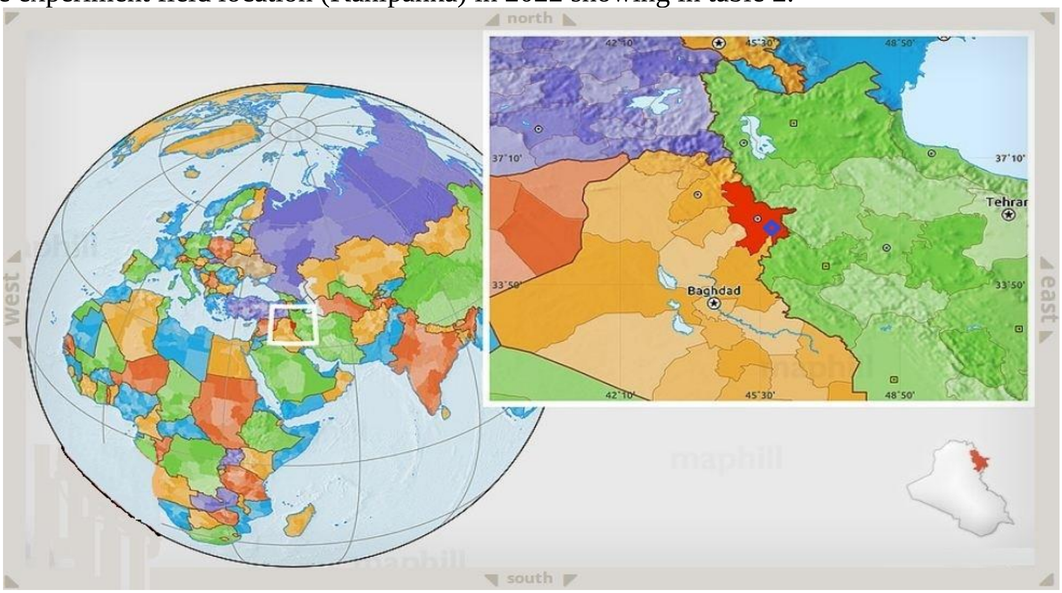

Figure 1. The location of the studied area.

The experiment was conducted on the 149.5m^2 area (13m×11.5m), in 12 experimental units with three replicates, the area of each experimental unit was 6m^2 (2×3)m, each experimental plot included 3 rows in 3 m length, and the distance between these three was 0.70m while it was 0.30m within the rows of the individual plants, to obtain a mean density of 51,000plants ha^{-1}, and the distance between the experimental units was 0.5m while the distance between the blocks was 2m. Experimental treatments have been organized in experiment by using the complete randomized block design (CRBD). Treatments were as follows:

T1 = (control) T2 = 20 kg HA ha^{-1} T3 = 40 kg HA ha^{-1} T4= 80 kg HA ha^{-1}

Fertilizers were applied, 200 kg N ha^{-1} from urea 46% N was added and divided into two equal doses the first dose was applied after 20 days of germination and the second dose was applied at the testing stage, 200 kg P_2O_5 ha^{-1} as triple superphosphate (TSP) and 150 kg K_2O ha^{-1} as KCl was applied at the seeding time. The crop was irrigated through a surface irrigation system every 5-7 days at a required time.

Soil samples were taken before planting from a depth of 0-40 cm of the soil used in the field experiments. The soil samples were air-dried, filtered by a 2 mm sieve, and kept in plastic bottles until analyzed. (*Table 1*) illustrates the main physical and chemical properties of the soils.

Table 1. Some physical and chemical studied soil of the field experiment

Soil Properties	Value	Unit
Available P	3.66	mg kg^{-1}
Available K	185.21	

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Total N		1.39	
Soluble	Ca^{2+}	4.28	mmol L^{-1}
	Mg^{2+}	1.22	
	Na^{+}	0.77	
	HCO_3^{-}	4.36	
	SO_4^{2-}	0.93	
pH		7.50	
EC		0.588	dS m^{-1} at 25 °C°
Organic matter (OM)		22.39	g kg^{-1}
$CaCO_3$		58.55	
Particle size distribution (PSD)	Sand	104.0	g kg^{-1}
	Silt	431.0	
	Clay	465.0	
Textural class		Silty Clay	

Harvesting was done after the plant tasseling and silking reached 50% of the total plants (Maruf, 2019). The whole plant, including leaves and stems, was harvested. The remaining roots in the soil were removed carefully and cleaned using tap and distilled water. The plant parts (leaves, stems, and roots) were then oven dried at 60ºC until constant weight and their dry matter were determined. Each plant part was ground. Then samples were analyzed for total Nitrogen, Phosphorus, Potassium, iron, manganese, zinc and Copper.
The total Nitrogen in the plant samples were determined by Kjeldahl method, using wet digesting with H_2SO_4 and H_2O_2 (Batey et al., 1974), Phosphorus determined according to the colorimetric method and Potassium determined using (Corning 400 Flame photometer), using wet digesting with H_2SO_4 and H_2O_2, according to. The micronutrients (iron, manganese, zinc and Copper) in the plant samples were determined by using Atomic Absorption Spectrometer, Perkin Elmer, Analyst 800 (Ryan et al., 2003).
Nutrients uptake in the leaves, stems and roots of maize plant were calculated by the following formula.

$$\textbf{Nutrients uptake (kg ha}^{-1}\textbf{)} = \frac{\textbf{Nutrients content \% × yield (kg ha}^{-1}\textbf{)}}{\textbf{100}}$$

Table 2. Average of the rainfall and air temperature climatic data of the experiment field location (Kanipanka), in 2022

Day	April			May			June			July			August		
	Rainfall mm	Temp. °C		Rainfall mm	Temp. °C		Rainfall mm	Temp. °C		Rainfall mm	Temp. °C		Rainfall mm	Temp. °C	
		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.
1	0	26	14	3.8	26	14	0	38	27	0	40	23	0	45	25
2	0	28	13	21	17	15	0	39	33	0	38	24	0	43	27
3	0	30	15	0	24	11	0	40	26	0	37	26	0	43	26
4	0	31	16	0	30	15	0	42	21	0	36	26	0	43	25
5	0	27	15	0	26	20	0	39	22	0	35	25	0	43	24
6	0	28	14	0	25	16	0	38	21	0	38	27	0	43	25
7	0	27	17	0.5	22	13	0	41	21	0	37	29	0	43	24
8	0	26	17	0	21	12	0	38	17	0	39	28	0	43	24
9	0	24	17	0	24	11	0	39	16	0	40	30	0	43	25
10	0	24	15	0	22	12	0	34	23	0	43	31	0	44	26
11	0	28	13	0	25	13	0	36	22	0	41	26	0	45	26
12	0	26	17	0	27	13	0	38	27	0	42	25	0	44	26

13	0	22	10	0	26	15	0	38	25	0	41	26	0	44	28
14	0	23	4	0	29	17	0	35	17	0	45	27	0	40	26
15	0	25	13	0	32	17	0	34	22	0	44	29	0	41	25
16	0	23	10	0	27	22	0	36	22	0	44	32	0	41	25
17	0	25	15	0	27	19	0	40	24	0	44	29	0	40	25
18	0	26	16	0	30	16	0	41	24	0	44	28	0	39	25
19	0	34	16	0	31	17	0	42	28	0	43	28	0	39	25
20	0	29	20	0	33	19	0	42	29	0	44	26	0	39	25
21	0	28	17	0	28	18	0	40	25	0	42	22	0	38	25
22	0	28	13	0	33	16	0	33	26	0	40	28	0	39	24
23	0	30	14	0	27	16	0	33	24	0	38	25	0	39	24
24	0.4	24	16	0	27	19	0	36	24	0	40	25	0	38	24
25	16	25	15	0	30	15	0	38	24	0	39	27	0	39	24
26	6.0	22	15	0	29	16	0	35	23	0	40	28	0	39	24
27	20	21	14	0	37	21	0	34	24	0	40	24	0	38	23
28	0	26	14	0	37	24	0	36	22	0	41	24	0	38	22
29	9	25	12	0	35	21	0	38	23	0	42	35	0	37	22
30	0	25	14	0	35	25	0	41	17	0	42	27	0	37	23
31				0	37	22				0	42	26	0	37	23

Nutrients use efficiency was determined by the following formula (Pomares-Garcia and Pratt 1987):

$$\textbf{\% Efficiency} = \frac{\textbf{A - B}}{\textbf{C}} \times \textbf{100}$$

Where A = uptake with fertilizer, B = uptake without fertilizer, C = total amount of fertilizer that had been applied.

Data were subjected to analysis of variance (ANOVA) performed by XLSTAT 2016.02.28451 Package, and the differences were compared by Duncan Multiple Range Test (DMRT) at 5% significance level.

RESULTS AND DISCUSSION

The soil used in the experiment (Kanipanka) had silty clay texture, and neutral PH (7.56). It was high in term of lime (58.64 g kg^{-1}) and neutral organic matter content. The soil was not adequate in terms of nitrogen and phosphorus (Table 2).

Table 3. Some chemical characteristics of humic acid

Characteristics	Value	Unit
Humic Acid	85	%
Fulvic Acid	8	%
Total Nitrogen	2.5	%
Total Phosphorus	7132.08	mg kg^{-1}
Total Potassium	6482.85	mg kg^{-1}
pH	9	
Moisture	3	%
Appearance	Black powder	

High values of the selected chemical properties of the humic acid suggest the high quality of this humic acid for plant growth and development (Table 3). For example, high pH and organic matter of the humic acid may have improving nutrient retention when applied to soils. Besides serving as a source of nutrients, such as N, P and K.

The results showed in Table (4) the effect of humic acid on dry weight of leaf, stem, and root of maize when humic acids were application to soil compared with the control treatment. Results showed that the humic acid- level (80 kg ha^{-1}) (T4) significantly compared with the other and control treatment. The highest dry weight was obtained with 80 $kgha^{-1}$ treatment (T4). The highest dry weight of (leaf, stem, and root) were (990.760, 1363.400 and 467.160 $kgha^{-1}$) obtained by the (T4) respectively, while the lowest dry weight of (leaf, stem, and root) were (753.270, 1241.340 and 374.850 $kgha^{-1}$) obtained by the (T1) respectively. The data in table (4) revealed that the total dry weight was significantly affected by humic acid levels at ($p \leq 0.05$). Depending on the applied levels of humic acid, the humic acid-level (80 $kgha^{-1}$) were significantly different from all other treatments which obtained maximum mean value of total dry weight (2821.320 $kgha^{-1}$) when the lowest mean value was (2369.460 $kgha^{-1}$) recorded at control.

Table 4:Effect of different treatments of humic acid on dry weight($kgha^{-1}$) of leaves, stems, and roots of Maize plants:

No	Treatments	Leaves	Stems	Roots	Total
1	T1	753.270 d	1241.340 c	374.850 c	2369.460 d
2	T2	782.340 c	1235.390 c	406.470 b	2424.200 c
3	T3	939.250 b	1328.380 b	453.730 a	2721.360 b
4	T4	990.760 a	1363.400 a	467.160 a	2821.320 a
	Pr > F	0.000	0.000	0.000	0.000
	Significant	Yes	Yes	Yes	Yes

There was a difference for all nutrient (N, P, K, Mn, Cu, Fe and Zn) concentrations in the maize plant in the growing season and plant parts (Leaves, Stems and Roots) evaluated (Table 5). Effects of soil application of humic acid on the plant nutrients concentration, the soil applications of humic acid had a significant effect on the concentration of (N, P, K, Mn, Cu, Fe and Zn) in the plant leaves. When compared with the control treatment, the mineral nutrients concentration of plant leaves were found higher at (T4) application dose of humic acid (Table5). The highest nutrient concentrations were obtained with 80 $kgha^{-1}$ treatment (T4). The highest concentration of (N, P, Mn, Cu, Fe and Zn) were (3.1, 0.13, 0.00908, 0.00128, 0.00711 and 0.00411 %) obtained by the (T4) respectively, and the highest concentration of (K) was (1.393%) obtained by the (T3), while the lowest concentration of (N, P, K, Mn, Cu and Zn) were (2.657, 0.037, 0.930, 0.00888, 0.00097 and 0.00362 %) obtained by the (T1), respectively, and the lowest concentration of (Fe) was (0.00680 %) obtained by the (T2). The data in table (5) revealed that the (N, P, K, Mn, Cu, Fe and Zn) concentration in the stems plant parts were significantly affected by humic acid levels at ($p \leq 0.05$). Depending on the applied levels of humic acid, the humic acid-level (80 kg ha^{-1}) were significantly different from all other treatments which obtained maximum mean values of (N, P, K, Mn, Cu, Fe and Zn) concentrations in the plant stems (3.383, 0.137, 3.150, 0.00916, 0.00128, 0.00704 and 0.00459 %) respectively, when the lowest mean concentrations were (2.117, 0.017, 2.203, 0.00853, 0.00106, 0.00628 and 0.00387%)respectively recorded at control.

Table 5:Effect of different treatments of humic acid on contents(%) of N, P, K, Mn, Cu, Fe and Zn in Leaves, Stems and Roots of Maize plant:

No	Treatments	N	P	K	Mn	Cu	Fe	Zn
		Leaves						
1	T1	2.657c	0.037c	0.930d	0.00888c	0.00097d	0.00682c	0.00362d
2	T2	2.830b	0.083b	1.063c	0.00890c	0.00105c	0.00680c	0.00380c
3	T3	3.003a	0.097b	1.393a	0.00900b	0.00114b	0.00699b	0.00388b
4	T4	3.100a	0.130a	1.290b	0.00908a	0.00128a	0.00711a	0.00411a
	Pr > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Stems						
1	T1	2.117c	0.017b	2.203b	0.00853d	0.00106c	0.00628d	0.00387c
2	T2	2.803b	0.117a	2.767a	0.00866c	0.00107c	0.00651c	0.00425b
3	T3	3.350a	0.113a	3.087a	0.00903b	0.00114b	0.00681b	0.00437b
4	T4	3.383a	0.137a	3.150a	0.00916a	0.00128a	0.00704a	0.00459a
	Pr > F	0.000	0.000	0.003	0.000	0.000	0.000	0.000
	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Roots						
1	T1	1.147c	0.057b	1.273c	0.01253c	0.00123c	0.01002c	0.00419c
2	T2	1.493b	0.077b	2.197b	0.01256c	0.00142b	0.01135b	0.00453b

3	T3	2.067a	0.140a	2.240b	0.01288b	0.00147a	0.01190a	0.00485a
4	T4	2.273a	0.170a	2.763a	0.01303a	0.00154a	0.01211a	0.00487a
	Pr > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Depending on the plant roots parts , the result in table (5), the humic acid- level (80 kg ha^{-1}) were significantly different from all other treatments which obtained maximum mean values of (N, P, K, Mn, Cu, Fe and Zn) concentration in the plant roots (2.273, 0.170, 2.763, 0.01303, 0.00154, 0.01211 and 0.00487 %)respectively, when the lowest mean concentrations were (1.147, 0.057, 1.273, 0.01253, 0.00123, 0.01002 and 0.00419%) respectively recorded at control.

This may be referring to the humic acids improving soil structure will improve aeration, and the effect of humic acid is to increase root growth and its intensity that increases contact surface area with the soil and increases its absorption rather than root exudate may decreases pH in the rhizospher and increases nutrients availability in sorption zone system (Ali *et al.* 2011) and which have been reported to enhance nutrient availability, nutrient absorption, nutrient utilization, plant growth, physiology and metabolism through various mechanisms (Berbara and Garcia, 2014).

Data related to uptake of nutrients are presented in Table 6. Results illustrated in Table 5 showed the effect of humic acid on micro and macronutrients Uptake ($kgha^{-1}$) in maize Leaves, Stems and Roots during 2022 season. The results showed that different treatments of humic acid caused significant increase of micro and macro-nutrients Uptake in maize parts. Effects of soil application of humic acid on the nutrients uptake, the soil applications of humic acid had a significant effect on the nutrients uptake of (N, P, K, Mn, Cu, Fe and Zn) in the plant leaves. When compared with the control treatment, the mineral nutrients uptake of plant leaves were found higher at (T4) application dose of humic acid (Table 6). The highest nutrients uptakes were obtained with 80 $kgha^{-1}$ treatment (T4). The highest nutrients uptake of (N, P, Mn, Cu, Fe and Zn) were (30.715, 1.288, 0.090, 0.013, 0.071 and 0.041 $kgha^{-1}$) obtained by the (T4) respectively, and the highest nutrients uptake of (K) was (12.782 $kgha^{-1}$) obtained by the (T3), while the lowest nutrients uptake of (N, P, K, Mn, Cu, Fe and Zn) were (20.011, 0.275, 7.007, 0.067, 0.007, 0.052 and 0.027 $kgha^{-1}$) obtained by the (T1), respectively.

The data in table (6) revealed that the nutrients uptakes in the stems plant parts were significantly affected by humic acid levels. Depending on the applied levels of humic acid, the humic acid-level (80 $kgha^{-1}$) were significantly different from all other treatments which obtained maximum mean values of (N, P, K, Mn, Cu, Fe and Zn) uptake in the plant stems (46.114, 1.862, 42.940, 0.125, 0.017, 0.096 and 0.062 $kgha^{-1}$) respectively, when the lowest mean nutrients uptake were (26.281, 0.206, 27.359, 0.106, 0.013, 0.078 and 0.048 $kgha^{-1}$)respectively recorded at control. Depending on the plant roots parts , the result in table (6), the humic acid- level (80 $kgha^{-1}$) were significantly different from all other treatments which obtained maximum mean values of (N, P, K, Mn, Cu, Fe and Zn) nutrients uptake in the plant roots (10.625, 0.795, 12.907, 0.061, 0.007, 0.057 and 0.023 $kgha^{-1}$) respectively, when the lowest mean nutrients uptake were (4.303, 0.212, 4.772, 0.047, 0.005, 0.038 and 0.016 $kgha^{-1}$) respectively recorded at control.

Table 6 :Effect of different treatments of humic acid on Uptake ($kgha^{-1}$) of N, P, K, Mn, Cu, Fe and Zn in leaves, stems and roots of Maize plant:

No	Treatments	N	P	K	Mn	Cu	Fe	Zn
		Leaves						
1	T1	20.011d	0.275d	7.007c	0.067d	0.007c	0.052c	0.027d
2	T2	22.139c	0.652c	8.317b	0.070c	0.008c	0.053c	0.030c
3	T3	28.204b	0.907b	13.084a	0.085b	0.011b	0.066b	0.036b
4	T4	30.715a	1.288a	12.782a	0.090a	0.013a	0.071a	0.041a
	Pr > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Stems						
1	T1	26.281c	0.206c	27.359c	0.106c	0.013c	0.078d	0.048d
2	T2	34.640b	1.442b	34.145b	0.107c	0.013c	0.081c	0.053c
3	T3	44.507a	1.506ab	41.001a	0.120b	0.015b	0.091b	0.058b
4	T4	46.114a	1.862a	42.940a	0.125a	0.017a	0.096a	0.062a
	Pr > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Roots						
1	T1	4.303c	0.212b	4.772d	0.047c	0.005c	0.038d	0.016c
2	T2	6.069b	0.312b	8.927c	0.051b	0.006b	0.046c	0.018b
3	T3	9.383a	0.637a	10.168b	0.059a	0.007ab	0.054b	0.022a
4	T4	10.625a	0.795a	12.907a	0.061a	0.007a	0.057a	0.023a
	Pr > F	0.000	0.000	0.000	0.000	0.001	0.000	0.000
	Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The improvement of macro and micronutrients Uptake (kgha^{-1}) in maize leaves stems and roots in the present study shows by the effect HA and this agreement with many studies, which showed that humic acid caused the increase in the uptake of mineral elements (Hakan *et al.*, 2011, Hakan *et al.*, 2008 and Erdal et al., 2000). Finally, it might be concluded that application of humic acid could be caused significant increase of micro and macro-nutrients uptake in maize leaves, stems and roots.

The effects of the soil application of humic acid on dry matter, the nutrient contents and uptake of mineral nutrients are given in Tables 4, 5 and 6. According to the analysis results, increasing amounts of humic acid in control affected the dry weight of the maize plants negatively (Table 4). The increasing humic acid levels also had negative effects on the N, P, K, Fe, Cu, Mn and Zn contents and uptake of maize (Table 5 and 6). Especially at 0 and 20 kg ha^{-1} of humic acid levels there were obvious decreases in dry weight and in the uptake of mineral elements of plants.

The soil application of humic acid had a statistically significant effect in dry weight, and in the uptake of N, P, K, Mn, Cu, Fe and Zn in leaves, stems and roots of Maize plant. The addition of humic acid in powder HA was expected to increase the dry weight and the nutreints uptake, the result was as expected. Common humic acid application by surface application of T3 can cause nutrients to be easily increases in plant parts, especially N, K, Mn, Cu, Fe and Zn . The rich nutrient use efficiency observed for plant parts was partly because of best root development (Table 7). Besides, humic acid may have reacted with nutreints in the soil and from the fertilizer, a soluble compounds of nutreints that is generally available to plants, especially roots. Nutreints are very important for root development. roots may affect the growth system of a plant posatively. This might be one of the reasons for the best plant growth, nutrient uptake, and use efficiency observed for plants of T2, T3, and T4.

Table 7 : Effect of different treatments of humic acid on N, P, K, Mn, Cu, Fe and Zn Use efficiency (%) in leaves, stems and roots of Maize plant:

No	Treatments	N	P	K	Mn	Cu	Fe	Zn
		Leaves						
1	T1	Nd	Nd	Nd	Nd	Nd	Nd	Nd
2	T2	8.511b	1.506a	5.243b	0.011c	0.004b	0.008c	0.010b
3	T3	16.386a	1.265ab	12.155a	0.035a	0.007a	0.029a	0.019a
4	T4	10.703b	1.013b	5.776b	0.023b	0.005ab	0.019b	0.014b
	Pr > F	0.011	0.110	0.001	0.000	0.014	0.001	0.005
	Significant	Yes	No	Yes	Yes	Yes	Yes	Yes
		Stems						
1	T1	Nd	Nd	Nd	Nd	Nd	Nd	Nd
2	T2	33.438a	4.942a	27.144a	0.005b	0.001b	0.010b	0.018a
3	T3	36.452a	2.599b	27.284a	0.028a	0.004a	0.025a	0.020a
4	T4	19.834a	1.656b	15.582a	0.019ab	0.004a	0.018ab	0.014a
	Pr > F	0.096	0.000	0.526	0.020	0.006	0.029	0.542
	Significant	No	Yes	No	Yes	Yes	Yes	No
		Roots						
1	T1	Nd	Nd	Nd	Nd	Nd	Nd	Nd
2	T2	7.062a	0.399b	16.624a	0.016ab	0.005a	0.034a	0.011a

3	T3	10.159a	0.850a	10.793b	0.023a	0.004ab	0.033a	0.013a
4	T4	6.322a	0.583ab	8.136b	0.014b	0.003b	0.019b	0.007b
	Pr > F	0.126	0.075	0.009	0.099	0.042	0.009	0.017
	Significant	No	No	Yes	No	Yes	Yes	Yes

Nd = No data

CONCLUSION

We can conclude that the soil application of humic acids may be used in case of the negative effect of the calcareous soil conditions that could inhibit plant growth and the uptake of nutrient elements.The use of humic acids can ameliorate the bad soil properties, and improves plant growth and the uptake of nutrients; but its economical application levels should be determined and mixing soil with humic acid significantly increased maize dry matter production, N, P, K, Mn, Cu, Fe and Zn uptake. This practice does improve nutreints use efficiency, and it helps to reduce the use of based fertilizers.

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