THE IMPACT OF SEVERAL ANIMAL MANURE TYPES IN COMPARISON WITH UREA ON GROWTH AND YIELD OF MAIZE (*Zea mays* L.)

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ABSTRACT:
This study was conducted at the Research Station of the College of Agriculture, University of Anbar, to evaluate the effects of different manure sources (Poultry manure, Sheep manure and Cow manure), used as organic fertilizer, and chemical fertilizer (Urea 46%N) on the growth , contents of chlorophyll, carbohydrate and nutrients of maize plants (*Zea mays* L.). Experiment was laid out in Randomized Complete Block Design (RCBD), with three replications having five treatments: control (without any fertilizer), sheep manure (SM): 32 ton ha^{-1}, cow manure (CM): 32 ton ha^{-1} and poultry manure (PM): 18 t ha^{-1} and chemical fertilizer (CF) 300 kg N ha^{-1}. Poultry manure showed significantly higher values of all recorded parameters followed by sheep manure, whereas cow manure showed little or insignificant differences, compared with CF. Poultry manure exceeded CF in almost all recorded parameters of growth (plant height, number of leaves, leaf surface area, and biomass production) and the content of chlorophyll, carbohydrate and nutrients N, P and K concentrations in maize leaves. The advantages in using animal manure were ascribed to more availability and uptake of nutrients throughout the growing season, improved soil organic matter and other soil properties favoring biomass production rather than CF application. The study showed that poultry manure was the best alternate source to urea fertilizer for growth and development of maize plants at the rate of 18 t ha^{-1}under the conditions of this experiment.
Keywords: Maize, Animal manures, Urea, growth, chlorophyll, carbohydrate, mineral nutrients

تأثير عدة أنواع من المخلفات الحيوانية مقارنة مع سماد اليوريا على نمو وأنتاج الذرة الصفراء (Zea mays L.)

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الخلاصة :
نفذت تجربة حقلية في المحطة البحثية لكلية الزراعة ، جامعة الانبار بهدف تقييم تأثير عدة مصادر للمخلفات الحيوانية (مختفات الدواجن ومختفات الاغنام ومختفات الابقار) أستخدمت كأسمدة عضوية مقارنة مع السماد الكيميائي يوريا N

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46% على النمو ومحتوى الكلوروفيل والكاربوهيدرات والعناصر الغذائية لنبات الذرة الصفراء (.Zea mays L). طبقت التجربة وفق تصميم القطاعات كاملة التعشية (RCBD) شملت خمسة معاملات وبثلاث مكررات: معاملة السيطرة (بدون سماد كيميائي او سماد حيواني) ، مخلفات الاغنام بمستوى 32 طن في الهكتار، مخلفات الابقار 32 طن في الهكتار ،مخلفات الدواجن 18 طن في الهكتار والسماد الكيميائي 300 كغم N في الهكتار . أظهرت معاملة مخلفات الدواجن تفوقا معنويا عاليا في غالبية الصفات الفسيولوجية والأنتاجية المدروسة وجائت بعدها مخلفات الأغنام بينما كان تأثير مخلفات الأبقار قليلا او غير معنوي قياسا بمعاملة السماد الكيميائي. حققت معاملة التسميد بمخلفات الدواجن تفوق معنوي واضح لمجمل خصائص النمو مثل ارتفاع النبات وعدد الأوراق والمساحة السطحية للأوراق و انتاج الوزن الجاف. كذلك حققت تفوق معنوي واضح في محتوى الكلوروفيل والكاربوهيدرات وتركيز العناصر الرئيسية N, P, k في اوراق الذرة . يعود السبب في تفوق معاملة التسميد بمخلفات الدواجن الى توفر اكثر للعناصر الغذائية مما زاد من معدل امتصاصها خلال موسم النمو وتحسين خصائص التربة ومنها الخصائص العضوية والتي بدورها ساعدت على زيادة معدلات النمو والأنتاج والوزن الجاف قياسا بالسماد الكيميائي. نستنتج من هذه الدراسة امكانية اعتبار مخلفات الدواجن أحسن مصدر للسماد العضوي قيد الدراسة و كمصدر بديل لسماد اليوريا 46% N لنمو وتطوير نبات الذرة الصفراء وبمعدل 18 طن للهكتار تحت ظروف هذه التجربة.

Introduction:

Maize is an important cereal crop grown all over the world; it contributes 62% in the total cereal production. Maize is multipurpose crop and provides food for human beings, fodder for livestock and feed for poultry. It has great nutritional value as it contain about 66.7% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugars, and 7% ash (Chaudhary, 1983). It is a major source of income in several developing countries and one of the best sources for bio-fuel in developed countries (Ali *et al.*, 2014).

Soil productivity maintenance is a major constraint of Iraqi agriculture. Declining fertility of Iraqi soil is becoming increasingly critical to secure sustainable agricultural productivity. Soil low organic matter content, soil salinity and erosion problems have predisposed the soils to degradation. The decompose in organic matter occurred, firstly because of arid climate and high temperature resulting in a rapid decomposition of organic matter and secondly due to low quantity of organic materials applied to Iraqi fields. This is worsened by the unwise application of chemical fertilizers and their effects on environmental quality.

Nutrient balance is always an important consideration for crop response to applied fertilizers. Use of inorganic fertilizers can improve crop yield and nutrient availability, but it's unwise use can cause nutrient imbalance and environmental pollution in addition to high production cost (Das *et al.*, 1991; Oad *et al.*, 2004; Ali, 2005; Mbah and Mbagwu, 2006; Mbah *et al.*, 2006 ; and Ali, 2012).

The rising cost of mineral fertilizers coupled with the inability to condition the soil has brought attention to organic manure in many parts of the developing countries in recent times (Baoteng *et al.*, 2006). The applicant of manures to soil provides potential benefits and serve as soil conditioners through improving soil physical properties including soil structure, water infiltration, soil water holding capacity, aeration and permeability, soil aggregation , decreased soil crusting, bulk

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density, and erosion and increasing rooting depth, improving soil organic matter microbial biomass and soil fertility, reducing the amount of synthetic fertilizer needed for crop production (Allison, 1973; Sumner ,2000; Phan *et al.*, 2002 and Blay *et al.*, 2002) . Also, since manure poses environmental concern, its use in crop production will assist in environmental sanitation.

Keeping in view the above facts and increasing demand for sustainable agriculture, the present study was therefore designed to examine the effects of different sources of animal manures, in comparison with chemical fertilizer, on growth and development of maize.

Materials and Methods:

This study was conducted at the Research Area of the College Agriculture, University of Anbar. The site is located about 2 Km away from Ramadi-city center, west of Iraq. The site where the experiment was conducted did not have a history of manure application. The soil texture was sandy loam.

The experimental field was cleared, deeply ploughed, harrowed and was cultivated two times each followed by planking. Soil samples were taken across the experimental field to a depth of approximately 30 cm before manure application and sowing of crop. The samples were bulked for the necessary physical and chemical properties, and the results are presented in table (1).

Table 1: Soil physical and chemical properties (0-15 cm depth) of the experimental site before planting

Material	value	unit
EC	5.3 dSm^{-1}	dSm^{-1}
pH (H_2O)	7.6	
N	126	mg kg^{-1}soil
P	17	
K soluble	37	
K exch.	173	
O.M	14	g kg^{-1} soil
Sand	737.5	
Silt	62.5	
Clay	200	
Texture class	Sandy loam	
Analyses were preformed according to Black, (1983)		

Treatments included in the experiment were: (1) control: (no animal manure and no chemical fertilizer); (2) sheep manure (SM): 32 ton ha^{-1}; (3) cow manure (CM): 32 ton ha^{-1}; (4) Poultry manure (PM): 18

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ton ha^{-1} and (5) chemical fertilizer (CF) Urea 46% N: 300 kg N ha^{-1}.

Experiment was laid out in Randomized Complete Block Design with three replications. Experimental site was divided into three plots with 2m intra plot, each plot was divided into five units with 1m intra units and each experimental unit consisted of four planting lines with 0.75 m intra lines. Samples from each source of animal manure were air- dried, crushed, sieved, and incubated for decomposition and stabilizing for 120 days. Chemical analysis for the applied manures was carried out before field spreading (table 2). The different animal manures were incorporated into the soil of the respective plots, in one dose before seed sowing, by broadcast prior seed bed preparation, and mixed into the top layer of the soil with a field cultivator and fine harrow. The chemical fertilizer (Urea 46% N) was splitted in two doses, one dose before planting and the other dose two weeks after planting as side dressing (in lines parallel with that of the sowing lines). Other chemical fertilizers, i.e. K_2So_4 (58 Kg K ha^{-1}) and super phosphate (86 Kg P ha^{-1}) were also applied uniformly to all treatments, including the control. Irrigation was performed according to crop need and all management practices were done whenever required.

Table 2: Some chemical properties of the animal manures used in the study

Animal manure source	C/N ratio	O.C %	O.M %	P %	N %	K %	Na %	Mg %	Ca %	pH (H_2O)	EC dSm^{-1} 1:5
SM	15.6	31.2	53.8	0.5	2.0	2.6	1.0	4.3	6.0	6.4	12.3
CM	21.28	29.8	50.4	0.3	1.4	1.5	1.4	1.8	7.0	6.8	4.6
PM	8.09	33.2	61.65	2.09	4.1	2.93	0.46	5.3	4.5	6.60	3.4
SM: Sheep manure; CM: Cow manure; PM: Poultry manure											

Maize seeds cultivar "Bohoth Tarkeby-106" was hand sown by placing 4 seeds per hole (bed) at 5 cm deep and 25 cm apart in lines in the field. A total of 11 plants per line and 44 plants per experimental unit were maintained, in order to achieve plant population of 53300 plants per hectare. Two weeks after seed sowing, one plant per hole was maintained.

At the final harvest, a sample of ten plants was taken randomly from each treatment in each plot, to avoid any border effects, samples for soil characteristic, biomass, growth, and other determinations were taken from the middle of plot. Measurements of plant growth parameters, included plant height, number of leaves, leaf surface area, and dry weights of roots, and shoots were also estimated.

Samples from leaves were oven dried at 70 C^{O}, grounded and sieved and then wet digested. Nitrogen, P and K in plant tissues were determined according to methods mentioned by Haynes (1980). The obtained data were statistically analyzed and means separation was carried out

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using Least Significant Differences test (LSD) at $p< 0.05$.

Results and Discussion

Animal manure treatments(SM, CM, and PM) and chemical fertilizer M (CF), as urea treatment significantly increased growth parameters of maize plants over those of the control (Table 3). Manure grown plants, mainly PM and SM, grew rapidly and their growth parameters including: plant height, number of leaves, leaf surface area, roots biomass, shoot biomass, and total biomass were all significantly higher than those of CF grown plants, however, plant height, leaf number and leaf surface area were not significantly different between CM grown plants and CF grown plants, but root, shoot and plant biomasses were significantly higher in CM than CF grown plants. In addition, poultry manure gave the highest percentage increase of plant height, number of leaves, leaf surface area, root biomass, shoot biomass and plant biomass by 51.02%, 23.1%, 111.63%, 109.47%, 43.42%, and 51.74%, respectively over those of the control. The chemical analyses of PM indicated that PM had higher OC, P, N, and K and lower C/N ratio and EC (table 2) which made this source of manure superior than others.

Table 3: Influence of animal manure and chemical fertilizer on some growth parameters of maize plant

Treatment	Plant height (cm)	Leaf number (leaf plant^{-1})	Leaf area (dm^2 leaf^{-1})	Root biomass (g root^{-1})	Shoot biomass (g shoot^{-1})	Plant biomass (g plant^{-1})
Control	131.75	13	29.83	21.54	97.178	325.06
SM	181.85	15	56.37	35.25	125.83	424.08
CM	175.13	14	44.67	30.27	114.830	400.11
PM	198.90	16	63.13	45.13	139.37	493.25
CF	173.25	14	43.26	26.30	107.39	381.22
LSD	4.08	0.53	4.14	2.27	2.08	4.93

LSD: Least Significant Difference; SM: Sheep manure; CM: Cow manure; PM: Poultry manure; CF: Chemical fertilizer

The characteristics and beneficial uses of many sources of manures were reviewed (Sumner, 2000; Uwah *et al.*, 2011). Poultry manure produced significantly highest leaf area per plant. Maize height was found to be significantly improved using poultry manure (Boateng *et al.*, 2006). Root dry weight also showed a trend quite similar to the above-ground pattern. A number of researchers have reported an increase in leaf area of plants with the application of organic manure (van Delden, 2001). Increased leaf area has implications for light interception and dry matter production to support plant growth and development (Board, 2004). The effect

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of manure and CF applications played a different physiological role on biomass production. It is possible to assume that the higher means of biomass production under manures, mainly PM, than CF application was achieved by a mineralization process which provides nitrogen removal and other nutrient compounds for plant development whose biomass production exceeded those of CF supply. Many researchers reported increased biomass and yield of several crops including corn plants (Bittman *et al.,* 1999; Zang *et al.,* 2006). Boateng et al. (2006) reported significant improve of average corn height and biomass production upon application of poultry manure. It was found that the use of PM alone (Shortall and Liebharfit,1975) or a combination of PM and CM (Hensler *et al.,* 1970) resulted in the highest biomass and productivity of maize. However, the addition of higher rates of PM (0, 22, 56, 90, 124 and 198 t ha^{-1}) was found to reduce the rate of biomass production in maize (Shortell and Liebhrafit, 1975). Penn *et al.*, (2011) tested degraded chicken litter and found that it provided equivalent agronomic performance to CF when applied on equivalent N and P basis. Mohanty *et al.,* (2006) suggested that organic manure contribute to plant growth through their favorable effects on the physical, chemical and biological properties of soil presumably due to chelating of cations by organic acids and other decay products. It may be suggested that when crop improvements with manure were greater than those attained with CF, response was usually attributed to improved soil conditions not provided by CF. The superiority of PM to the other sources of organic manure and CF in producing taller plants with higher number of leaves and more leaf area (table 3) may be attributed to good and slow release balanced nutrients and low C/N ratio (table 2) which support plant growth.

The content of chlorophylls (A, B and A+B) and carbohydrates (table 4) were much higher in plants grown with organic manure, especially PM and SM treatments, compared with other treatments, including CF treatment. The content of chlorophylls and carbohydrates in CM grown plants were significantly higher than those of control, but showed insignificant differences with those of CF grown plants. Poultry manure registered the highest percentage increase in the content of total chlorophyll and carbohydrates (153.38% and 25%, respectively) over those of control**.** This can be attributed again to reasons mentioned above.

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Table 4: Influence of animal manure and chemical fertilizer on the content of Chlorophylls and Carbohydrates

Treatment	Chlorophyll A	Chlorophyll B	Chlorophyll A+B	Carbohydrates
	mg g plant^{-1}			g 100^{-1}
Control	**1.033**	**0.446**	**1.480**	**1.160**
SM	**2.393**	**0.870**	**3.263**	**1.310**
CM	**2.196**	**0.790**	**2.986**	**1.270**
PM	**2.790**	**0.963**	**3.753**	**1.450**
CF	**2.150**	**0.790**	**2.940**	**1.330**
LSD	**0.120**	**0.071**	**0.085**	**0.100**
SM: Sheep manure; CM: Cow manure; PM: Poultry manure; CF: Chemical fertilizer ,LSD: Least Significant Difference				

Hokmalipour and Darbandi (2011) reported a significant increase in chlorophyll content with increase in nitrogen levels. The significantly higher chlorophyll content of maize leaves observed with PM and SM could be due to differences in nitrogen content of the organic manures (table 2) and to efficient absorption and assimilation of nitrogen from the manure by the plant which serves as a constituent of chlorophyll which has been reported to be directly proportional to photosynthetic potential of any given plant (Biljana and Aca, 2009). The greater chlorophyll values in leaves of manure treated plants are of importance because photosynthetic activity and carbohydrate yield increase with increased chlorophyll content of leaves (Ramesh *et al.*, 2002).

Results in table (5) indicated that application of the animal manure sources tested in this work generated higher percentage of N, P and K in the leaves of maize plants compared with control. The highest percentage of N, P and K were found in the leaves of PM grown plants compared with other treatments including, CF treatment. However, the percentage of N, P and K in the leaves of maize was not significantly different between CM and SM with CF grown plants.

Table 5: **Nutrients concentrations in the leaves of Maize as influenced by animal manure and chemical fertilizer**

Treatment	N	P	K
	%		
Control	0.37	0.18	1.32
SM	0.95	0.25	3.35
CM	0.79	0.20	2.96
PM	1.30	0.26	3.75
CF	0.75	0.19	2.85
LSD	0.09	0.11	0.12
SM: Sheep manure; CM: Cow manure; PM: Poultry manure; CF: Chemical fertilizer , LSD: Least Significant Difference			

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Comparatively, the highest increase in the N%, P% and K% achieved in the leaves of PM grown plants over those of CF probably due to higher release of available mineral nutrients, at rates that could sustain appreciable rate of uptake by plants. Manures are the main sources of N supply in organic crop production. Nitrogen availability from applied manure includes the inorganic N in manure plus the amount of organic N mineralized following application. Nitrogen mineralization differs for different manure types since the inorganic/organic fraction and quality of organic N varies (Jae-Hoon *et a*l., 2006). Uwah *et al.* (2012) reported that N levels increased from 0.45 g kg^{-1} to 0.83 g kg^{-1} in highest PM amended plots at 15 mt ha^{-1}. Nitrogen is part of the enzymes associated with chlorophyll synthesis (Chapman and Barreto, 1995) and the chlorophyll concentration reflects relative crop N status and yield level (Blackman and Schepers, 1995). Nitrogen is essential for cell division and elongation as well as the root growth and dry matter content of maize plants (Marschner, 1995). Poultry manure application gave over 53% increases of N level and exchangeable cations (Boateng *et al*., 2006). The chemical analysis of the applied manures (table 2) indicated that PM appeared to contain the highest values of organic matter and mineral nutrients (N, P, and K) compared with other manure sources. This would probably have considerably increased the availability of mineral nutrients in the soil. Other researchers obtained similar results on organic amendments of soil (Boateng *et al.,* (2006) and Islam *et al.,* (2006). It was reported that poultry manure in contrast to chemical fertilizer, added organic matter to soil which improved soil structure, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Deksissa *et al.,* 2008). Other researchers claimed that PM significantly increased soil moisture content (Adeleye *et al*.; 2010 and Uwah *et a*l., 2011) and reduced soil bulk density and soil compaction which ultimately increased porosity and water holding capacity of soils (Uwah *et al*., 2012). It has been shown that, the continuous application of PM on some farmer's soil has led to a build-up of P exceeding 150-200 mg kg^{-1} (Penn *et al*., 2011). In addition, Silva and Menezes (2007) proposed that manure application was more effective to provide nutrients for plants because of its ability to prevent the immobilization of soil N (in short term) and increase the contents of available P and K soil over the period of culture. Phosphorous is the most important nutrient element, after N, limiting agricultural production, and unlike nitrogen, P is less soluble in water and leaching is minimal. Hence, PM appeared to contain higher levels of P compared with other manure treatments (i.e. SM and CM), and a build-up of P in soils might have reached an agronomic optimum level. Animal manures were found to raise root-zone temperature to a favorable level which promotes the rate of mineral uptake (AL-

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Hadi, 1987). Apart from the nutrients in manures, its effects on increasing P level and enhancing the biological life of the soil are well recognized (Chang *et al.*, 1990), particularly at high rates of application. Garg and Bahla (2008) reported that PM more readily supplies P to plants than other organic manure sources. In general, 90 to 100% of K in manure is available during the first year of application and the availability of K in manure is considered similar to that in CF since the majority of K in manure is in the organic form (Motavalli et al., 1989). The higher rate of K uptake by manure treated plants was ascribed to the activities of humus and folic acids; released by manures; in dissolving minerals that contain K (Elssa *et al.*, 1995). Potassium is known to accumulate in the parts of plants in which cell division and growth occur. Plants require high amounts of K to sustain their physiological activities during flowering and yielding stages, thus the higher percentage of K found in the leaves of PM grown plants exhibited the higher rates of physiological activities and of K uptake by these plants. Our results suggest that the addition of manures to soils, and hence mainly PM at rate 18 mt ha^{-1}, increased soil organic matter which might have promoted the increase in soil moisture contents and enhanced the mineralization process and released more nutrient into soil solution, consequently enhanced the uptake processes by plants.

Conclusions:

In this experiment, animal manure was found to be a labile pool for essential mineral nutrients which are steadily and gradually released at slower rates from this pool into the soil solution which can be extracted or mined by plant roots and utilized by the plant metabolic activates for growth and development throughout its life cycle. In contrast, CF placement exhibited different performance probably due to leaching loss of nutrients and or earlier and possibly shorter period of uptake by plants. It is suggested therefore, that placements of organic manure as fertilizer may be a more sustainable treatment, positively influenced the photosynthetic efficiency of manure grown plants, possibly because it maintained fertility status of the grown medium and ensured steadier supply of nutrients (i.e. N, P and K) to plant roots for absorption and utilization. It could be concluded that the uses of PM at the rate 18 mt ha^{-1} is a valuable alternate to CF for growth and development of maize plants. Economic benefits may be achieved if considering PM availability, sourcing and field applied at lower cost than CF.

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