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ENHANCED YIELD AND QUALITY OF ONION (*ALLIUM CEPA* L. cv GIZA 6) PRODUCED USING ORGANIC FERTILIZATION

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ABSTRACT:

A field experiment was conducted in 2004/2005 and 2005/2006 cropping seasons, in the Vegetables Research Station, Faculty of Agriculture, Assiut University, to evaluate yield performance of onion cv. (Giza 6) fertilized with animal or chicken manures or mineral fertilizer. The applied quantity of organic fertilizers was decided based on their contents of N, P and K and taking into account the recommended amounts of these nutrients. The results obtained showed that the yield and quality of onion were significantly influenced by fertilizer types. The highest yield of onion bulbs (7.26 and 8.82 ton/feddan for 2004/2005 and 2005/2006, respectively) was obtained by the application of chicken manure in both seasons comparing with animal manure and mineral fertilizers in 2004/2005 (7.04, 7.74, respectively) and in 2005/2006 (5.55, 7.17 ton/feddan, respectively). Additionally, the application of chicken manure increased onions dry matter, weight of individual bulb and bulb diameter.

INTRODUCTION:

Before the widespread use of chemical fertilizers, animal manures were used as a primary source of nutrients in crop production. In addition to supplying nutrients to the soil, manure also improves soil health by increasing soil organic matter and promoting beneficial organisms. Incorporating manure into a field will help to reduce water and wind erosion by improving soil structure (Lombin and Abdullahi, 1977; Hermanson, 1996; Ojeniyi, 2000). Livestock and chicken manures contain a broader range of nutrients than most commercial fertilizers. This is because a large portion of the plant nutrients initially ingested by the animals and chicken. Generally 80% of the phosphorus, 90% of the potassium and 75% of the nitrogen are still present in the manure. Chicken manure tends to be high in nitrogen (N) and phosphorus (P), while dairy manure tends to be high in potassium (K). Nutrient availability, however, is determined by the manure handling system, as well as by climate and soil characteristics. Nutrient values also vary with different types of livestock and the animal feed rations, which vary with the season (Antoun *et al.*, 1985; Drinkwater *et al.*, 1995).

Whenever manure is applied to food crops, fruits and vegetables, safety precautions should be taken to avoid contamination that might result in human illness. The best way to prevent food crops and nearby water sources from being contaminated by pathogens in livestock and chicken manures is to: : 1) avoid using fresh manure that has come from young animals, especially dairy calves, 2) compost manure to kill pathogens that may be present, 3) use buffer strips on your property to reduce chance of

nutrient loss and water contamination, and 4) time the manure application appropriately to avoid excessive leaching or runoff (Karikari and Yayock, 1987; Nyathi and Campbll, 1995; Pell, 1997; Carol et al 1999).

Mineral fertilizers are considered to be an important source of major and minor elements in crop production. Continuous application of mineral fertilizers may adversely affect soil chemical composition, nutrient imbalance, soil degradation and crop yield (Obi and Ebo, 1995; Ojeniyi, 2000). Cultivating with persistent application of mineral fertilizers increases soil acidity and soil physical degradation which may reduce crop yield (Ojeniyi *et al*., 2007; Adeinyan and Ojeniyi, 2003).

Over the past 15 years, the total surface area dedicated to the onion crop in the world has doubled reaching its present figure of 2.74 million ha. (Pelter *et al*. 1992; FAO, 2002). Average world yields increased from 12 Mt ha^{-1} in the early 1960s to 17 Mt ha^{-1} in 2001. As a result of the increase in both the surface area cultivated and the yield obtained, the world production of onions is now 39,400,000 Mt per year which is by far higher than the 14,000,000 Mt per year obtained in 1960. Onion is considered to be a high cash value crop for Egyptian farmers. This is because the international market demands of the Egyptian dry, fresh and processed onions. The total cultivated onions area in Egypt is about 123.352 fedden with a productivity of 11.92 tons/feddan (Medwest Universities Consortium for international Activities (MUCIA) DATABASE, 2004). Egypt exports about 302.412, 19.096 and 12.170 tons of fresh, dry and green onions, respectively (Marketing Technology Information Network-UPEHC (2006). The main factor that limits the exportable quantities of the Egyptian green, fresh and dry onions is the pesticides and mineral fertilizers residuals. The presented study, therefore, aimed to study the performance of onion under different organic fertilization types.

MATERIAL AND METHODS:

The present study was conducted during two consecutive winter growing season (2004/2005 and 2005/2006) in the Vegetables Research Station, Faculty of Agriculture, Assiut University. The soil was clay and having pH 7.8 and field capacity 42%. The soil contents of NPK and some micronutrient elements are presented in Table (1). Onion culture in this experimental trial site was preceded by cowpea crop in 2004/2005 and cucumber in 2005/2006. The chicken and livestock manures were added to the experimental plots in September 2004 and 2005. The livestock and chicken manure were obtained from the Poultry and Livestock Research Station, Faculty of Agriculture, Assiut University, Egypt. Manure and soil samples were analyzed to determine their nutrient contents (Table 1). The applied quantities of chicken and livestock manures in both seasons are presented in Table (2). For mineral fertilizer (reference treatment), 208 kg ammonium nitrate (NH_4NO_3 33.5% N), 266 (kg) calcium super phosphates (15.5% P_2O_5) and 50 kg potassium sulphate (48% K_2O) per fedden were applied (Table 2). Otherwise, there were no organic and/or inorganic fertilizers added to the control plots.

Seedlings of the onion cv. Giza 6 were transplanted on October 20th, 2004 and November 1st, 2005. The experiment was conducted in randomized complete-blocks (RCB) with 4 replicates in 2004/2005 and 2005/2006. Treatment plot consisted of 7 rows each row was 3 m long and 0.5 m wide. Onion seedlings were planted on 7 cm apart to reach a plant density of 300 plant/plot. The following development and yield parameters were

assessed on plot basis: number of onion bulbs, yield of onion bulbs and total yield per feddan (calculated based on the plot size). The following parameters were recorded using 20 randomly sampled bulbs: average weight of individual bulbs (g) and bulb diameter (cm). Additionally, the dry matter of 100 g fresh cut onions was determined.

Analysis of variance relevant to RCB experiments, as described by Gomez and Gomez, (1984), was conducted. Combined analysis was applied based on the results of chi-square test of error homogeneity (Bartlett's test) as described by Gomez and Gomez, (1984). The Least Significant Difference' ($LSD_{0.05}$) was used for mean comparisons.

Table (1): Soil analysis (control plots) and element contents of the used mineral and organic fertilizers[(1)]

Treatments	% N	% P	% K	Fe (ppm)	Zn (ppm)	Mn (ppm)
Control [(2)]	1.78	0.624	3.3	0.6	4	11
Mineral fertilizer:						
NH_3NO_3	33.5	NA	NA	NA	NA	NA
P_2O_5	NA[(3)]	22.5	NA	NA	NA	NA
K_2O	NA	NA	48	NA	NA	NA
Animal manure	2.86	0.483	2.4	0.4	3	8
Chicken manure	4.2	0.342	3.9	0.2	2	9

(1) This analysis was achieved by the lab of Soil and Water Science, Faculty of Agric., Assiut Univ., 71526, Assiut, Egypt.
(2) Soil analysis of the Experimental Farm of Faculty of Agric., Assiut University.
(3) No data were available.

Table (2): The recommended and applied quantities of mineral and organic fertilizers were used in the presented study

Treatment	Recommended quantity/fedden	Applied quantity/fedden*
Mineral fertilizer:		
Ammonium Nitrate, NH_4No_3 (33.5%)	200 (kg)	208 (kg)
Calcium super phosphate (15.5%)	200 (kg)	266 (kg)
Potassium sulfate (48%)	50 (kg)	50 (kg)
Animal manure	20 (m^3)	2447 (kg)
Chicken manure	20 (m^3)	1666 (kg)

*** The applied quantities were estimated based on: a) percentage of N, P and K in each fertilizer, and b) N:P:K quantities required per fedden.**

RESULTS AND DISCUSSION:

The onion cultivar Giza 6 is mainly improved for production in winter season under Upper Egypt climatic conditions. The bulbs quality of this cultivar (including bulb weight, color, shape and size) was considered to meet exportation criteria. The data presented in Fig. (1) and Fig. (2) show clear differences in number of onion bulbs/plot, bulb diameter, average weight of individual bulb, dry matter and total yield between the organic (livestock and chicken manure) and inorganic (mineral) fertilizer applications. While the greatest number of onion bulbs/plot was obtained when applying livestock manure in 2004/2005 (Fig. 1A), chicken manure in 2005/2006 produced the greatest number of onion bulbs/plot (Fig. 2A). The control treatment (without organic and/or inorganic fertilizers) produced the lowest number of bulbs per plot (122.52 and 138.75 for 2004/2005 and 2005/2006, respectively). These trends could be ascribed to the improvement of soil structure which reflected on water

movement by applying organic fertilizers (e.g. livestock and chicken manures) (Batal, 1991; Ahmed, 1997 and El-Emam, 1999).

The chicken manure treatments affected significantly the bulb diameter and average bulb weight. Applying chicken manure prior to onion cultivation increased significantly bulb diameter and average bulb weight in both seasons (Fig. 1B & 1C and Fig. 2B &2C). There were no significant differences between animal manure and mineral fertilizer treatments. The control treatment showed the smallest bulb diameter and average bulb weight in both seasons. These results may attribute to the application of chicken and/or animal manure which improve the soil structure which reflected on decreasing nutrient losses by leaching and deep percolation compare to mineral fertilizer (Metwally and Abdel-Bary, 1999). A strong relationship between nitrogen fertilizer supply and onion bulbs development was observed by Brewster and Butler (1989) and Halvorson *et al.* (2002). They found that the lower the nitrogen, the later bulb scale initiation occurred and an initial period of low N delayed bulb scale development and ripening relative to high N throughout. Regarding the average bulb weight, the performance of onion cv Giza 6 was not consistent during the growing seasons of this investigation. Significant differences were observed between the two growing seasons. The performance of onion cv Giza 6 regarding average weight of onion bulbs was greater in the second season than the first season. These results can ascribed to the N, P, and K residuals in the experimental soil from the application of organic and inorganic fertilizers during the first season. Same results were observed on cotton and sorghum by Blaise *et al*., 2003; on wheat by Ahmed and Ali, 2005 and on sorghum by Bayu *et al*., 2006.

The results of dry matter accumulation of bulbs of the onion cv Giza 6 are presented in Fig. (1D) and Fig. (2D). Dry matter accumulation in the bulbs tended to be greater with the application of chicken manure than animal manure and mineral fertilizers, with the difference being significant between chicken manure and mineral fertilizer applications only in second season. As expected the control treatments showed the lowest values of onion dry matter (13.74 and 13.15 for 2004/2005 and 2005/2006, respectively). Applying chicken manure to the onion field prior cultivation was reported to give higher nutrient uptake than mineral fertilizer, animal manure and untreated soil (Stevens, 1997; Thornton *et al.*, 1997; Halvorson *et al.*, 2002). Similar results were recorded in maize by Adenyian and Ojeniyi, (2003). They recorded an increase in nutrient uptake by maize plant with applying poultry manure alone. Additionally, they observed an increase of extended availability of the nutrients in the soil and maize plants due to the application and residual effects of poultry manure. The illustrated data in Fig. (1E) and Fig. (2E) show that applying chicken manure produced the highest onion bulbs yield comparing to untreated soil (control) and mineral fertilizers in both growing seasons. Bulb yield were higher produced using chicken manure than using animal manure in 2005/2006 only. Chicken manure increased the onions yield by 3.03%, 23.5% and 36.6% more than animal manure, mineral fertilizer and untreated soil in 2004/2005, respectively. Also, the chicken manure application increased the dry onion yield in 2005/2006 by 12.6%, 18.7% and 31.5% more than animal manure, mineral fertilizer and untreated soil, respectively. The reasons of high yield of applying organic fertilizers can be explained by the greater capacity of treated soils with chicken and/or animal manures to retain

the nutrients in forms that can easily be taken up by plants onion plants over a long period of time. Conversely, the lower performance of mineral fertilizers could be attributed to the fact that nutrients released from mineral fertilizers are for short period of time because of leaching problems (Antoun *et al.*, 1985; Carol *et al.*, 1999). Moreover, applying of organic manure fertilizers was reported to increase the uptake of N, P, K, Ca, and Mg contents in the soil and, therefore, organic manure are considered to be a good source for soil fertility (Nyathi and Campbll, 1995; Adenyian and Ojeniyi, 2003). The differences in total yield/fedden were almost significant between chicken and animal manures and mineral fertilizers applications in both seasons. The total yield of onion cv Giza 6 at all examined treatments was shown to be greater, especially, in the second season. These results can be attributed to the same reason mentioned above at the trait of average weight of onion bulbs.

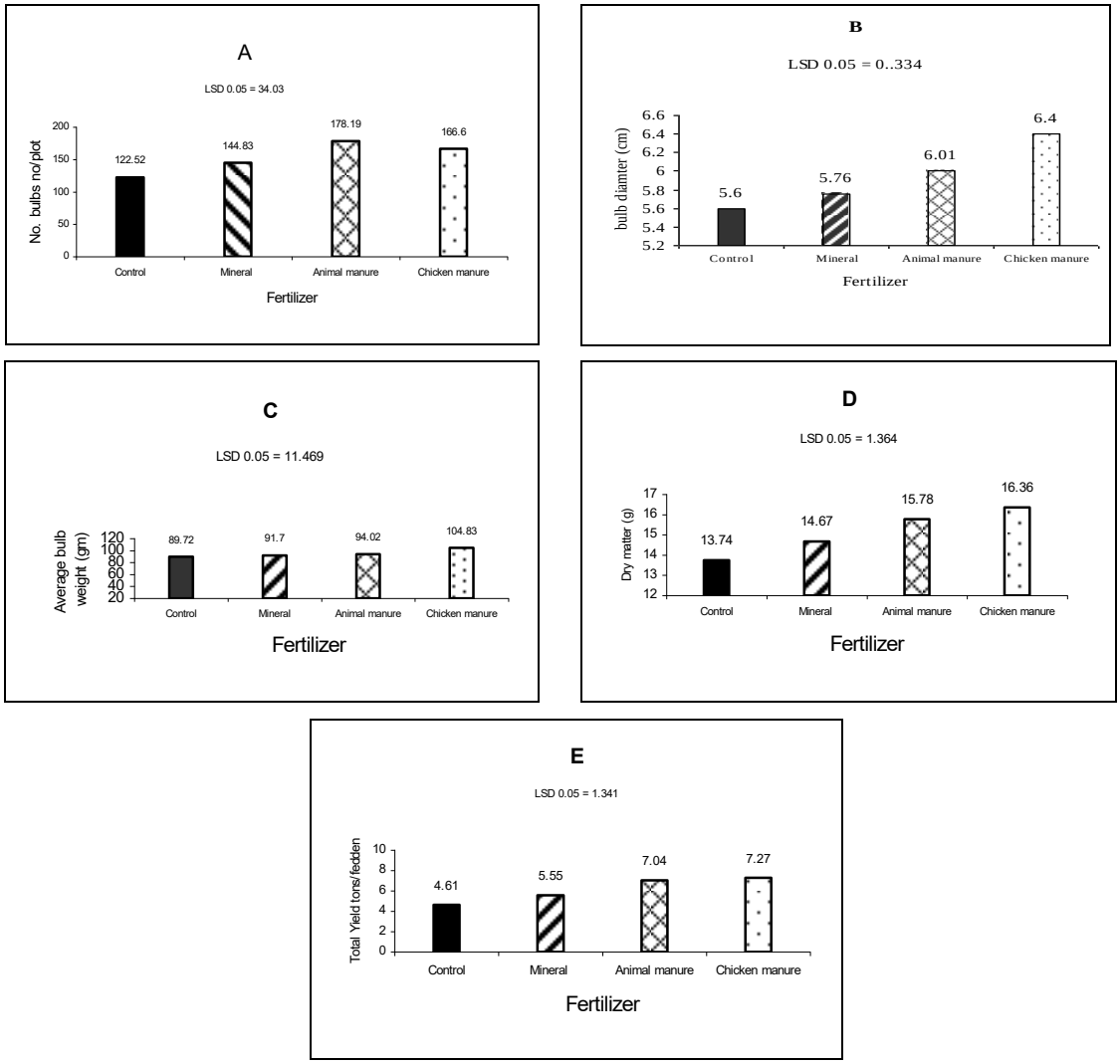

Fig. (1): Effect of fertilizer types on onion (*Allium cepa* cv Giza 6) yield and quality (2004/2005): A) number of bulbs per plot, B) bulb diameter (cm), C) average bulb weight (g), D) dry matter (g), and E) total yield (tons)/fedden

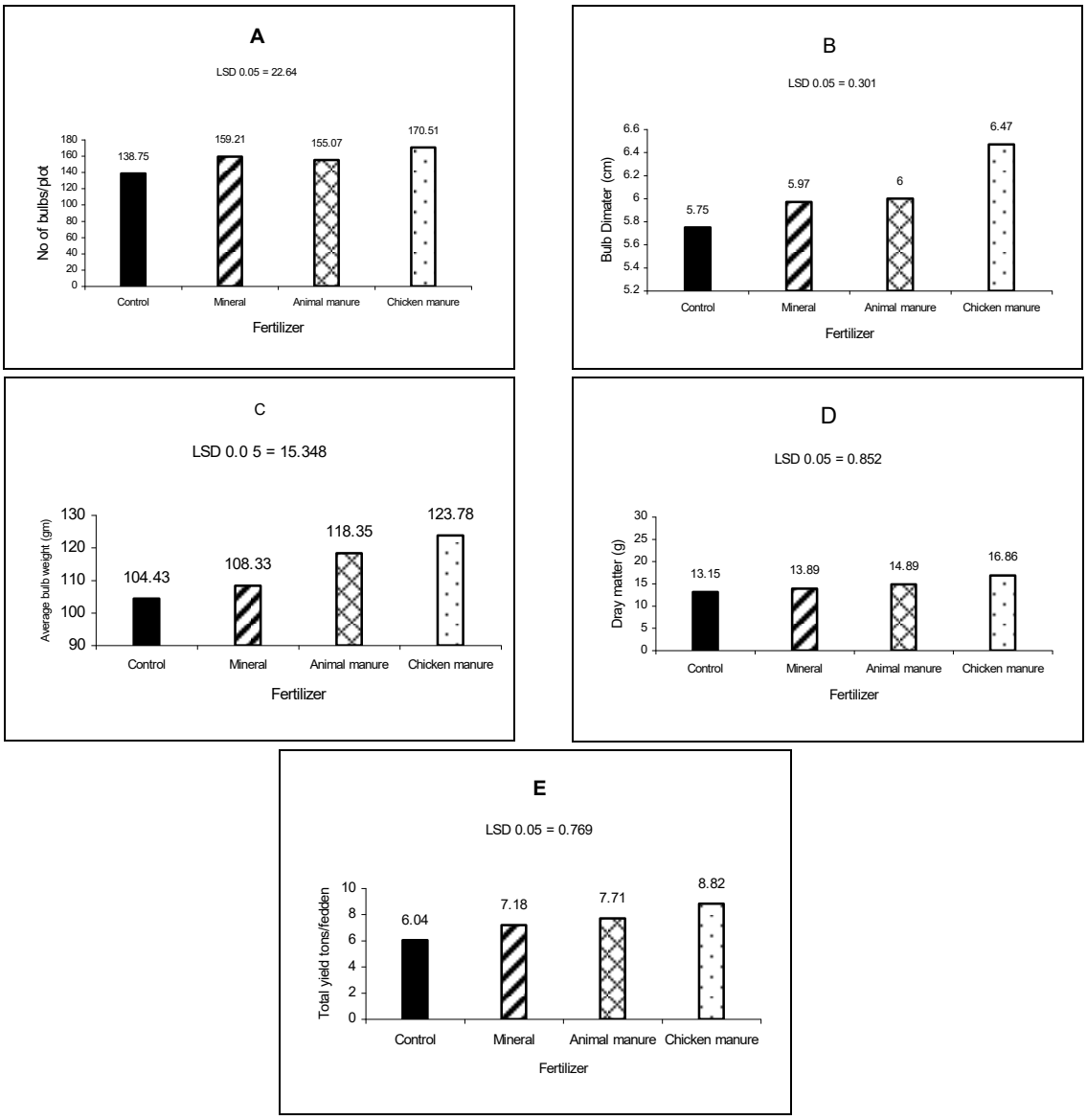

Fig. (2): Effect of fertilizer types on onion (*Allium cepa* cv Giza 6) yield and quality (2005/2006): A) number of bulbs per plot, B) bulb diameter (cm), C) average bulb weight (g), D) dry matter (g), and E) total yield (tons)/fedden

CONCLUSION:

Overall results suggest that manure (chicken or animal manure) is considered to be a valuable resource that can be used as source of nutrients to fertilize onion crop. Thus use of these fertilizers can make onion production complying with the current trends in exportation that is in favor of vegetable products using bio-and organic farming. However, food safety considerations should be a priority when utilizing manure to fertilize food crops, especially fruits and vegetables. Prices of mineral fertilizers are recently dramatically increased and farmers directed to look for manure sources which will be consequently

increased in prices. Thus, until local manure fertilization industry develops, economical evaluation of its application in vegetable production will remain unknown clearly.

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تحسين محصول وجودة صنف البصل جيزة ٦ باستخدام التسميد العضوي

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أجريت هذه التجربة في موسمين زراعيين ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦, بالمزرعة البحثية لقسم الخضر (كلية الزراعة) جامعة أسيوط, وذلك لدراسة تقييم أداء محصول صنف البصل جيزة ٦ تحت ظروف التسميد بمخلفات الدواجن أو الحيوانات أو التسميد الكيماوي. تم حساب الكميات المستخدمة من الاسمدة العضوية بناء علي محتواها من العناصر الكبري N , P, K مع الأخذ في الاعتبار الكميات الموصي بها لمحصول البصل. أظهرت النتائج التأثير المعنوي لنوع السماد على جودة محصول البصل. وقد كان أعلى محصول إبصال (٧.٢٦، ٨.٨٢ طن/فدان في عام ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦ على التوالى) من نصيب التسميد بمخلفات الدواجن, وذلك بالمقارنة بالتسميد باستخدام مخلفات الحيوانات والتسميد العضوي في عام ٢٠٠٤/٢٠٠٥ (٧.٧٤، ٧.٠٤ طن/فدان على التوالي)، وفي عام ٢٠٠٥/٢٠٠٦ (٧.١٧، ٥.٥٥ طن/فدان على التوالى)، بالإضافة إلى ذلك فإن سماد مخلفات الدواجن زاد الوزن الجاف للإبصال, وزن الإبصال الفردية وقطر البصلة.