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Impact of Organic Manures and Slow-Release Nitrogen Fertilizer (Enciabein) on Productivity and Quality of Garlic (*Allium Sativum*, L.)

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ABSTRACT: The present experiment was carried out at Abees area, Alexandria governorate, Egypt, during the winter growing seasons of (2021/2022 and 2022/2023) to investigate the response of garlic crop to organic fertilizer applications and slow release-N fertilizer (urea-formaldehyde"UF") additions. The experiments were carried out in a split-plot design with three replicates. Two kinds of organic manure fertilizers (cow and chicken manures) were arranged in main plots and five nitrogen fertilization treatments (120 kg N fed^{-1} in the form of soluble nitrogen fertilizer, 120, 100, 80, and 60 kg N fed^{-1} in the form of urea- formaldehyde as a slow release N fertilizer) were in sub-plots. The gained results revealed that the studied vegetative characters were significantly affected by urea- formaldehyde additions. Plant height (cm) and number of leaves/plant characters significantly affected with the interaction between the two studied independent variables (organic manure fertilizers and nitrogen fertilization rates). Cow manure fertilizer possessed a higher garlic yield (ton/fed^{-1}) and average bulb weight (g) compared to chicken manure fertilizer during the first season, while there were no significant differences during the second season. The results of the first season indicated that there were no significant differences between the nitrogen fertilization treatments (120 kg N fed^{-1} as soluble N fertilizer, 120 and 100 kg N fed^{-1} as UF fertilizer) for the garlic yield (ton/fed.), while the treatments of 100 and 120 N units as UF fertilizer outperformed the soluble N treatment (120 kg N fed^{-1}) during the second season. The highest mean values for garlic yield (ton fed^{-1}) were obtained from the combinations of cow manure + 80 kg N fed^{-1} UF, cow manure + 100 kg N fed^{-1} UF and chicken manure + soluble nitrogen treatment (120 kg N fed^{-1}) during the first study season, while the results of the second season indicated that the combinations of chicken manure + 120 kg N fed^{-1} UF, cow manure + 100 kg N fed^{-1} UF and cow manure + 120 kg N $fed.^{-1}$ UF gave the highest mean values for garlic yield (ton fed^{-1}). The combination of organic fertilizers and nitrogen fertilization treatments showed a significant effect on bulb dry matter (%) during the first study season. The findings in this study recommended that fertilization growing garlic plants during preparation soil with cow manure fertilizer (20 m^3 fed^{-1}) + urea-formaldehyde (100 kg N fed^{-1}) would be advantageous to maximize garlic productivity in addition to maintaining a safe environment by using environmentally friendly fertilizers.

***Keywords**:* Garlic, *Allium sativum*, L., slow-release N-fertilizers, urea-formaldehyde, Enciabein, cow manure, chicken manure, garlic productivity.

INTRODUCTION

Garlic (*Allium sativum* L.) is considered as one of the most important vegetable crops in Egypt for local consumption and exportation, either fresh or dried **(Shalaby and El-Ramady, 2014)**. The total cultivated area of garlic in Egypt reached 17946 ha according to 2022 statistics. Egypt ranks the fourth leading country in the world for garlic production (369,477.59 MT). The top ten producers are China, India, Bangladesh, Egypt, Spain, Republic of Korea, Ethiopia, Uzbekistan, United States of America and Myanmar **(FAOSTAT, 2022)**.

The use of farmyard manure as organic fertilizer is increasing in Egypt due to its prominence as a quick-acting fertilizer, its effects on physical, chemical, and biological attributes of the soil, its effect as a source of necessary elements, its ability to increase the obtainability of particular nutrients as well as its effect in reducing the leaching out of minerals **(Abdelkader, 2019)**. Organic fertilizers are all-important for vegetable cultivation in the densely peopled areas due to the frequently low organic matter content of the arable land. This production system is an important priority area globally because of the growing demand for safe and healthy food and long-term sustainability in addition to concerns about environmental pollution. In this system, production is grounded on synergism with nature which accounts for its sustainability **(Sheraz *et al*., 2010)**. Decreasing environmental pollution and saving healthy foods are the fundamental goals and optimal use for the integration of organic fertilizers. The popularity of garlic crops has lately increased, in part because of the multitudinous health and nutritive benefits attributed to garlic consumption **(Rashwan *et al*., 2018)**.

Nitrogen is the most restrictive nutrient for crop production in frequent of the world's cultivated zones and its effective use is critical for the commercial sustainability of cropping structures. Crop reaction to applied N and use efficacy are essential principles for assessing crop N necessities for extreme economic yield. Recovery of N in crop plants is frequently less than 50% global. Low recovery of N in yearly crops is related to its loss by volatilization, leaching, surface runoff, denitrification, and plant canopy. Low recovery of N is not only accountable for the higher cost of crop production, but likewise for environmental pollution. Hereafter, improving N use effectiveness (NUE) is desirable to progress crop yields, dipping the cost of product, and keeping environmental superiority **(Fageria and Baligar, 2005)**. Also, the stable rise in population progress and food requests and the continuous reduction in cultivated land per person persuade stable intensification of fertilizer requests worldwide.

Slow-release nitrogen is a detectable quantity and is defined as that portion of nitrogen in a fertilizer that slowly releases to the soil. Slow release-N is dependent upon one or more factors including soil pH, soil moisture and soil temperature. Many slow-release N fertilizers are formed by incorporating urea into chemical reactions forming bonded urea products that slowly breakdown in the soil releasing its nitrogen content **(Hojjatie, 2021)**. The reaction of aldehydes, including formaldehyde, acetaldehyde, and crotonaldehyde, is well-recognized in organic chemistry. Condensation products of urea and different aldehydes (formaldehyde, isobutyraldehyde, crotonaldehyde) are used in huge amounts (more than 300,000 tons per year) in controlled-release and slow-release nitrogen fertilizers for various crops, lawns, trees or shrubs **(Trenkel, 2010)**. Most produced slow-release fertilizers are chemical composites that are only slightly answerable in water or are sluggishly broken down by microbial action **(Sartain *et al*., 2004)**. Alternatively, controlled-release fertilizers (CRF) are made of soluble fertilizers coated with ingredients that limit contact of the soluble material to water and / or release of the resulting nutrient solution by diffusion. Thus, the rate of nutrient liberation from slow-release fertilizers (SRF) is accompanied by their water solubility, microbiological degradation, and chemical hydrolysis. Significant factors affecting degradation and hydrolysis are particle size, soil temperature, and microbial activity. Particle size relates to increased surface area for chemical and biological degradation in reduced particle size. Release rates of CRF products, conversely, are a function of temperature and soil water content **(Morgan *et al*., 2009)**.

Slow-release nitrogen fertilizers offer several possible advantages for the production of vegetables. Usage slow release nitrogen fertilizers in sandy soils may lessen N leaching. However, N uptake by the growing crop may conceivably come more effective, if the slow-release N fertilizer has a release pattern that matches crop requirements. Likewise, if slow- release fertilizers (SRF) can be applied as apre-plant operation, product costs might be dropped, barring the demand for multiple operations of soluble nitrogen fertilizer. Synthetic slow-release fertilizers can be split into two overall groups: those that are slow-release as a byproduct of a chemical reaction (for example urea-formaldehyde), and those that are slow-release via a sulfur, wax, or resin coating around the fertilizer prill. In vegetable crop investigations, much of the obtainable literature has focused on the use of sulfur coat urea and urea-formaldehyde. In most studies, the use of slow-release N fertilizers as a pre-plant treatment did not reduce crop yield, but yield was seldom increased when compared with standard split applications of soluble N **(Guertal, 2009)**.

Urea-formaldehyde fertilizers propose useful physical properties and slow-release rates; they can promote the formation of an aggregated soil structure, improve soil permeability, and raise penetrating power into crop roots. With fast, long-term functioning, the nitrogen use efficacy might exceed 50% **(Yamamoto *et al*., 2016)**. In the soil, this could result from microbial hydrolysis into ammonium, carbon dioxide, and water, which involves plant absorption and usage. Urea formaldehyde slow-release fertilizers are effectual and environmentally friendly fertilizers. They have good slow-release belongings and can meaningfully improve the consumption rate of fertilizers **(Guo *et al*., 2023)**.

From the viewpoint of improving nutrient recovery by plants, three principal advantages are mentioned for controlled-release fertilizers :

1- Decrease of nutrient loss by leaching and runoff.
2- Decrease of chemical and biological immobilization reaction in soils which produce plant-unavailable form and for nitrogen.
3- Decrease of quick nitrification and nitrogen loss over ammonia volatilization and denitrification **(Fox *et al*., 1996)**.

In this respect, **Allen (1984)** stated that possible benefits from slow-release fertilizers include: (i) extra efficient use of nitrogen by the crop, (ii) less leaching of nitrogen, (iii) lower toxicity, (iv) longer lasting nitrogen providing, (v) decreased volatilization losses of nitrogen and (vi) minor application cost.

Therefore, the purpose of this investigation is to find out the impact of the efficiency of adding slow-release fertilizer (Ensiabein) with two different types of organic fertilizers and their interactions on the growth, productivity and quality characteristics of garlic crops.

MATERIALS AND METHODS

Two field experiments were conducted at village No. 6 , Abees area, Alexandria governorate, Egypt, during the winter growing seasons of (2021/2022 and 2022/2023) to study the response of garlic crop (Chinese cv.) to organic fertilizer applications and slow-release nitrogen fertilizer (urea-formaldehyde) additions. Cloves were planted on October 24th in both growing seasons.

Experimental site and soil properties

This study was conducted during the two successive winter seasons of 2021/2022 and 2022/2023 at Abees region at 31° 10.102' N and 29° 58.085' E with altitude of (-5 m) under sea level. Some physical and chemical analyses of the experimental soil are presented in Table (1). Soil analysis demonstrated that the soil experiment is a sandy clay texture. Soil sample properties of the soil site were measured using laboratory tests suggested by **Black (1965)**.

Table 1. Some of the physical and chemical properties of the experimental soil.

Particle size distribution							
Sand %	Silt %	Clay %	Textural class	pH (1:1, water suspension)	EC (dS m^{-1}) (1:1, water extract)	O.M. %	Total $CaCO_3$ %
47.52	**6.00**	**46.48**	**Sandy clay**	**8.20**	**1.62**	**1.62**	**59.60**

Chemical analyses

Soluble cations (meq/l)				Soluble anions (meq/l)		
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
3.16	10.46	11.00	0.45	2.20	7.65	1.70

Available Nutrients (mg kg^{-1})

KCl-extractable N	$NaHCO_3$-extractable P	NH_4-Acetate extractable K
27.00	12.00	212.50

TREATMENTS

Organic manures:

Two kinds of organic manures were used in this study during both seasons (Cow and chicken manures). Based on the analysis of the used organic manures, cow manure fertilizer was added at a rate of 20 m^3/fed^{-1}, whereas the chicken manure was added at a rate of 10.0 m^3 fed^{-1}. at the soil preparation. The analyses of the used organic manures are presented in Table (2) according to **Peters *et al*. (2003)**.

Table 2. The analyses of the used organic manures (Cow and Chicken manures)

Parameters	Cow manure	Chicken manure	Unit
pH (1:10 water suspension)	8.7	8.4	-
EC (1:10 water extract)	7.9	7.7	dS/m
Organic matter	20.6	10.5	%
Organic carbon	11.95	6.09	%
C/N ratio	9.2/1	3.6/1	-
Available nutrients content			
N	1.3	1.7	%
P	0.4	0.66	%
K	2.6	2.0	%
Moisture content	7.3	21.4	%

Slow-release nitrogen fertilizer:

Slow release-N fertilizer (urea formaldehyde); produced by the General Authority of Agricultural Budget Fund (GAABF), Agricultural Research Center (ARC) under the trade name (Enciabein 40% N), was used in this study during the two seasons. Urea formaldehyde (Enciabein 40% N) fertilizer was applied during soil preparation at the rates of 120 kg N fed^{-1}, 100 kg N fed^{-1}, 80 kg N $fed^{-1}$and 60 kg N fed^{-1} in addition to the recommended dose (RD) of N units at the rate of 120 kg N fed^{-1} using soluble nitrogen fertilizer. The recommended dose was added in the form of Ammonium sulfate (20.5% N) which was banded at three applications; 3, 7 and 10 weeks after planting.

Experimental layout:

The experiments were carried out in a split-plot design with three replicates. The two kinds of organic manure fertilizers were arranged in the main plots. The five nitrogen fertilization treatments were arranged in the subplots. Each subplots contained 4 rows.

The treatments of the two studied factors can be illustrated as below:

Uniform and healthy cloves (each 1.0 g ±0.1/clove) of Chinese garlic cultivar were planted upright with apical tips on both sides of the row at in-row spacing 10 cm running from east to west. Each sub-plot contained four rows of 4 m length and 0.60 m width occupying an area of 9.6 m^2.

Agricultural operations:

All experimental units received identical doses of calcium super phosphate (15.5 % P_2O_5) at rate of 75 kg fed^{-1} and potassium sulfate (48% K_2O) at rate of 48 kg fed^{-1}. Phosphorus fertilizer was added all at once during soil preparation; while Potassium fertilizer was added in three doses, the first dose was added after germination was completed, the second dose was added a month after the first dose, and the third dose was added a month after the second dose. Other fertilizer requirements of garlic crops were added according to the recommendation of the Horticulture Research Institute, Agriculture Research Center, Ministry of Agriculture and Land Reclamation. All other agrarian practices were performed when they were needed and as recommended for the commercial garlic production. The crop was harvested on the 10^{th} of May in both seasons.

MEASUREMENTS AND DATA RECORDED

Vegetative growth characters:

A random sample of ten plants was collected from each sub-plot after 150 days from planting to measure plant height (cm) and count the number of leaves/plant.

Bulb yield and its component characters:

At harvest time, marketable garlic plants from each sub-plot were weighed (kg) to estimate the total fresh yield (untopped). Total yield (untopped) ton / feddan was calculated by multiplying the sub-plot's productivity by the total area per feddan and then dividing the product by the sub-plot's area. A random sample of 10 head bulbs, derived was taken from each sub-plot for determination of yield component characters: average bulb weight (g) and average cloves number per bulb.

Physical bulb characteristics:

The below traits were determined as an average of ten randomly bulbs were taken to determine the bulbing ratio, which calculated according to the following equation:

Bulbing ratio = neck diameter (cm) / bulb diameter (cm).

A random sample of cloves weighing 100 grams was taken from each sub-plot and dried at 70°C until constant weight. Then the percentage of dry matter content in cloves was calculated.

Nitrogen content of leaves and bulbs (%):

Total nitrogen was determined in digested plant material colorimetrically using the Micro-Kjeldahl method described by **AOAC (1995)**. Leave samples from randomly ten plants were taken for nitrogen determination after 82, 98, 122, 152 and 172 days of planting, orderly. The results were calculated based on the two-year average.

Statistical analysis:

The obtained data were subjected to the proper methods of statistical analysis of variance (ANOVA) as described by **Snedecor and Cochran (1980)**. The treatment means were compared using the least significant differences (L.S.D.) test procedure at $p \leq 0.05$ level of probability. For performing the mentioned statistical analysis, CoState Software version 6.400 was used.

RESULTS AND DISCUSSION

Vegetative growth characteristics of garlic crop

Data presented in **Table (3)** are the averages of plant height (cm), and leaves number/plant of garlic plants as affected by organic manure additions, nitrogen fertilization treatments and their combinations during the two study seasons.

During the first and second seasons in terms of the main effect of organic manure treatments, the given results did not show significant ($p \leq 0.05$) effect regarding plant height (cm) and leaves number / plant traits.

As for the main effect of nitrogen treatments, the results of the first season cleared that plant height character was significantly affected ($p \leq 0.05$) with the applied nitrogen treatments. The results of **Table (3)** demonstrated that the treatment UF2 (100 kg N fed^{-1} in the form of urea formaldehyde) significantly gave the highest average followed with the control (120 kg soluble N fed^{-1}), UF1 (120 kg N fed^{-1} in the form of urea formaldehyde) and UF3 (80 kg N fed^{-1} in the form of urea formaldehyde) treatments. The lowest average for plant height trait was given by the treatment UF4 (60 kg N fed^{-1} in the form of urea-formaldehyde).

As for the interaction between the two studied independent variables on plant height character, the data of **Table (3)** regarding the first season showed that the treatment cow manure + UF2 gave the highest mean average in this respect without significant differences with the treatment chicken manure + UF3). The treatment of chicken manure + UF4 gave the lowest plant height mean value without significant differences with the two treatments of cow manure + UF3 and chicken manure + UF1 **(Table, 3)**.

The results of the second season showed that the main effect of nitrogen treatments affected significantly ($p \leq 0.05$) plant height trait. The tabulated data **(Table, 3)** appeared that the control N treatment gave the highest mean value without significant differences with each of the treatments UF1 and UF2. The lowest mean value was given by the treatment UF3 without significant differences with the most studied nitrogen treatments.

As for the interaction between the two studied independent variables (organic manure additions and nitrogen fertilization treatments) on plant height character during the second season, the data of **Table (3)** showed that the treatment cow manure + soluble N fertilizer gave the highest mean value without significant differences with most studied treatments. The treatment of cow manure + UF4 possessed the lowest mean value in this respect.

The results of the two studied seasons clearly showed that the effect of the main independent variable organic manure additions was not significant on the number of leaves per plant character **(Table, 3)**. Regarding the effect of the main independent variable nitrogen fertilization treatments, the results in **Table (3)** showed that there was a significant effect of nitrogen fertilization treatments on the number of leaves per plant during the second season only. In this respect, the soluble N treatment possessed the highest mean value without significant differences with the treatment 120 kg N fed^{-1} (UF1). The significantly lowest mean value was possessed by the treatment 60 kg N fed.$^{-1}$ (UF4).

As for the results of the interaction between the two studied independent variables, the results tabulated in **Table (3)** showed that the effect of this interaction was significant on the number of leaves per plant trait during the two seasons of this investigation. For the first study season, cow manure + soluble N rate treatment gave the highest mean average; while the treatment of cow manure + UF1 gave the highest mean value during the second season. The treatment of cow manure + UF4 gave the lowest mean average for the No. of leaves/ plant traits during the two study seasons **(Table, 3)**.

Abou El-Magd *et al*. (2012) reported that the highest vegetative growth parameters were recorded with the application of organic materials like poultry manure, farm-yard manure, sheep manure and compost. The above-mentioned findings are in disagreement with that obtained by **Sitaula *et al*. (2020)** regarding plant height character; where the authors stated that the interaction between the organic manure and urea as nitrogen fertilizer was non-significant. **Farooqui *et al.* (2009)** reported that the application of 200 kg N ha^{-1} significantly increased the growth attributes like plant height (cm) and number of leaves per plant in comparison to 50 kg N ha^{-1} and 100 kg N ha^{-1}. These results agreed especially with data from the second season, where the previous characters significantly affected by the various applied nitrogen fertilization rates. Likewise, **Hassan (2015)** noticed the direct relationship between nitrogen rates and garlic vegetative growth. As nitrogen level increased vegetative growth (plant height and number of leaves) increased up to the highest nitrogen level, i.e., 100 kg N/fed. Similar results were reported, more or less, by **Taha and Helal (2019)** on garlic vegetative growth and yield attribute; where the authors demonstrated that the plants which received the recommended nitrogen level produced higher plant length, leaf number, leaf width, plant fresh weight, dry weight, higher bulb weight, diameter and total yield compared to those fertilized the half-recommended N level in both seasons.

Table 3. Mean values of garlic vegetative growth characters recorded during the two study seasons (2021/2022 and 2022/2023).

Treatments		2021/2022		2022/2023	
		Plant height (cm)	Leaves number/ plant	Plant height (cm)	Leaves number/ plant
Main effect of organic manure additions (A)					
Cow manure		79.819 a	8.667 a	75.871 a	8.216 a
Chicken manure		80.377 a	8.267 a	76.407 a	8.030 a
Main effect of nitrogen fertilizer rates (B)					
Soluble nitrogen fertilizers; 120 kg N fed.$^{-1}$ (control)		80.617 b	8.600 a	78.294 a	8.455 a
Urea formaldehyde (UF1); 120 kg N fed.$^{-1}$		79.998 b	8.633 a	77.012 ab	8.413 ab
Urea formaldehyde (UF2); 100 kg N fed.$^{-1}$		81.9 a	8.300 a	76.823 abc	8.119 bc
Urea formaldehyde (UF3); 80 kg N fed.$^{-1}$		80.675 b	8.400 a	73.837 bc	8.105 c
Urea formaldehyde (UF4); 60 kg N fed.$^{-1}$		77.3 c	8.400 a	74.728 bc	7.522 d
Interaction effect (A × B)					
Organic manure	**N fertilization**				
Cow manure	**Soluble N (Control)**	81.033 bc	8.800 ab	78.595 a	8.624 a
	UF1	80.097 cd	8.933 a	76.105 abc	8.665 a
	UF2	82.733 a	8.533 abc	76.883 abc	8.163 b
	UF3	79.3 de	8.467 abc	74.048 bc	8.125 b
	UF4	75.933 f	8.600 abc	72.908 c	7.500 c
Chicken manure	**Soluble N (Control)**	80.2 cd	8.400 abc	77.993 ab	8.286 ab
	UF1	79.9 cde	8.333 bc	77.105 abc	8.160 b
	UF2	81.0667 bc	8.067 c	76.764 abc	8.075 b
	UF3	82.05 ab	8.333 bc	73.625 c	8.084 b
	UF4	78.667 e	8.067 c	76.547 abc	7.545 c

Means followed by a similar letter within a column for each parameter are not significantly different at the 0.05 level of probability by the LSD test procedure.

Garlic Yield and its component characteristics

The results of **Table (4)** generally indicated that both garlic yield (ton fed-1) and average bulb weight (g) characters were significantly affected ($p \leq 0.05$) by both of the independent studied variables (organic manure additions and nitrogen fertilization treatments) during the first season. The data of the average cloves number per bulb trait did not significantly affect with the two studied main independent variables. Concerning the main effect of organic manures on garlic yield and its component characteristics, cow manure addition significantly expressed the highest mean values for total yield (ton/ fed.) and average bulb weight (g) compared to the addition of chicken manure. The average number of cloves / bulb characteristic was not significantly affected by the additions of organic manures. Nevertheless, the average cloves number / bulb trait was not significantly affected by organic manure additions.

As for the main effect of nitrogen fertilization treatments, there was a significant effect ($p \geq 0.05$) of this independent variable on many non-independent traits, i.e., total yield (ton fed^{-1}) and average bulb weight (g) except for average cloves number/ bulb trait **(Table, 4)**. In this respect, the highest mean value for the total yield trait was possessed by the soluble nitrogen treatment without significant differences with the nitrogen fertilization treatments of UF1 and UF2 **(Table, 4)**. The nitrogen fertilization treatment of UF4 significantly gave the lowest mean value for the total yield trait. To some extent, the same performance was found regarding average bulb weight character, as the soluble nitrogen treatment gave the highest mean value, while the treatment of UF4 showed the lowest mean value **(Table, 4)**. In contrast, nitrogen fertilization treatments did not show any significant differences in the average cloves number/ bulb trait.

Regarding the interaction between the two studied independent variables, similar performances, as the earlier studied traits were noticeable, where this interaction exerted significant effects ($p \leq 0.05$) on total yield/ fed. and average bulb weight characters, while the character of average cloves number/ bulb did not affect with this interaction **(Table, 4)**. It was observable that the interaction treatment of cow manure + UF3 significantly possessed the highest mean value of total yield (ton/fed.) trait without significant differences with the interaction treatments of cow manure + UF2 and chicken manure + soluble nitrogen treatment. On the contrary, the significantly lowest mean values were possessed by the interaction treatments of chicken manure + UF3 and chicken manure + UF4, as shown in **Table (4)**. The data of average bulb weight (g) character demonstrated that the interaction treatment between cow manure + UF3 significantly gave the highest mean average without significant differences with each of the interaction treatments of cow manure + UF2 and chicken manure + soluble nitrogen treatment. The significantly lowest value was possessed by the interaction treatment between cow manure + UF4, as illustrated in **Table (4)**.

As for the results of the second season (2022/2023), the data recorded in **Table (4)** showed that both garlic yield (ton/fed.) trait, as well as its component characteristics, were not significantly affected ($p \leq 0.05$) by the independent studied variable (organic manure additions).

Total yield (ton fed^{-1}) and average bulb weight (g) were significantly affected ($p \leq 0.05$) by the main independent variable of nitrogen fertilization treatments **(Table, 4)**. In this respect, the obtained results showed that adding 120 kg N fed^{-1} in the form of urea-formaldehyde (UF1 treatment) gave the highest mean value regarding total yield (ton/fed) trait without significant differences with the treatment of adding 100 kg N $fed.^{-1}$ in the form of urea formaldehyde (UF2 treatment). Each of the soluble nitrogen treatment (120 kg mineral N fed^{-1}) and UF3 treatment (80 kg N $fed.^{-1}$ in the form of urea-formaldehyde) possessed Intermediate mean averages. The treatment of UF4 (60 kg N fed^{-1} in the form of urea-formaldehyde) significantly gave the lowest mean average for the total yield character **(Table, 4)**.

Regarding the interaction between the two studied variables (organic manure additions and nitrogen fertilization treatments), the results tabulated in **Table (4)** showed that the studied traits of total yield (ton fed^{-1}) and its component characteristics were significantly affected by this interaction. The data of **Table (4)** showed that the treatment chicken manure + UF1gave the highest mean average for total yield character without significant differences with each of the treatments cow manure + UF1 and cow manure + UF1. The significantly lowest mean value was possessed by the treatment chicken manure + UF4. The highest mean average for average cloves No./ bulb was given by the treatment chicken manure + UF2 followed with the treatments chicken manure + UF1, cow manure + soluble nitrogen, chicken manure + UF3 and cow manure + UF2. The lowest mean value in this respect was given by the treatment cow manure + UF1 followed by the treatment chicken manure + UF4 **(Table, 4)**. As for average bulb weight (g) character, the treatment chicken manure + UF1 gave the highest mean value followed with the treatments chicken manure + soluble nitrogen and chicken manure +

UF2. The lowest mean value was obtained by the interaction of chicken manure + UF4 without significant differences with the most studied interaction treatments, as shown in **Table (4)**. Results of the two seasons indicated that the plants received cow manure + 100 kg N fed^{-1} urea-formaldehyde led to an increase in garlic productivity by 6.56 % and 19.83 % compared to using conventional soluble N fertilizer (120 kg N fed^{-1}) during the two seasons, respectively.

Zaghloul *et al.* (2016) illustrated that the increase in total garlic yield could be due to being FYM + chemical valuable as a source of macro and micro elements to plants and used as a good natural soil texture conditioner, which in turn leads to increased availability and uptake of nitrogen phosphorus and potassium. **Nursasi *et al*., (2023)** stated that, it can be concluded that to increase the yield of garlic in the study area, 500 kg ha^{-1} of urea fertilizer and 40 tons ha^{-1} of chicken manure are needed. The above-mentioned findings agree, one way or another, with **Farooqui *et al*. (2009)** who illustrated that increasing nitrogen rate up to 200 kg N ha^{-1} significantly increased the yield parameters like number of cloves per bulb, fresh weight of 20 cloves, fresh weight of bulb and bulb yield in comparison to 50 kg N ha^{-1} and 100 kg N ha^{-1}. However, a non-significant difference was recorded between 200 kg N ha^{-1} and 150 kg N ha^{-1}. The results of **Waddell *et al.* (1999), Tartoura *et al*. (2003) and Pack (2004);** in their experiments on potatoes, indicated that using slow-release-N fertilizers gave a higher yield compared to using chemical nitrogen fertilizers. The results of **Ezzat and Abd El-Hameed (2010)** on potato crop revealed that the application of slow-release fertilizers will save about 50% of the required amounts of N-fertilizer, and will also reduce the pollution of the environment. On the other side, the use of slow-release fertilizers will reduce production cost, especially in developing countries like Egypt, and give the highest net profit for farmers. The data of **Taysom *et al*. (2023)** suggested that, at similar fertilizer rates, slow-release fertilizer was more efficient than immediately soluble urea-N in supplying N to potato plants.

Table 4. Mean values of garlic yield and its component characteristics recorded during the two study seasons (2021/2022 and 2022/2023).

Treatments		2021/2022			2022/2023		
		Total Yield (ton/fed)	Av. cloves No./bulb	Av. bulb weight (g)	Total Yield (ton/fed)	Av. cloves No./bulb	Av. bulb weight (g)
Main effect of organic manure additions (A)							
Cow manure		11.839 a	17.421 a	69.74 a	7.639 a	18.333 a	45.622 a
Chicken manure		11.157 b	18.243 a	65.881 b	7.222 a	19.087 a	47.040 a
Main effect of nitrogen fertilizer rates (B)							
Soluble nitrogen fertilizers; 120 kg N fed.$^{-1}$ (control)		12.169 a	17.332 a	72.27 a	7.243 b	18.933 ab	46.625 ab
Urea formaldehyde (UF1); 120 kg N fed.$^{-1}$		11.843 ab	17.388 a	69.124 b	8.852 a	19.133 ab	47.603 a
Urea formaldehyde (UF2); 100 kg N fed.$^{-1}$		12.080 a	18.330 a	70.841ab	8.377 a	19.567 a	46.983 a
Urea formaldehyde (UF3); 80 kg N fed.$^{-1}$		11.641 b	18.388 a	69.608 b	6.904 b	17.967 b	45.864 ab
Urea formaldehyde (UF4); 60 kg N fed.$^{-1}$		9.757 c	17.721 a	57.217 c	5.776 c	17.950 b	44.580 b
Interaction effect (A × B)							
Organic manure	**N fertilization**						
	Soluble N (Control)	11.92 cd	17.443 a	70.937 b	7.247 cd	19.800 ab	45.785 b
	UF1	12.303 bc	17.777 a	71.947 b	8.471 ab	17.867 bc	45.094 b
Cow manure	**UF2**	12.702 ab	17.220 a	74.482 ab	8.684 ab	18.600 abc	46.690 b
	UF3	12.9 a	18.000 a	76.407 a	7.487 c	17.200 c	45.603 b
	UF4	9.37 g	16.665 a	54.945 f	6.307 e	18.200 bc	44.937 b
	Soluble N (Control)	12.418 abc	17.220 a	73.603 ab	7.238 cd	18.067 bc	47.464 ab
	UF1	11.383 e	17.000 a	66.300 cd	9.235 a	20.400 a	50.112 a
Chicken manure	**UF2**	11.46 de	19.440 a	67.201 c	8.070 bc	20.533 a	47.277 ab
	UF3	10.382 f	18.777 a	62.810 de	6.321 de	18.733 abc	46.124 b
	UF4	10.145 f	18.777 a	59.489 e	5.246 f	17.700 c	44.222 b

Means followed by a similar letter within a column for each parameter are not significantly different at the 0.05 level of probability by the LSD test procedure.

Physical garlic bulb characteristics

The results presented in **Table (5)** are the averages of bulb dry matter (%), and bulbing ratio as affected by organic manure additions, nitrogen fertilization treatments and their combinations during the two study seasons. Concerning the main effect of organic manure additions, in general, the two types tested of organic manure fertilizers (cow and chicken manures) did not exhibit significant ($p \leq 0.05$) effects on the studied bulb characteristics during the two seasons.

In terms of the main effect of nitrogen fertilization treatments, the given results declared significant ($p \leq 0.05$) effects on bulb dry matter (%) percentage only during the first season. On the contrary, the bulbing ratio was affected by the main independent variable of nitrogen fertilization treatments only during the second season. As for bulb dry matter percentage trait, the obtained data demonstrated that adding 60 kg N fed^{-1} in the form of urea-formaldehyde (UF4) possessed the highest mean value in this respect, while adding 120 kg soluble N fed^{-1} (control nitrogen treatment) gave the lowest mean value for the previously mentioned characteristic. The other applied nitrogen fertilization treatments (UF1, UF2 and UF3) exhibited intermediate mean values **(Table, 5)**. The results of the bulbing ratio showed that the treatment UF3 (80 kg N fed^{-1}) significantly gave the highest mean percentage without significant differences with the treatments of UF1,UF2 and UF4, as shown in Table (5).the lowest value was given by the soluble nitrogen treatment (120 kg soluble N fed^{-1}) .

The results of **Farooqui *et al.* (2009)** agree with our obtained results regarding bulb dry matter percentage during the first season. The authors explained that this studied trait significantly affected with various nitrogen rates. In this respect **Farooqui *et al.* (2009)** stated that 200 kg N ha^{-1} significantly increased bulb dry weight in comparison to 50 kg N ha^{-1} and 100 kg N ha^{-1}.

As for the interaction between the two studied independent variables on the physical garlic bulb characteristics, the results of **Table (5)** showed that bulb dry matter (%) was significantly affected ($p \leq 0.05$) with this interaction only during the first study season. The tabulated data cleared that in the presence of chicken manure with adding 60 kg N fed^{-1} in the form of urea-formaldehyde (UF4 treatment) the bulb dry mater characteristic highly possessed percentage, whereas the lowest percentage was given in the presence of cow manure with applying the soluble nitrogen treatment (120 kg soluble N fed^{-1}). The other studied interactions possess intermediate percentages **(Table, 5)**. Bulbing ratio results clearly showed that this characteristic was not affected by this interaction during the two seasons of this study.

Table 5. Mean values of physical garlic bulb characteristics recorded during the two study seasons (2021/2022 and 2022/2023).

Treatments		2021/2022		2022/2023	
		Bulb Dry matter (%)	Bulbing ratio	Bulb Dry matter (%)	Bulbing ratio
Main effect of organic manure additions (A)					
Cow manure		40.002 a	0.190 a	44.053 a	0.164 a
Chicken manure		40.591 a	0.211 a	44.795 a	0.164 a
Main effect of nitrogen fertilizer rates (B)					
Soluble nitrogen fertilizers; 120 kg N fed.$^{-1}$ (control)		39.483 b	0.193 a	43.890 a	0.156 b
Urea formaldehyde (UF1); 120 kg N fed.$^{-1}$		40.458 ab	0.205 a	44.703 a	0.166 ab
Urea formaldehyde (UF2); 100 kg N fed.$^{-1}$		40.222 ab	0.192 a	44.397 a	0.165 ab
Urea formaldehyde (UF3); 80 kg N fed.$^{-1}$		40.265 ab	0.213 a	44.763 a	0.169 a
Urea formaldehyde (UF4); 60 kg N fed.$^{-1}$		41.055 a	0.201 a	44.367 a	0.163 ab
Interaction effect (A × B)					
Organic manure	**N fertilization**				
Cow manure	**Soluble N (Control)**	39.197 c	0.209 a	43.447 a	0.158 a
	UF1	40.527 abc	0.168 a	44.353 a	0.163 a
	UF2	39.973 abc	0.168 a	43.940 a	0.164 a
	UF3	39.550 bc	0.215 a	44.413 a	0.167 a
	UF4	40.763 ab	0.193 a	44.113 a	0.166 a
Chicken manure	**Soluble N (Control)**	39.770 bc	0.178 a	44.333 a	0.155 a
	UF1	40.390 abc	0.243 a	45.053 a	0.169 a
	UF2	40.470 abc	0.216 a	44.853 a	0.165 a
	UF3	40.980 ab	0.211 a	45.113 a	0.171 a
	UF4	41.347 a	0.210 a	44.620 a	0.160 a

Means followed by a similar letter within a column for each parameter are not significantly different at the 0.05 level of probability by the LSD test procedure.

Total nitrogen content of leaves and bulbs

The data of **Table (6)** did not show any significant effect regarding the main effect of organic manures on the nitrogen leaf content during the five studied growth stages of garlic plants. **Figure (1)** showed that the highest nitrogen mean values were achieved at 98 DAP, while the lowest mean values were achieved at 172 DAP. As for the main effect of nitrogen fertilization treatments, the data of **Table (6)** showed significant ($p \leq 0.05$) effects on the nitrogen leaf content during the five studied growth stages of garlic plants. **Figure (2)** showed that the control nitrogen treatment (recommended soluble fertilizers) gave the highest mean value for nitrogen content at 82 DAP, after which there was a gradual downward decline in the nitrogen leaf content, while the lowest nitrogen value was at 172 DAP. The other studied nitrogen fertilization treatments (UF1, UF2, UF3 and UF4) gave the lowest mean values of nitrogen leaf content at 82 DAP, then the nitrogen values increased until 98 DAP. The values stabilized to some extent until 122 days of planting, then the values began to gradually decline downward until 172 DAP. As for the interaction between the two independent variables and their effect on the nitrogen leaf content, the data of **Table (6)** appeared significant ($p \leq 0.05$) effects on the leaf nitrogen content during the five studied growth stages of garlic plants. **Figure (3)** showed that the obtained results took the same general trend to what was previously mentioned. In this respect, the two treatments: cow manure + soluble nitrogen fertilizers and chicken manure + soluble nitrogen fertilizers gave the highest mean nitrogen leaf values at 98 DAP, then the values began to decrease gradually until 172 DAP. As for the interactions between the organic manures and urea-formaldehyde treatments, **Figure (3)** showed that the nitrogen leaf content gradually increased until 98 DAP, then the values stabilized at approximately the same nitrogen levels until 122 DAP, after which the values began to decrease gradually until 172 DAP. The data of **Figures (2 and 3)** showed that slow-release fertilizers provide garlic growing plants with their nitrogen needs according to the development of growth stages. In the early stages of growth (until 82 DAP), plants' need for nitrogen is low, while these needs gradually increase with the development of vegetative growth (from 98 to 122 DAP), while in the later stages of growth from 152 to 172 DAP), these needs decrease. **Waddell *et al.* (1999), Allen (1984) and Zvomuya *et al*. (2003)** explained that using slow-release fertilizers can lower the dissolution rate of urea than ammonium nitrate fertilizer (soluble form), 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.

Table 6. Mean values of nitrogen content of garlic leaves and bulbs recorded as an average of the two seasons (2021/2022 and 2022/2023).

Treatments		N in leaves (%) (82 DAP)	N in leaves (%) (98 DAP)	N in leaves (%) (122 DAP)	N in leaves (%) (152 DAP)	N in leaves (%) (172 DAP)	N in bulbs (%)
Main effect of organic manure additions (A)							
Cow manure		2.008 a	2.378 a	2.300 a	1.922 a	1.437 a	0.719 a
Chicken manure		1.970 a	2.356 a	2.259 a	1.870 a	1.446 a	0.723 a
Main effect of nitrogen fertilizer rates (B)							
Soluble nitrogen fertilizers; 120 kg N $fed.^{-1}$ (control)		3.170 a	2.745 a	2.449 b	1.924 c	1.336 c	0.668 c
Urea formaldehyde (UF1); 120 kg N $fed.^{-1}$		2.016 b	2.697 b	2.695 a	2.367 a	1.994 a	0.997 a
Urea formaldehyde (UF2); 100 kg N $fed.^{-1}$		1.783 c	2.396 c	2.375 c	2.042 b	1.645 b	0.823 b
Urea formaldehyde (UF3); 80 kg N $fed.^{-1}$		1.548 d	2.150 d	2.094 d	1.725 d	1.237 d	0.619 d
Urea formaldehyde (UF4); 60 kg N $fed.^{-1}$		1.426 e	1.846 e	1.783 e	1.422 e	0.994 e	0.497 e
Interaction effect (A × B)							
Organic manure	**N fertilization**						
	Soluble N (Control)	3.217 a	2.749 a	2.457 b	1.920 c	1.335 d	0.667 d
	UF1	2.011 c	2.701 bc	2.700 a	2.380 a	1.990 a	0.995 a
Cow manure	UF2	1.746 d	2.419 d	2.395 bc	2.060 b	1.603 c	0.801 c
	UF3	1.578 e	2.167 e	2.131 d	1.755 d	1.233 e	0.616 e
	UF4	1.487 f	1.853 f	1.816 e	1.495 f	1.025 f	0.512 f
	Soluble N (Control)	3.123 b	2.743 ab	2.442 b	1.929 c	1.336 d	0.669 d
	UF1	2.021 c	2.693 c	2.690 a	2.354 a	1.997 a	0.999a
Chicken manure	UF2	1.820 d	2.374 d	2.357 c	2.025 b	1.688 b	0.844 b
	UF3	1.519 ef	2.133 e	2.058 d	1.695 e	1.242 e	0.621 e
	UF4	1.366 g	1.839 f	1.749 e	1.350 g	0.963 g	0.482 g

Means followed by a similar letter within a column for each parameter are not significantly different at the 0.05 level of probability by the LSD test procedure.

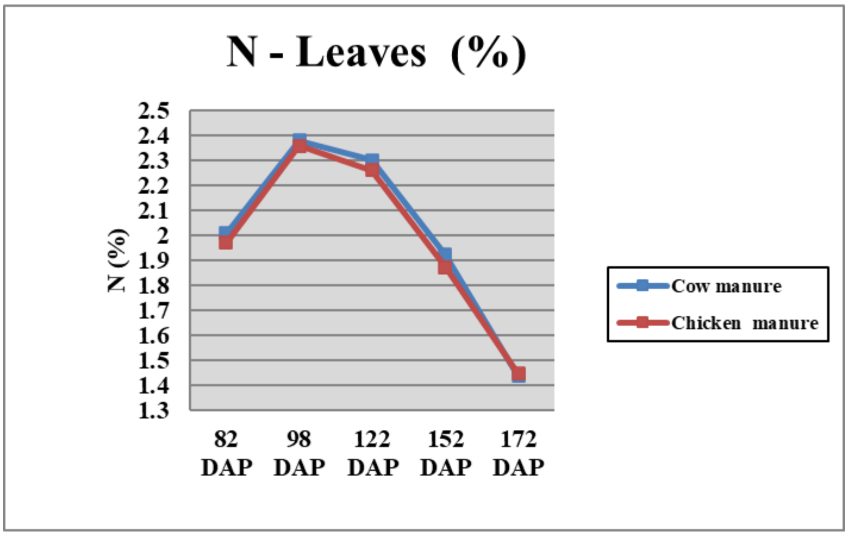

Figure 1. Nitrogen concentration in garlic leaves at different stages as affected by organic manure fertilizers (average two seasons).

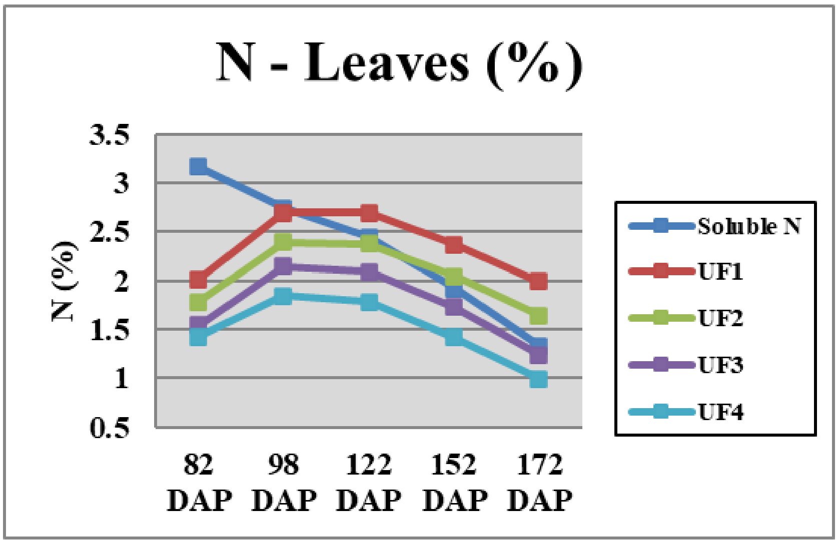

Figure 2. Nitrogen concentration in garlic leaves at different stages as affected by nitrogen fertilization treatments (average two seasons).

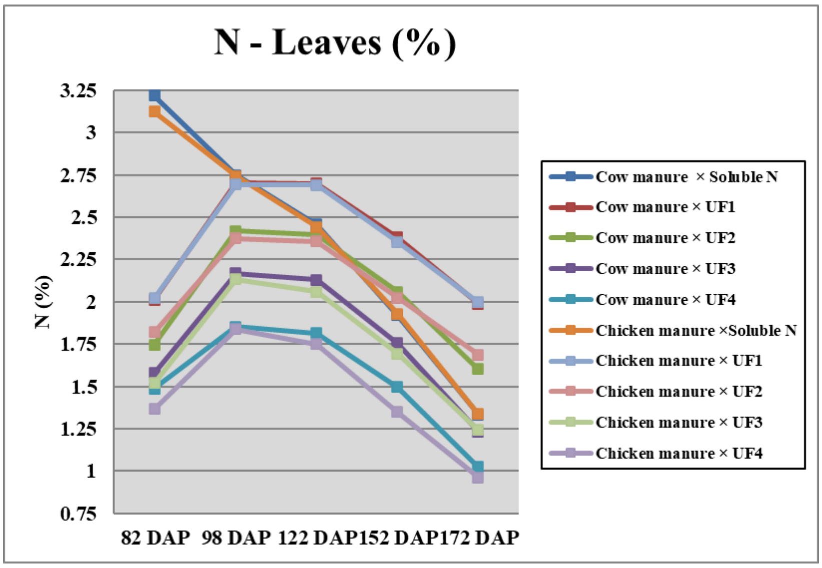

Figure 3. Nitrogen concentration in garlic leaves at different stages as affected by organic fertilizers × nitrogen fertilization treatments interaction (average two seasons).

The percentages of nitrogen bulbs were not significantly affected by the independent variable related to organic manure fertilizer **(Table, 6)**. In contrast, the obtained results shown in **Table (6)** cleared that the percentages of nitrogen in the cloves were significantly affected by the nitrogen fertilization treatments. The highest nitrogen mean value was associated with the UF1 Treatment (120 Kg N Fed^{-1}), while the lowest nitrogen mean value was given by the UF4 treatment (60 Kg N Fed^{-1}). As for the interaction between organic manure additions and nitrogen fertilization treatments, the data of **Table (6)** showed that the treatment chicken manure + UF1 significantly possessed the highest nitrogen mean value without significant differences with the treatment cow manure + UF1. The lowest nitrogen mean value was obtained by the treatment of chicken manure + UF4. The results illustrated that, at the same rate of nitrogen addition per feddan, the bulb nitrogen contents under slow-release fertilizer conditions are higher than their counterparts when nitrogen is added in the soluble form.

It is also necessary to point out that urea-formaldehyde fertilizer is an environmentally friendly fertilizer that is added all at once during soil preparation, which reduces labor costs. Under the conditions of this study, our data indicated that garlic plants that received 20 m^3 $Fed^{-1}$of cow manure + 100 kg N Fed^{-1} in the form of urea-formaldehyde, their production increased by13.19 % (average two seasons) compared to using conventional soluble nitrogen fertilizers at the rate of 120 kg N Fed^{-1}.

CONCLUSIONS

The results of this study suggest that the urea-formaldehyde fertilizer (slow- release N fertilizer) can supply garlic plants with a steady supply of N throughout the vegetative portion of the growing season. These results support the work of other investigators that show that the slow-release N fertilizers result in similar or greater garlic yields. Our data suggests that urea-formaldehyde fertilizer was more efficient than soluble nitrogen fertilizers in supplying nitrogen to garlic plants.

REFERENCES

AOAC (1995). Official Methods of Analysis 16th Ed, A.O.A.C. Benjamin ranklin Station, Washington, D. C., U. S. A. pp 490-510.

Abdelkader, A. E. (2019). Effect of different levels of farmyard manure, mineral fertilization and potassium humate on growth and productivity of garlic. Middle East J. Appl. Sci., 9(2): 287-296.

Abou El-Magd, M.M., T. El-Shourbagy, S.M. Shehata (2012). A comparatives study on the productivity of four Egyptian garlic cultivars grown under various organic materials in comparison to conventional chemical fertilizer. Vegetable research department, National research center, Cairo, Egypt. Aust. J. Basic Appl. Sci. 6(3):415-421.

Allen, S. E. (1984). Slow-release nitrogen-fertilizers. *In*: Nitrogen in Crop Production, pp. 195-206. National Fertilizers Development Center – South Sagoe Road, Madison, WI-53711, USA.

Black, C. A. (1965). Methods of Soil Analysis. Part 1 and 2. Amer. Soc. Agron. Inc., Madison, Wisconsin, USA.

Ezzat, A. S. and A. M. Abd El-Hameed (2010). Effect of slow release nitrogen fertilizers on productivity and quality of potato (*Solanum tuberosum* L.). J. of Soil Sciences and Agricultural Engineering, Vol. 1 (2):169–184.

Fageria, N.K. and V.C. Baligar (2005). Enhancing nitrogen use efficiency in crop plants. Advances in Agronomy, Vol. 88: 97-185.

FAOSTAT, Food and Agriculture Organization (2022). https://www.fao.org/faostat/en/#data/QCL/visualize. (Accessed 18.2.2024).

Farooqui, M.A. I.S. Naruka, S.S. Rathore, P.P. Singh and R.P.S. Shaktawat (2009). Effect of nitrogen and sulphur levels on growth and yield of garlic (*Allium sativum* L.) As. J. Food Ag-Ind. Special Issue, S18-23.

Fox, R. H., W. P. Piekielek, and K. E. Macned. (1996). Estimating ammonia volatilization losses from urea fertilizers using a simplified micrometeorological sampler. Soil Sci. Soc. Am. J., 60: 596.

Guertal, E.A. (2009). Slow-release Nitrogen Fertilizers in Vegetable Production: A Review Hort. Technology. 19(1): 16-19.

Guo, Y., Y. Shi, Q. Cui, X. Zai, S. Zhang, H. Lu and G. Feng (2023). Synthesis of Urea-Formaldehyde fertilizers and analysis of factors affecting these processes. Processes, (11), p 3251.

Hassan. A. H. (2015). Improving Growth and Productivity of two Garlic Cultivars (*Allium sativum* L.) Grown under Sandy Soil Conditions. Middle East Journal of Agriculture, Vol. 4 (2): 332-346.

Hojjatie, M.M. (2021). Urea triazone fertilizers- A slow-release nitrogen fertilizer. J. Agric. Sci. Food Technol. 7(3): 272-276.

Morgan, K. T., K. E. Cushman and S. Sato (2009). Release Mechanisms for Slow- and Controlledrelease Fertilizers and Strategies for Their Use in Vegetable Production. Hort.Technology Vol.19(1): 10-12.

Nursasi, D., A. F. Aziez, T. S. K. Dewi and O. Cahyono (2023). Maximizing Growth and Yield of Garlic by using Different Sources and Dosages of Nitrogen and Chicken Manure on Andisol Soil Agricultural Science Journal of Agriculture Engineering Faculty of Agriculture, Merdeka University Surabaya,Indonesia :6(2)Available on :

https://agriculturalscience.unmerbaya.ac.id/index.php/agriscience/index

Pack, J. E. (2004). Controlled release nitrogen fertilizer release characterization and its effects on potato (*Solanum tuberosum*) production and soil nitrogen movement in northeast Florida. M. Sc. Thesis, Florida Univ., 136 p.

Peters, J., S. Combs, B. Hoskins, J. Jarman, J. Kovar, M. Watson, A. Wolf and N. Wolf (2003). Recommended methods of manures analysis. University of Wisconsin Coop. Ext. Publication A3769. Coop Ext. Publishing, Madison, WI.

Rashwan, B. R. A., M. A. M. Ali and H. Ferweez (2018). Growth, Yield, Bulb Quality and Storability of Garlic (*Allium sativum* L.) as Affected by Using Poultry Manure, Sulphur and Different Levels of Phosphorus Fertilizer. J. Soil Sci. Agric. Eng., Mansoura Univ., Vol. 9 (10): 447 – 459.

Sartain, J.B., W.L. Hall, R.C. Littell and E.W. Hopwood. (2004). Development of methodologies for characterization of slow-released fertilizers. Soil Crop Sci. Soc. Fla. Proc. 63: 72-75.

Shalaby, T.A. and H. El-Ramady (2014). Effect of foliar application of bio-stimulants on growth, yield, components, and storability of garlic (*Allium Sativum* L.). Australian J. Crop Sci. 8(2):271-275.

Sheraz, M.S.; G.I. Hassan; S.A. Samoon; H.A. Rather; A. ShawkatDar and B. Zehra (2010). Bio-fertilizers in organic agriculture. J. Phytology, 2(10):42-54.

Sitaula, H. P., R. Dhakal, C. Bhattarai, A. Aryal and D. Bhandari (2020). Effects of different combinations of poultry manure and urea on growth, yield and economics of garlic (*Allium sativum* L.) .J. Agric. and Natural Resources (2020) 3(1): 253-264

Snedecor, G. H. and W. C. Cochran (1980). Statistical Methods. 7th ed. Iowa State University press, Ames., Iowa, U.S.A.

Taha, N.M. and N.A.S. Helal (2019). Effect of Nitrogen Fertilization and Some Foliar Applications on Growth, Yield and Quality of Two Garlic (*Allium sativum* L) Cultivars. Curr. Sci. Int., 8(1): 212-220.

Tartoura, E. A. A., M. A. El-Saei, E. M. El-Said and G. A. Baddour (2003). Suppressing the nitrate pollution in plant and soil using a clean performance in N-fertilization on potato. J. Envir. Sci., 25: 313-331.

Taysom, T. W., J. J. LeMonte, C. J. Ransom, J. C. Stark, A. P. Hopkins and B. G. Hopkins (2023). Polymer Coated Urea in 'Russet Burbank' Potato: Yield and Tuber Quality. Amer. J. Potato Res. 100:451–463.

Trenkel, M.E. (2010) Slow- and Controlled-Release and Stabilized Fertilizers: An Option for Enhancing Nutrient Use Efficiency in Agriculture. International Fertilizer Industry Association (IFA), p.163, Paris, France.

Waddell, J. T., S. C. Gupta, J. F. Moncrief, C. J. Rosen, and D. D. Steele (1999). Irrigation and nitrogen management effects on potato yield, tuber quality and nitrogen uptake. Agron. J., 91: 991-997.

Yamamoto, C.F., E.I.Pereira, L.H.C. Mattoso, T. Matsunaka and C. Ribeiro (2016). Slow-release fertilizers based on urea/ureaformaldehyde polymer nanocomposites. Chemical Engineering J. 287: 390-397.

Zaghloul, M. M. 1; A. H. Morsy and S. S. Elafifi (2016). Effect of Mineral, Bio and Organic fertilization on Garlic production. J. Plant Production, Mansoura Univ., Vol. 7(10): 1109 - 1113, 2016.

Zvomuya, F., C. R. Rosen, M. P. Russelle, and S. C. Gupta (2003). Nitrate leaching and nitrogen recovery following application of polyolefin-coated urea to potato. J. Environ. Qual., 32: 480-489.

الملخص العربي

تأثير الأسمدة العضوية و سماد النيتروجين بطيء الإمداد (إنسيابين) على إنتاجية و جودة الثوم

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أجريت هذه التجربة بمنطقة أبيس بمحافظة الإسكندرية ، مصر خلال موسمي النمو الشتويين 2022/2021 ، و 2023/2022 لدراسة تأثير استجابة محصول الثوم لإضافات كل من الأسمدة العضوية و السماد النيتروجينى بطيء الإمداد (اليوريا فورمالدهايد). نفذت التجارب بتصميم القطع المنشقة مرة واحدة ذو ثلاث مكررات. تم توزيع الأسمدة العضوية (سماد الأبقار ، والدواجن)على القطع الرئيسية ، وخمس معاملات سماد نيتروجيني (120 كجم نيتروجين / فدان على صورة سماد نيتروجينى قابل للذوبان، 120، 100، 80 و 60 كجم نيتروجين / فدان على صورة اليوريا فورمالدهايد كسماد نيتروجينى بطيء الإمداد) تم توزيعها على القطع المنشقة.

و قد أوضحت النتائج ما يلى :

أظهرت النتائج أن الصفات الخضرية المدروسة تأثرت معنويا بإضافات اليوريا فورمالدهايد . تأثرت صفتا ارتفاع النبات (سم) وعدد الأوراق / نبات معنويا بالتداخل بين المتغيرين المستقلين المدروسين (السماد العضوي ومعدلات التسميد النتروجيني). التسميد بسماد الأبقار أعطى أعلى إنتاجية لمحصول الثوم (طن/ فدان) ، وأعلى متوسط لصفة وزن الرأس (جم) مقارنة بالتسميد بسماد الدواجن خلال الموسم الأول، بينما لم تكن هناك فروق معنوية خلال الموسم الثاني . أشارت نتائج الموسم الأول إلى عدم وجود فروق معنوية بين معاملات التسميد النتروجيني (120 كجم نيتروجين/ فدان كسماد قابل للذوبان، 120 و100 كجم نيتروجين / ف على صورة يوريا فورمالدهيد)، بينما تفوقت معاملات 100 و 120 كجم نيتروجين / ف (على صورة يوريا فورمالدهيد) فى إنتاج محصول أعلى من الثوم على معاملة النيتروجين القابل للذوبان (120 كجم نيتروجين/ فدان) خلال الموسم الثاني. تم الحصول على أعلى متوسطات قيم لصفة محصول الثوم (طن/فدان) من خلال المعاملات التالية: سماد الأبقار + 80 كجم نيتروجين / فدان من سماد اليوريا فورمالدهيد، و سماد الأبقار + 100 كجم نيتروجين / فدان من سماد اليوريا فورمالدهيد ، و سماد الدواجن + 120 كجم نيتروجين / فدان فى صورة سماد قابل للذوبان ، وذلك خلال الموسم الأول . بينما أشارت نتائج الموسم الثاني إلى أن كل من المعاملات التالية: سماد الدواجن + 120 كجم نيتروجين / فدان من سماد اليوريا فورمالدهيد ، و سماد الأبقار + 100 كجم نيتروجين / من سماد اليوريا فورمالدهيد ، و سماد الأبقار + 120 كجم نيتروجين / فدان من سماد اليوريا فورمالدهيد أعطوا أعلى متوسطات قيم لصفة محصول الثوم (طن/فدان).كان للتداخل بين الأسمدة العضوية × معاملات التسميد النيتروجينى تأثيرا معنويا على صفة المادة الجافة لرؤوس الثوم (%) .

نتائج هذه الدراسة توصى بتسميد نباتات الثوم النامية بسماد الأبقار بمعدل 20 م3 / فدان + سماد اليوريا فورمالدهايد (40 % نيتروجين) بمعدل 100 كجم نيتروجين / فدان لتعظيم إنتاجية الثوم بالإضافة إلى الحفاظ على بيئة آمنة باستخدام الأسمدة الصديقة للبيئة.