



The Effect of Urea Coated with Certain Chemical Compounds (Nitrogen Levels on Nitrification and their interaction on Ammonia Volatilization in Soil, and the Growth and Yield of Maize) *Zea mays* L.

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Abstract:

The field experiment was conducted in the Abu-Jwelana area, North of Al-Samawah city, located 6 km from the city centre, during the spring agricultural season of 2025-2026 . The site coordinates are between latitude 31.3682880 and longitude 45.2596586. The study aimed to evaluate the field efficiency of chemical compounds in inhibiting the nitrification process and ammonia volatilization, and their impact on the growth of maize (*Zea mays* L.). The experiment was laid out using a Randomized Complete Block Design (RCBD) in a split-plot arrangement. It included three treatments of aqueous extracts: urea treated with water only, the chemical compound, and urea only, coded as (N0, N1, and N2) respectively. These were added to the urea fertilizer at a concentration of 100 ml/kg (extract: fertilizer). Three Nitrogen levels were applied: 0, 107, and 214 Kg/H, coded as (F0, F1, and F2) respectively. Seeds of the maize cultivar "Laila" were planted on 28th March 2025, and the plants were harvested on 25th July 2025. The results of the study showed the following: Adding the chemical compound to the urea fertilizer inhibited the nitrification process compared to the urea-only treatment without an inhibitor. Conversely, at the later periods of 30 and 60 days post-fertilizer application, the lowest volatilization was recorded for the urea-only treatment. Adding the chemical compound (SCU) to the urea fertilizer positively influenced growth traits, achieving significant superiority in the chlorophyll content of the plant. Increasing the levels of nitrogen fertilizer added to the soil led to a significant superiority in grain yield .

Keywords: Maize, Nitrogen, Ammonia Volatilization, Nitrification.

Introduction

Nitrogen is a major essential element and the most crucial component in fertilization programs because plants require it in larger quantities than other nutrients. This element is

directly involved in building chlorophyll molecules, proteins, enzymes, and cell membranes. It also drives cell elongation, cell division, and the formation of new cells,

alongside enhancing plant tolerance to extreme environmental conditions (Al-Samawi, 2012).

However, the use of chemical nitrification inhibitors is not without constraints and drawbacks. These include the high cost of treated fertilizers, increased production costs, potential disruptions to the nutrient balance and biological processes in the soil, plant toxicity, and environmental pollution.

Conversely, the slow release of nitrogen from coated fertilizers extends the retention time of ammonium in the soil and promotes its organic immobilization. This improves synchronization between nutrient supply and crop demand while minimizing leaching losses (Liu et al., 2024). Consequently, ammonium remains available for uptake by plant roots for a longer duration, especially during early growth stages when nitrogen demand is relatively low (Rathbone & Ullah, 2024).

A field study demonstrated that adding nitrification inhibitors alongside coated fertilizers slowed down the nitrification process and increased the retention time of fertilizer nitrogen as extractable ammonium, while reducing the accumulation of mobile nitrates in the soil (Liu et al., 2024).

Initial Soil Analysis

Table (1). Some initial physical and chemical properties of the study soil.

Soil Property	Value	Unit	
pH	8.00	-----	
E.C.e	7.40	dS m ⁻¹	
Available Nitrogen (N)	31.00	mg kg ⁻¹	
Available Phosphorus (P)	17.32	mg kg ⁻¹	
Available Potassium (K)	184.75	mg kg ⁻¹	
Organic Matter	10.20	g kg ⁻¹	
Cation Exchange Capacity (CEC)	24.5	Cmole (+) kg ⁻¹	
Sand	260.80	gm kg ⁻¹	Clay Loam
Silt	364.20		
Clay	375.00		

Study Treatments

The study included the following treatments:

Furthermore, maintaining low and steady concentrations of ammonium prevents sudden spikes in soil pH—the primary driver of ammonia volatilization. This ultimately increases nitrogen use efficiency and mitigates environmental losses (Rathbone & Ullah, 2024). Therefore, this study aims to mitigate nitrogen volatilization and loss by utilizing coated compounds and investigating their interaction with various levels of applied nitrogen to achieve optimal plant growth and crop yield .

Materials and Methods :

Study Site and Soil Sampling :

A field experiment was conducted in the Abu-Jwelana area, North of Samawah city, located 6km from the city centre (latitude 31.3682880 and longitude 45.2596586) during the spring agricultural season of 2025 – 2026 . The study aimed to evaluate the field efficiency of aqueous extracts from certain plants in inhibiting the nitrification process and ammonia volatilization, and their impact on the growth of maize (*Zea mays* L.).

Nitrogen Levels

Three nitrogen levels were used in the form of urea fertilizer (46% N):

0 kg N ha⁻¹, 107 kg N ha⁻¹ and 214 kg N ha⁻¹

Urea Fertilizer Treatments

1. Urea treated with water only (added in an amount equal to the volume of the extract).
2. Sulphur-Coated Urea (SCU) treated with the chemical compound.
3. Urea only (untreated control).

Field Preparation and Management :

An area of 1250m² was selected to conduct the field experiment. The soil was plowed twice perpendicularly using a mouldboard Plow to a depth of approximately 30 cm, followed by land leveling. The experimental field was divided into 60 experimental units, with each unit measuring 3 × 2 m. These units were distributed across three replicates, with 20 experimental units per replicate. An irrigation channel separated each pair of replicates to ensure that every experimental unit was irrigated individually.

Phosphorus was applied at a rate of 60 kg P ha⁻¹, and potassium was applied at a rate of 120 kg K ha⁻¹ to the soil before planting as a single basal dose. Maize seeds (cv. "Laila") were planted on 28 March 2025. The fertilizer treatments were applied in two split doses: the first dose was added one week after planting, and the second dose was applied one month after the first dose.

At the end of the season, plants from each experimental unit were harvested. Grains were separated and weighed, and the vegetative parts of the plants were dried and weighed to determine the total biological yield (grains + vegetative mass). Finally, the total nitrogen uptake was calculated by multiplying the total plant dry weight by the nitrogen concentration.

Studied Traits

Ammonia Volatilization After 30 Days , Volatilization after 60 days , Chlorophyll Content and Grain Yield (Mg ha⁻¹)

Statistical Analysis

The study was conducted as a factorial experiment using a Randomized Complete Block Design (RCBD) in a split-plot arrangement with three replications, where traits were analysed via ANOVA and means compared using Least Significant Difference (L.S.D.) test, as detailed in Al-Rawi and Khalaf Allah (1980).

Results and Discussion

Volatilization after 30 days

The results in Table (2) showed significant differences in ammonia volatilization 30 days after fertilizer application. The urea treatment recorded 1.26kg N ha⁻¹ compared to 1.19kg N ha⁻¹ for the other chemical treatments. The lower volatilization in urea alone is attributed to the low amount of nitrogen in the form of ammonium, whereas the inhibitors led to sustained volatilization at a later stage, which aligns with (Santos *et al.*, 2025).

The results in Table (2) demonstrated a significant increase in the amount of volatilized ammonia with higher nitrogen application levels. The fertilizer level F2 achieved the highest amount of volatilized nitrogen, reaching 3.07kg N ha⁻¹, which was significantly superior to level F1 (which recorded 2.65 kg N ha⁻¹). Conversely, volatilization was minimal in the control treatment) F0 (amounting to 0.19 kg N ha⁻¹, these findings agree with Al-Malki (2018), Majeed (2019), and Mousa (2021), all of whom indicated that the amount of volatilized ammonia increases with higher rates of nitrogen fertilizer applied to the soil.

Furthermore, the results in the table revealed a significant two-way interaction between the chemical compound application to urea fertilizer and the added nitrogen levels on the

amount of volatilized ammonia. The highest volatilization rates were recorded in the interaction treatments F2N1 and F1N1, reaching 5.28 and 71.kg N ha⁻¹, respectively. In

Table :(2) Effect of chemical compounds and nitrogen fertilizer levels on the amount of volatilized ammonia 30 days after fertilizer application".

contrast, the lowest volatilization was observed across all interaction treatments that received no nitrogen fertilizer.

Treatments	F2	F1	F0	Mean of Fertilizers
N0	1.91	1.59	0.03	3.46
N1	5.28	4.71	0.40	1.19
N2	2.03	1.59	0.15	1.26
Mean of Treatment	3.07	2.65	0.19	
L.S.D _{0.05}	F= 0.667	N= 0.667	F*N=1.155	

Volatilization after 60 days

The statistical analysis of the data in Table (3) indicates significant differences regarding the addition of chemical compounds to urea fertilizer in increasing the amount of volatilized ammonia 60 days after fertilizer application.

The results of the study after 60 days showed that the addition of ammonia volatilization inhibitors led to a significant increase in the amount of volatilized ammonia compared to the standard, untreated urea treatment. The chemical compound SCU recorded 5.70kg N ha⁻¹, compared to the urea-only treatment, which recorded the lowest volatilization value of 3.19kg N ha⁻¹. This trend may be attributed to an accumulation of ammonium in the chemical compound treatment during this specific period of fertilizer application, which subsequently accelerated volatilization. In contrast, the available nitrogen in the urea-only treatment decreased during the later

stages due to higher ammonia volatilization occurring earlier in the application period (Al-Samarrai, 2012; Mousa, 2021).

Furthermore, the results in Table (3) revealed a significant increase in the amount of volatilized ammonia with increasing nitrogen application levels. Fertilizer level F2 achieved the highest amount of volatilized nitrogen, reaching 7.42kg N ha⁻¹, which was significantly superior to level F1, which recorded 4.09kg N ha⁻¹. Conversely, volatilization was minimal in the control treatment (F0), amounting to 0.03kg N ha⁻¹.

The data in Table (3) also demonstrated a significant two-way interaction between the application of chemical compounds to urea fertilizer and the added nitrogen levels on the amount of volatilized ammonia. The highest volatilization rate was observed in the interaction treatment F2N1, reaching 10.81kg N ha⁻¹. This treatment was significantly superior to both interaction treatments F1N1

and F2N2, which recorded (6.27) and (5.84 kg N/ha⁻¹, respectively. In contrast, the lowest volatilization rates were observed across all

interaction treatments that received no nitrogen fertilizer.

Table :(3) Effect of chemical compounds and nitrogen fertilizer levels on the amount of volatilized ammonia 60 days after fertilizer application.

Treatments	F2	F1	F0	Mean of Fertilizers
N0	5.60	2.31	0.01	2.64
N1	10.81	6.27	0.01	5.70
N2	5.84	3.68	0.06	3.19
Mean of Treatment	7.42	4.09	0.03	
L.S.D _{0.05}	F= 0.961 N= 0.961 F*N= 1.664			

Chlorophyll Content

The data in Table (4) showed that the nitrogen application and fertilizer treatments did not differ significantly from one another regarding plant chlorophyll content.

Furthermore, the results in Table (4) revealed significant differences for the two-way interaction between the chemical compounds

added to urea and the soil-applied nitrogen fertilizer levels on chlorophyll content. The F2N2 interaction treatment yielded the highest value, reaching 42.82 SPAD, which did not significantly differ from several other interaction treatments. In contrast, the lowest chlorophyll content was observed in the F2N0 treatment, which recorded 30.07 SPAD.

Table :(4) Effect of aqueous plant extracts, chemical compounds added to urea, and applied nitrogen fertilizer levels on chlorophyll content(SPAD)

Treatments	F2	F1	F0	Mean of Fertilizers
N0	30.07	38.32	37.41	35.27
N1	37.94	33.52	32.35	34.60
N2	42.82	39.61	33.00	38.48

Mean of Treatment	36.94	37.15	34.25
L.S.D_{0.05}	F= N.S N= N.S F*N= 6.162		

Grain Yield :

The results in Table (5) indicate the presence of significant differences at the 0.05 probability level among the urea treatments (sulfur-coated urea and urea alone) regarding plant grain yield. The urea-only treatment (without inhibitor) yielded the highest mean among all treatments, differing significantly from the rest by reaching 5.94 Mg ha⁻¹, whereas the SCU treatment achieved 5.20Mg ha⁻¹. The superiority of the chemical compound treatment in enhancing the grain productivity of maize (yellow corn) is attributed to its role in inhibiting the nitrification process. This inhibition reduced the conversion of ammonium into nitrate within the soil and minimized nitrogen loss via leaching or denitrification. Consequently, this increased the available nitrogen in the soil and enhanced its uptake, leading to improved plant growth and higher productivity. These findings agree with Al-Burki (2020), who demonstrated that the application of coated urea led to an increase in plant grain yield weight.

Table (5) also indicates that the soil-applied nitrogen fertilizer levels significantly affected grain yield. It was observed that the F1 treatment achieved 5.54 Mg ha⁻¹, followed by the F2 fertilizer level treatment, which recorded a grain yield of 5.41 Mg ha⁻¹. Conversely, the F0 level produced the lowest mean, amounting to 4.67 Mg ha⁻¹. These results align with the findings of Nasser and Abboud (2014), Al-Rufaiei (2016), and Al-Hamdawi (2021), who concluded that the increase in grain productivity is a direct result of increasing nitrogen fertilizer levels for the plant.

The results in Table (5) indicate significant differences in grain yield due to the interaction between plant extracts and nitrogen fertilizer levels. The treatment combining *Conocarpus* leaf extract with fertilizer level 2 (F2N2) achieved the highest value, significantly outperforming several other treatments with a yield of 6.76Mg ha⁻¹. On the other hand, the lowest grain yield was recorded for the F1N0 interaction treatment, which yielded 4.37Mg ha⁻¹.

Table (5): Effect of aqueous plant extracts added to urea and applied nitrogen fertilizer levels on the grain yield of maize Mg\ ha⁻¹.

Treatments	F2	F1	F0	Mean of Fertilizers
N0	4.47	4.37	4.46	4.43
N1	5.00	5.65	4.95	5.20
N2	6.76	6.62	4.46	5.94
Mean of Treatment	5.41	5.54	4.67	
L.S.D_{0.05}	F= 0.828 N= 0.828 F*N=1.434			

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