

Responses of maize (*Zea mays* L.) production and soil fertility to application controlled-release N-fertilizers and poultry manure

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Abstract

A field study was carried out during the two consecutive summer seasons of (2019 and 2020) at the Experimental Farm, Faculty of Agriculture, Al-Azhar University, Assiut governorate, located 375 km south of Cairo, Egypt. Aims study evaluation of some fast and slow-release nitrogen fertilizers in terms of speed nutrients loss and get maximum benefits from crop productivity. The experimental design was randomized complete block with three replicates. The experiment including five treatments; Control (T_c), 100% Ammonium sulfate (AS) at the rate of 120 kg N feddan⁻¹ (T_1) (feddan = 4200 m² = 0.420 hectares = 1.037 acres), 100% Sulfur Coated Urea (SCU) at the rate of 120 kg N feddan⁻¹ (T_2), 100% Enciabeen (EN) at the rate of 120 kg N feddan⁻¹ (T_3) and Poultry manure (PM) at the rate of 120 kg N feddan⁻¹ respectively (T_p). The obtained results in the highest N-uptake yield and yield component of maize as compared to the other treatments. Treatment T_2 gave the highest biological yield was 12.44 and 12.24 ton feddan⁻¹ and grain yield was 2.34 and 2.68 ton feddan⁻¹. Poultry manure treatments produced higher values for electrical conductivity (EC) was 1.06 and 1.12 dS m⁻¹, Soil reaction pH was 7.89 and 7.76, organic matter (OM) was 39.53 and 40.77 g kg⁻¹, available P was 16.32 and 17.64 ppm and available K was 345 and 451 ppm. The overall results suggest that slow-release N-fertilizers could be advised to grow maize plant under conditions of Egypt.

Keywords: slow-release N-fertilizers, maize, soil properties, poultry manure.

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1. Introduction

Nitrogen is the most limiting nutrient for crop production in many of the world's agricultural areas (Toor *et al.*, 2021) and its efficient use is important for the economic sustainability of cropping systems (Sarwar *et al.*, 2021). Furthermore, the dynamic nature of N and its tendency for losing from soil-plant systems creates a unique and challenging environment for its efficient management. Crop response to applied N and use efficiency are important criteria for evaluating crop N requirements for maximum economic yield (Congreves *et al.*, 2021). Recovery of N in crop plants is usually less than 50% worldwide (Galindo *et al.*, 2021), low recovery of N in annual crop is associated with its loss by volatilization, leaching, surface runoff denitrification, and plant canopy (Cui and Wang, 2019). Low recovery of N is not only responsible for higher cost of crop production. But, also for environmental pollution. Hence, improving N use efficiency is desirable to improve crop yields, reducing cost of production (Khalofah *et al.*, 2021). Use of controlled-release fertilizers CRF starts to evolve as a promising direction offering an excellent means to improve management of nutrient application and by this reducing significantly environmental threats while, maintaining high crop yields of good quality. Low-cost effectiveness and limited recognition of the potential benefits to be gained from the CRF were so far from the main reasons for their limited consumption (Chien *et al.*, 2009).

Also, controlled release urea CRU could control the release rate of N by the functional materials added to urea which has been widely used in recent years (Zheng *et al.*, 2020). For example, resin-coated urea and sulfur-coated urea control the N-release rate by coating on the surface of urea granules with resin and sulfur respectively (Bortoletto-Santos *et al.*, 2020). Ahmad *et al.* (2022) demonstrated that CRU could reduce N loss and realize one-time fertilization to increase NUE and plant yield. Poultry manure (PM) is an excellent organic fertilizer as it contains high N, P, K and other essential nutrients (Farhad *et al.*, 2009). It has been reported to supply P more readily to plants than other organic sources (Garg and Bahla, 2008). In another study, Uwah *et al.* (2012) reported that PM increased organic matter content, available P, exchangeable cations and micronutrients in soils. Maize (*Zea mays* L.) is the second crop in terms of importance in Egypt after wheat plants. Moreover, the Maize is most important crop worldwide for food, animal feed and bioenergy production (Randjelovic *et al.*, 2011). Maize is the most commonly grown crop in the summer season, grown on 26 percent of the farmed land in the season and equally distributed between the Delta and the Nile Valley. Eight million metric tons of maize are produced annually (Malr, 2016). Therefore, the objective of this study was evaluated and compared the slow release-N and traditional soluble-N fertilizers on maize productivity as well as their effects on soil fertility.

2. Materials and methods

2.1 Experimental site

A field experiments were conducted during summer season of 2019 and 2020

at research farm of Faculty of Agricultural, Al-Azhar University, Assiut, Egypt, In fulfillment of the purpose of the present work. Physical and chemical properties are shown in Table (1).

Table (1): Some physical and chemical properties of the soil experimental site in two seasons.

Property	1 st Season	2 nd Season	Property	1 st Season	2 nd Season
pH (1:2.5 suspension)	7.92	8.20	Total K (mg kg ⁻¹)	450	465
ECe (dS m ⁻¹) _(1:2.5)	0.93	0.85	Available N (mg kg ⁻¹)	60.00	55.00
Organic matter (g kg ⁻¹)	14.00	13.00	Available Olsen P (mg kg ⁻¹)	9.00	8.80
Sand (%)	24.40	22.70	Available K (mg kg ⁻¹)	345.00	339.00
Silt (%)	40.20	41.40	Cl (meq/L)	1.08	1.23
Clay (%)	35.40	35.90	Ca (meq/L)	2.03	2.21
Texture	Clay loam	Clay loam	Mg (meq/L)	1.10	1.27
Total N (mg kg ⁻¹)	540.00	523.00	Na (meq/L)	4.89	5.24
Total P (mg kg ⁻¹)	350.00	343.00	K (meq/L)	0.12	0.16

Each value in this table is the mean of three values.

The chemical composition of the tested poultry manure in two seasons are presented in Table (2). Weather condition during the experiment, the average mean

maximum, and minimum temperatures Also, the average of relative humidity, wind spread, and sunshine duration of the area presented in Table (3).

Table (2): Some chemical composition of the tested poultry manure in two seasons.

Properties	1 st Season	2 nd Season
pH (1:5) Susp.	8.20	8.50
EC (1:5) (dS m ⁻¹)	6.20	6.40
Organic matter (%)	30.00	32.00
Total N (%)	1.20	1.40
Total P (%)	0.70	0.90
Total K (%)	0.79	0.85

Each value in this table is the mean of three values.

Table (3): The meteorological data of the Experimental Farm Faculty of Agriculture, Al-Azhar University, Assiut, Egypt during both season 2019-2021.

Season	Month	T. Max. (°C)	T. Min. (°C)	R.H. (%)	W.S. (kmh ⁻¹)	S.D. (hr)
2019	May	38.10	22.00	28.90	18.90	11.40
	June	39.00	24.90	33.90	20.30	12.30
	July	38.90	25.20	35.10	16.80	12.20
	August	38.90	25.00	35.60	14.50	11.90
	September	35.40	22.20	45.70	18.20	10.80
	October	33.60	19.30	47.60	16.90	10.00
2020	May	35.50	19.50	35.80	17.50	11.40
	June	38.60	22.50	33.70	18.60	12.30
	July	38.50	23.90	35.10	18.60	12.20
	August	38.40	24.00	38.50	17.10	11.90
	September	37.80	23.20	41.10	17.80	10.80
	October	34.60	20.50	47.80	17.10	10.00

T. Max. = Maximum temperature (°C), T. Min. = Minimum temperature (°C), S.D. = Sunshine duration (hr), R.H. = Relative humidity (%), W.S. = Wind speed (Km/h).

2.2 Experimental design and treatments

The experimental design was a randomized complete block design with three replications. There were five treatments; Control (T_c), 100% Ammonium Sulfate (AS) at the rate of 358 kg feddan⁻¹ (T_1), 100% Sulfur Coated Urea SCU at the rate of 260 kg feddan⁻¹ (T_2), 100% Enciabean (EN) at the rate of 300 kg feddan⁻¹ (T_3) and 100% Poultry Manure PM at the rate of 16ton feddan⁻¹ (T_p) to supply the same amount of nitrogen as the amount of the above sources. The plot size was 4 × 2.8 m having, spacing between rows was 0.75 m and the spacing between hills was 30 cm. Nitrogen was applied to maize crop at the rate of 120 kg N feddan⁻¹ forms mineral N and poultry manure PM applied alone. The additions of poultry manure by broadcast. Also, SCU and EN by surface banding methods directly before cultivating maize at the rate of 120 kg/feddan throw soil preparation to planting. Ammonium sulphate after thinning 21 days after sowing. AS was applied to all pots as a soil application in three equal doses at the 1st and 2nd and 3rd irrigation. Potassium was used in the form of potassium sulphate (48% K₂O) to all plots at the rate of 50 kg/feddan. The phosphatic fertilizer was added in one dose 200 kg feddan⁻¹ as superphosphate 15.5% P₂O₅ were added to the plots before cultivation. Ammonium sulfate was used as a fast release N-fertilizer. While, poultry manure, EN and SCU were used as a slow-release N-fertilizers. The tested fertilizers were three chemical nitrogen sources ammonium sulfate AS 33.5% N as fast release and Enciabean (EN) 40 % N as slow release was got from Agriculture

Research Center, Ministry of Agriculture, Giza, Egypt. Sulfur Coated Urea SCU 46% N as slow release got from Abu Zaabal Company, Cairo, Egypt. While, organic manure sources, poultry manure 1.2% was obtained from the poultry production farm, Faculty of Agriculture, Assiut University. Maize variety (*Zea mays* L., cv Single Hybrid 10) grains were sown at a rate of 10 kg feddan⁻¹ on May 5th and 15th in both growth seasons. Measurements before harvesting vegetative growth maize, length, and chlorophyll. Plant high for 6 plants were selected randomly from each plot and their height was measured from the soil surface to the tip of panicle with the help of a measuring tape and average height was calculated in cm. Chlorophyll meter (SPAD-CMM200) readings were taken from the same relative plant leaf, The chlorophyll concentration was read for 6 plants in the plot also the average readings were taken to calculate the chlorophyll concentration in the plant for each plot. The maize plants were harvested at full maturity (*i.e.*, after 112 day) (August 25th 2019, and September 5th 2020), six plants were randomly taken from each plot to record the average of the following; 100-grain weight (g) adjusted to 15.5% moisture content. Grain yield and biological yield were determined for each plot then converted to ton feddan⁻¹.

2.3 Soil analysis

pH of the soil was measured in a soil-water suspension (1:2.5) using the pH meter (Hanna, model: 211) and the electrical conductivity (EC) was measured in a soil-water extract (1:2.5) using EC meter and

soil organic matter of the soil was determined according to Walkley and Black's rapid titration method as described by Jackson (1973). Available nitrogen was extracted with 1% K₂SO₄ at a ratio of 1:5. Then, 20 ml of the extract were distilled with the addition of 1 g Devarda's alloy using a micro Kjeldahls distilling unit into a flask containing 10 ml boric acid-mixed indicator solution until about 50 ml distillate in each flask was collected. After the distillation, available nitrogen (NH₄⁺ + NO₃⁻) content was determined in the distillate by titrating with standardized 0.01 N sulphuric acid (Jackson, 1973). Available phosphorus was extracted by (0.5 M Na HCO₃ at pH 8.5), the extracted P was measured colorimetrically using stannous chloride (Olsen *et al.*, 1954). Available potassium was extracted by ammonium acetate method and measured by flame photometry (Jackson, 1973).

2.4 Plant analysis

Half gram of maize plant was digested in 10 ml of H₂SO₄ and 2 ml perchloric acid

in a conical flask as described (Baethgen and Alley, 1989). The digested maize material was used to determine total nitrogen, phosphorus and potassium as described by Reuter (1997).

2.5 Economic evaluation

The net return and profit cost ratio (P/C) of the field experiment for maize crop in Table (4).

$$\text{Net return} = \text{gross income} - \text{total production costs}$$

$$\text{Benefit cost ratio (BCR)} = \text{gross income} / \text{total production costs}$$

$$\text{Revenue} = \text{ton grin yield} \times \text{Price}$$

$$\text{Net revenue} = \text{Revenue} - \text{total cost cultivation}$$

$$\text{P/C ratio} = \text{Net revenue} / \text{Revenue}$$

2.6 Data analysis

The Analysis of Variance (ANOVA) and Duncan multiple range tests at 5% level of probability were used to test the significant of differences between the treatments. Data statistical analyses were performed using Costat software (Steel and Torrie, 1986).

Table (4): Parameter used to calculate the economic returns for different nitrogen forms fertilization on treatments on maize yield.

1 st Season		2 nd Season	
Parameters	Actual values	Parameters	Actual values
Price of poultry manure (16 ton feddan ⁻¹)	4600 L.E/feddan	Price of poultry manure (16 ton feddan ⁻¹)	4800 L.E/feddan
Price of AS (100 kg feddan ⁻¹)	350 L.E/feddan	Price of AS (100 kg feddan ⁻¹)	375 L.E/feddan
Price of UCS (100 kg feddan ⁻¹)	500 L.E/feddan	Price of UCS (100 kg feddan ⁻¹)	550 L.E/feddan
Price of EN (100 kg feddan ⁻¹)	500 L.E/feddan	Price of EN (100 kg feddan ⁻¹)	550 L.E/feddan
Price of seed 10 kg feddan ⁻¹	500 L.E	Price of seed 10 kg feddan ⁻¹	540 L.E
Price of yield of seed	4.5 L.E/kg	Price of yield seed	4.70 L.E/kg
Price of straw of yield	50 L.E/ton	Price of straw of yield	60 L.E/ton
Labor wages and soil prepare (feddan)	3350 L.E/feddan	Labor wages and soil prepare (feddan)	3500 L.E/feddan

3. Results and Discussion

3.1 Growth parameters

3.1.1 Plant height

Regarding the effect of different types of N-fertilizers of maize plants data in Table (5) indicated significant improvement in maize plant height of all treatments compared to that of the control treatment.

Data demonstrated that the application of chemical fertilizers and organic form gave the highest values of plant height without any significant differences compared with the slow-release N-fertilizers forms. Whereas the differences among the treatments were slightly. The superiority of ammonium sulphate may be due to its chemical acid fertilizes these fertilizers lower the pH in alkaline soils.

Table (5): Effect of different types of N-fertilizers on growth parameters of maize during 2019 and 2020 seasons.

Treatment	Plant height (cm)		100 grain weight (g)	
	1 st Season	2 nd Season	1 st Season	2 nd Season
T _c	173±0.35 ^b	183±0.35 ^b	22.77±0.42 ^c	23.40±0.42 ^b
T ₁	212±10.50 ^a	213±7.90 ^a	28.63±1.63 ^b	29.40±1.84 ^a
T ₂	207±1.90 ^{ab}	208±1.49 ^a	30.70±0.74 ^a	31.00±0.90 ^a
T ₃	206±0.98 ^{ab}	209±0.48 ^a	31.30±0.26 ^a	31.07±0.28 ^a
T _p	210±0.94 ^a	212±0.33 ^a	28.44±0.74 ^b	30.43±0.42 ^a

Means denoted by different letters are significantly difference according to Duncan's test at $p < 0.05$. T_c=control, T_p=poultry manure (16 ton feddan⁻¹), T₁=Ammonium sulfate (358 kg feddan⁻¹), T₂=Sulfur coated urea (260 kg feddan⁻¹), T₃=Enciabebean (300 kg feddan⁻¹).

In addition, ammonium ions are absorbed on soil colloids clay and humus, thus resisting the leaching losses and therefore are more effective nitrogen fertilizer. Ahmad *et al.* (2013) who reported maximum plant height using in NPK (150-120-60). The increase in plant height with different nitrogen sources 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 (Amin, 2011). While, in another study the tallest plants were recorded from the application of 240 kg N ha⁻¹ (Worku *et al.*, 2020).

3.1.2 Chlorophyll content

The data listed in Table (5) and Figure (1)

show significant value between organic manure and sources of nitrogen in total chlorophyll. The results clearly indicate that the application of slow-release nitrogen fertilizer EN was the best treatment, producing the highest chlorophyll content (SPAD-value). The highest values of chlorophyll content 58.98 and 60.25 (SPAD-units) were recorded when soil fertilized by EN treatment. In this study, the effect of different nitrogen fertilization was reflected in leaf chlorophyll content, as dosage were responsible for higher chlorophyll content. Furthermore, proving the importance of the nutrient as a major constituent of the chlorophyll molecule, whose supply can trigger an accumulation of the photosynthetic pigment in plants, thereby influencing chlorophyll content (Abdallah *et al.*, 2016). Hokmalipour and

Darbandi (2011) found that the application of nitrogen fertilizer has positive effects on chlorophyll content.

3.1.3 100-grain weight

The data in Table (5) indicate that adding slow-release fertilizer T₂ and T₃ respectively. In both the two growing seasons increased 100-grain weight more and significantly than those obtained by adding T₁ or T_p treatments. On the other hand, the minimum values of 100-grain weight were occurred with chemical fertilizer or organic form whereas both of them gave the same values approximately. These may be attributed to the effect of

coating materials can decrease nitrogen loss through intermittent leaching by stalling the release of nitrogen. The coating of urea with sulphate, urease inhibitors and other biodegradable materials are the possible remedies to reduce N loss and enhance urea efficiency (Shaviv, 2001). Also, Zeidan and El Kramany (2001) they found that the application slow-release N fertilizer (Enciabein) gave heights 100-grain weight in wheat than ammonium nitrate or ammonium sulphate. Also, in the second study found the slow-release nitrogen fertilizers improved the 100-grain weight of maize (Abou-Zied *et al.*, 2014).

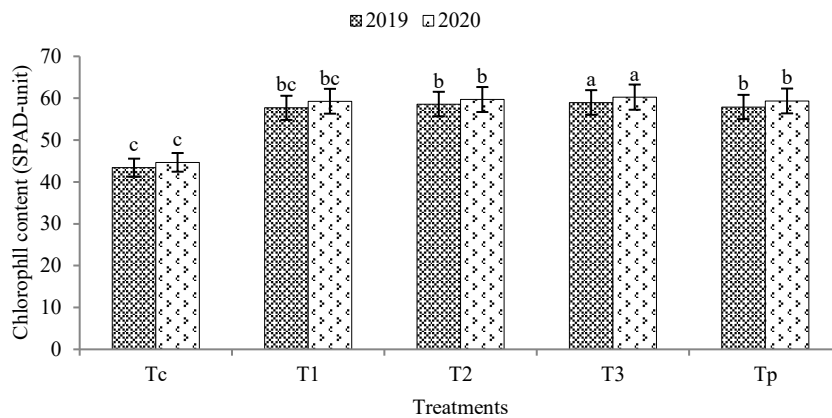


Figure (1): Effect of different forms of N-fertilizers on chlorophyll content of maize plants during two seasons.

3.1.4 Biological yield

Data in Table (6) and Figure (2) reveal that there was a significant increase in biological yield of all treatment compared to that of the control treatment for both two growing seasons. Table (6) pointed that the biological maize yield of treatment (T₂) SCU were higher than those of the other

treatments used. The increases in the biological yield were approximately two folds compared to the control when SCU were added at the rate of 120 kg N/feddan in the first season. The data added that similar trend as those obtained at 2020 season as indicated in Table (6) and Figure (2). But the differences were statistically non-significant for all treatments. This

might be due to its higher nutrients composition and capacity to increase availability of native soil nutrients through higher biological activity (Pengthamkeeratia *et al.*, 2011). The best results obtaining from using SCU can be attributed to the slow release of nitrogen to meet plants requirement, where the coat of urea with sulfur can low the dissolution rate of urea than another treatments, so reduce N loss

from soil, gradually hydrolyzed in parallel with the plant demand, gives a chance for more nitrogen uptake by plant roots and gradual improvement in N-supply power for improving N efficiency of slow release as compared with soluble form (Zvomuya *et al.*, 2003). The results showed that the slow-release nitrogen fertilizers led to improvement in biologic yield (Tajik Khaveh *et al.*, 2015).

Table (6): Effect of different types of N-fertilizers on yields of maize during 2019 and 2020 seasons.

Treatment	Biological yield (ton feddan ⁻¹)		Grain yield (ton feddan ⁻¹)		N-uptake of yield (kg feddan ⁻¹)	
	1 st Season	2 nd Season	1 st Season	2 nd Season	1 st Season	2 nd Season
T _c	6.20±0.07 ^c	6.45±0.17 ^b	1.08±0.10 ^b	1.1±0.02 ^b	16.77±0.70 ^b	25.13±0.59 ^b
T ₁	11.46±1.39 ^b	11.73±1.23 ^a	2.20±0.35 ^a	2.27±0.30 ^a	63.54±13.78 ^a	63.81±9.73 ^a
T ₂	12.24±0.25 ^a	12.44±0.31 ^a	2.34±0.07 ^a	2.38±0.07 ^a	69.27±4.75 ^a	76.09±5.15 ^a
T ₃	11.54±0.32 ^b	11.94±0.14 ^a	2.28±0.06 ^a	2.30±0.03 ^a	63.43±1.96 ^a	64.13±4.90 ^a
T _p	11.26±0.13 ^b	11.47±0.10 ^a	2.16±0.01 ^a	2.26±0.02 ^a	74.28±2.37 ^a	79.68±4.66 ^a

Means denoted by different letters are significantly difference according to Duncan's test at p<0.05. T_c= Control, T_p= Poultry manure (16 ton feddan⁻¹), T₁= Ammonium sulfate (358 kg feddan⁻¹), T₂ = Sulfur coated urea (260 kg feddan⁻¹), T₃= Enciabeam (300 kg feddan⁻¹).

3.1.5 Grain yield

The effect of nitrogen sources on the grain yield of maize results in Table (6) show that the grain yield was significantly affected by N-sources in both seasons as compared to that obtained from untreated control concerning among the different N-sources. The effect of different treatments on maize grain yield could be arranged in descending order of T₂ > T₃ > T₁ > T_p > T_c. Grain yield is the end result of many complex morphological and physiological

process occurring during the growth and development of crop (Fanuel and Gifole, 2013). Results obtained agree with those of Afe *et al.* (2015) and Magda *et al.* (2015), they found that the production of grain yield might be due to better growth, development and dry matter accumulation with proper supply of nutrients to plant and increase in the availability of other plant nutrients with the respective source of nitrogen application showed that the slow-release nitrogen fertilizers led to increase in grin yield (Guang-hao *et al.*, 2021).

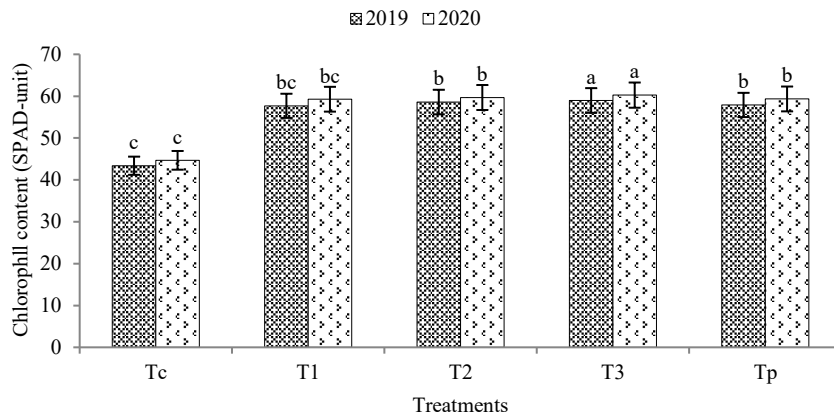


Figure (2): Effect of different of N-fertilizers on grain yield of maize plants during two seasons.

3.1.6 N-uptake yield

Data given in Table (6) indicate that the N-uptake yield by maize plant was significantly affected by adding poultry manure followed by slow-release nitrogen fertilizer (SCU) in both seasons. The highest values of N-uptake by maize plant were generally attained by adding T_p in 2019 and 2020, respectively, followed by the addition of T_2 in both seasons. The highest nitrogen uptake was observed was 74.28 and 79.68 kg fed.⁻¹ in both seasons. However, the lowest values of N-uptake by maize were obtained in T_c compared to the other treatments. The application of poultry manure to the soil enhanced the N-uptake by maize plants in different responses (Abd El-Gawad and Morsy, 2017). This could be attributed to the effect of the addition of poultry manure which enhanced the metabolic activity within plants and promoted the migration of the metabolites through root and stems toward leaves, thereby it may increase the percentage of nutrients in leaves and stems

(Sikander, 2001). Also, Abumere *et al.* (2019) showed that the highest nitrogen uptake was observed in plots amended with 20 ton ha⁻¹ poultry manure. The highest mean N-uptake was recorded under organic manure treatment (Obondo *et al.*, 2021).

3.2 Chang in soil chemical properties

3.2.1 Electrical conductivity (EC)

Chemical and physical properties of the experiment soil before maize planting and at harvest are illustrated in Tables (1) and (7). From the results obtained, it is apparent that most of electrical conductivity values were slightly decreased at harvest compared to their values before planting. Also, the results show the electrical conductivity values were significantly affected by fertilization after harvest and all the fertilization treatments decreased EC_e and the control treatment the lowest values of EC_e . In T_p treatments recorded the highest values of

EC_e. The highest increase in soil salinity was recorded in PM in both seasons as compared to the control. The increment in soil EC could be inferred to the amount of salt concentration in livestock manures, which in turn accumulated in the upper horizons and ultimately resulted in higher soil EC (Hao and Chang, 2003). Chang *et al.* (2007) showed that electrical conductivity in soil treated by organic manure was generally higher than those received chemical fertilizer treatment. Al-Sayed *et al.* (2019) stated that applied organic manure into soil increased its salt contents especially at the high rate.

3.2.2 Soil reaction (pH)

The results added that application 100% forms of N-fertilization (chemical or organic) resulted in soil pH increasing from 7.92 to 8.16 and 8.15 as the mean values of the chemical treatments (T₁, T₂ and T₃) during the two growing seasons

respectively. Whereas application of 100% (T_p) treatment as organic N-forms resulted in soil pH slight decreasing from 7.92 and 8.2 to .89 and 7.76 during tow growing seasons respectively. Tables (1) and (7) showed that soil pH of treatments control (T₀) were higher than those of the other treatments after harvest maize yield where, resulted in soil pH increasing from 7.92 and 8.2 to 8.26 and 8.24 during 2019 and 2020 seasons respectively. It appears, after maize that the soil pH decreased after the treatments fertilized by poultry manure due to the soil reaction pH slightly decreases with applying organic manures to the accumulation of acidic organic materials, especially the humic acids which react with the salts to produce salt humates that in turn, affects the soil pH (Mahmoud, 2000). This results agreement with Al-Sayed *et al.* (2019) stated that the soil pH decreased due to application of organic fertilizer (compost) compared to the control.

Table (7): Effect of different types of N-fertilizers on some soil properties after planting during 2019 and 2020 seasons.

Treatment	EC (1:2.5) dS m ⁻¹		pH (1:2.5)		OM (g kg ⁻¹)	
	1 st Season	2 nd Season	1 st Season	2 nd Season	1 st Season	2 nd Season
T _c	0.38±0.02 ^c	0.39±0.01 ^c	8.26±0.02 ^b	8.24±0.04 ^b	14.36±0.22 ^c	14.49±0.22 ^d
T ₁	0.52±0.04 ^b	0.53±0.04 ^b	8.17±0.06 ^a	8.16±0.03 ^a	16.97±0.72 ^b	18.01±0.89 ^{bc}
T ₂	0.51±0.0 ^b	0.51±0.01 ^b	8.14±0.01 ^a	8.13±0.00 ^a	18.01±0.69 ^b	19.25±0.29 ^b
T ₃	0.53±0.01 ^b	0.56±0.02 ^b	8.19±0.02 ^a	8.17±0.04 ^a	16.35±0.45 ^{bc}	17.59±0.78 ^c
T _p	1.06±0.15 ^a	1.12±0.15 ^a	7.89±0.09 ^a	7.76±0.11 ^a	39.53±6.37 ^a	40.77±6.37 ^a

Means denoted by different letters are significantly difference according to Duncan's test at p<0.05. T= Treatment, T_c= Control, T_p= Poultry manure (16 ton feddan⁻¹), T₁=Ammonium Sulfate (358 kg feddan⁻¹), T₂=Sulfur coated urea (260 kg feddan⁻¹), T₃= Enciabeane (300 kg feddan⁻¹), EC =Soil electrical conductivity, pH=Soil reaction, OM=Soil organic matter.

3.2.3 Soil organic matter (SOM)

Results of Tables (1) and (7) indicated that organic matter content was increased in all treatments especially those plots

treated with poultry manure, result in increasing the OM content over that originally present. On the other hand, among fertilization treatments, soil OM as significantly higher in the 100% T_p

treatments than 100% (T₁, T₂ and T₃) treatments. An increase in soil OM in the treatments may be due to the effects of manure, which act as storehouse of different plant nutrient. Babalola *et al.* (2012) who reported an increase in SOM with increasing rate of poultry manure under similar soil types using yam, okra, and tomatoes as test crops. Zhao *et al.* (2009) reported that the application of organic manure singly or in combination with inorganic fertilizer resulted in higher OM content than the exclusive application of chemical (NPK).

3.2.4 Available nitrogen (N)

It can be noticed from the results presented in Table (8) that there was a significant increase in the soil available N of all treatment compared to that of the control treatments for the two growing seasons.

The relative increase over control treatments were 144.15,149.2,164.4 and 133.9% for T₁, T₂, T₃ and T_p respectively at 2019 season. The corresponding values at 2020 season were 123.2, 137.1, 143.5 and 122.4% for T₁, T₂, T₃ and T_p respectively. Data in Table (8) showed application of 100% of nitrogen fertilizers and slow-release fertilizer for fertilizer maize crop, the differences among the N forms after harvest were not significantly in soil available N. However, the superiority for T₂ and T₃ (slow N-release fertilizer) compared with T₁ and T_p. Also, in the same table the highest mean value of soil N-available obtained with slow-release fertilizer as T₂ and T₃. The lowest mean value of soil N- available observed with control. These results may be attributed to the loss nitrogen from T₁ or due to the slow-release fertilizer. Sun *et al.* (2020) showed the available N-content an increasing trend with increasing N rate.

Table (8): Effect of different types of N-fertilizers on nutrients of NPK-available after planting during 2019 and 2020 seasons.

Treatment	Ava-N (mg kg ⁻¹)		Ava-P (mg kg ⁻¹)		Ava-K (mg kg ⁻¹)	
	1 st Season	2 nd Season	1 st Season	2 nd Season	1 st Season	2 nd Season
T _c	44.97±7.28 ^b	52.59±0.0 ^b	6.43±0.55 ^c	6.81±0.19 ^c	132±2.47 ^d	140±4.24 ^c
T ₁	109.76±18.64 ^a	117.38±17.43 ^a	8.38±0.52 ^b	8.91±0.63 ^b	197±17.67 ^{bc}	201±18.04 ^b
T ₂	112.05±1.87 ^a	125.0±3.06 ^a	8.90±0.05 ^b	9.69±0.08 ^b	201±1.25 ^b	209±2.88 ^b
T ₃	118.91±4.36 ^a	128.05±8.10 ^a	8.75±0.14 ^b	9.32±0.02 ^b	183±4.08 ^c	189±8.89 ^b
T _p	105.19±3.79 ^a	1116.98±2.77 ^a	16.32±1.93 ^a	17.64±1.16 ^a	345±47.11 ^a	451±74.03 ^a

Means denoted by different letters are significantly difference according to Duncan's test at p<0.05. T_c= Control, T_p= Poultry manure (16 ton feddan⁻¹), T₁=Ammonium sulfate (358 kg feddan⁻¹), T₂=Sulfur coated urea (260 kg feddan⁻¹), T₃= Enciabeane (300 kg feddan⁻¹), Ava-NPK= Available of nitrogen, phosphorus and potassium.

3.2.5 Available phosphorus (P)

Available P increased from 6.43 and 6.81 mg/kg to 17.64 mg/kg in 2019 and 2020 growing seasons respectively. Application of 100% T_p resulted in Available P that

was significantly higher than in control and the other treatments of (T₁, T₂ and T₃) and can be arranged as follows: T_p > T₂ > T₃ > T₁ > T_c. Adeleye *et al.* (2010) indicated that poultry manure application resulted in an increase in available P. The addition of

organic manure led to increase soil moisture contents which may be the reason of improved P availability in soil (Boateng et al., 2006). Also, Yadav et al. (2019) found that the available P was slightly improved due to addition of organic manure over the initial soil value.

3.2.5 Available potassium (K)

Concerning the effect of N- sources the data in Table (8) showed that the available K after maize harvest significantly increased by application all N-forms compared with the control during both seasons. The data added that, soil available K took the same trend of the available P, whereas T_p treatments were superior and had the highest soil available K after maize harvest. While, both T₂ and T₃ the different between each other in soil available K were negligible and approximately from T₁ values in this respect. The effect of the N-forms used can be arranged as follow: T_p > T₃ > T₂ > T₁ > T_c. The increase in soil exchangeable K may be due the direct of K addition in the soil K pool. The organic manure is enriching in NPK contents that increase their availability (Khaliq and

Abbasi, 2015).

3.2.6 Economic evaluation

Data in Table (9) and Figure (3) indicated that the economic evaluation of grain and stover yield of maize under UCS 100% showed the best treatment T₂ as a net revenue of about 6455.93 and 6702.67 (L.E feddan⁻¹), respectively in both seasons. The profitability gets it from revenue minis total costs (comes from adding investment costs to operating costs), and the proportion of profits to costs estimated at 0.58 and 0.58 in both seasons. The study, relating to the profitability of mineral and organic fertilizers under maize cultivation. Konan et al. (2018) showed that the treatment, with the mineral fertilizer, having obtained the greatest net profit (1 546 680 F CFA), is the most profitable and recommendable for maize growing. The net return of slow-release nitrogen fertilizers was significantly higher than that of chemical fertilizers because of the advantage of increased grain yield and decreased labor costs with one-time application (Guanghao et al., 2021).

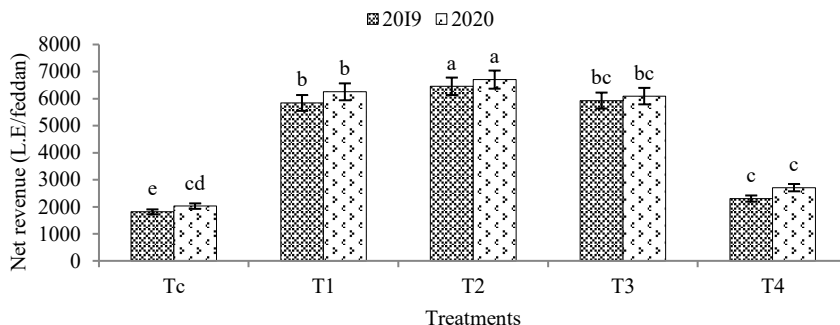


Figure (3): Effect of different type of N-fertilizer on net revenue maize plants during two seasons.

Table (9): Economic evaluation of maize production at 1st and 2nd seasons.

Treatment	Input				Output		
	I.C	O.C	T.C.C (L.E feddan ⁻¹)	Revenue	Economic criteria		
					N.R (L.E feddan ⁻¹)	P/C ratio	Order
1 st Season							
T _c	3350	0	3350	5163	1813	0.35	4
T ₁		1253	4603	10443	5840	0.56	2
T ₂		1304	4654	11109	6455	0.58	1
T ₃		1500	4850	10776	5926	0.55	3
T ₄		4600	7950	10253	2303	0.22	5
2 nd Season							
T _c	3500	0	3500	5524	2024	0.37	4
T ₁		1343	4843	11094	6251	0.56	2
T ₂		1434	4934	11636	6702	0.58	1
T ₃		1650	5150	11242	6092	0.54	3
T _p		4800	8300	11007	2707	0.25	5

T_c= Control, T_p= Poultry manure, T₁= Ammonium sulfate, T₂= Sulfur coated urea, T₃= Enciabebean, N.R= Net revenue, P/C ratio= Net revenue /Revenue, L.E= Egyptian pound, I.N= Investment costs, O.C= Operating costs, T.C.C= Total costs cultivation..

4. Conclusion

Use of different organic fertilizers are considered the best option not only to reduce the intensive use of chemical fertilizers, as well as to maximize crop yield. It is noticed that the best practice is using SCU since this treatment achieved the highest growth and yield Also poultry manures give the heights of yield components of maize crop as well as soil properties under Assiut condition, Egypt. It is also recommended to add SCU or poultry manure to obtain high productivity and improve soil properties.

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