The Effect of Some Chemical Compounds and Plants Water Extracts on Inhibiting The Nitrification in The Soil and Wheat (Triticum Aestivuim L.) Growth and Yield

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Abstract

A field experiment was carried out in Dhi Qar Governorate, Al-Fadhliya region, for season of 2018-2019. Chemical compounds DMPP, DCD, and ATS as well as aqueous extracts of capers seeds and palm bast, were added to inhibiting the nitrification in the soil, and some of the growth characteristics of the wheat. Three of nitrogen level were added as urea (46% N) fertilizer (100, 150 and 200 kg N per ha). Aqueous extracts of plants were added to the urea fertilizer at a concentration of 100 ml for each kg of fertilizer. The experiment designed used RCBD with three replications. Wheat seeds were sown at 11/15/2018. Soil samples were Collecting from the soil (0-30) cm during the growing season after (10, 20, 40 and 60) days after the fertilization. The amount of ammonium, nitrate and nitrite, were estimated. The results showed that the fertilizer level 150 kg N ha-1 with all extracts and chemical compound treatments were exceeded compared with 200 kg N ha-1 without treatments.

Key words: Aqueous extracts, Nitrification inhibitors, Urea fertilizer.

1. Introduction

Nitrogen is one of the main elements which are taken by plants in large amounts. Nitrogen is an important component of many parts of plant, for example cellular structure, cell protoplasm, amino acids and proteins, and is necessary for the plant's chlorophyll molecule. Urea fertilizer is the most widely used as nitrogen fertilizer in the world, and because of its high nitrogen content (46%), It is exposed to the mechanisms of loss after addition [1]. In order to provide nitrogen in sufficient quantity and compensate for what is lost, it is necessary to work to reduce the loss of fertilizer added to the soil and increase the efficiency of the plant's use of nitrogen. To achieve this goal, urease inhibitors and nitrification inhibitors are used, which slow down the decomposition of urea fertilizer in the soil, allowing the plant to absorb the largest possible amount of added nitrogen [2]. The use of chemical nitrification inhibitors has some limitations and problems, such as the high prices of fertilizers treated with inhibitors, the increase in the cost of production and the damage they can cause to the biological balance in the soil, plant toxicity and environmental pollution [3].

Plant extracts have been used as alternatives to chemical compounds in controlling some biological processes, including nitrogen transformations in the soil to reduce damage and environmental problems, as well as their easy decomposition in the soil and their abundance in nature. The results of laboratory, field and greenhouse studies showed the possibility of using aqueous extracts of some plants and chemical compounds to inhibit the nitrification process and increase the efficiency of nitrogen fertilizers [4-6]. Therefore, the study was proposed to achieve the following objectives:

- Evaluating the efficacy of chemical compounds and aqueous extracts of capers and capers seeds in inhibiting the nitrification process in the soil.
- Studying the effect of chemical compounds and aqueous extracts on nitrogen absorption and growth of the wheat plant
- Comparison the effect of chemical compounds and plant aqueous extracts which that coating urea fertilizer with traditional urea fertilizer, on inhibiting the nitrification process and wheat growth and yield.
2. Materials and Methods

2.1 Study site and soil sample collection

A field experiment was carried out in Dhi Qar Governorate, Al-Fadhliya region, to study evaluating the efficiency of aqueous extracts of some plants in inhibiting the nitrification process. The soil samples were air dried, hand cleaned to remove foreign particles and ground to pass through a 2 mm sieve and analyzed on organic matter content, pH, EC, texture. Table (1) shows some properties of the study locations.

| Property        | The value | Unit       |
|-----------------|-----------|------------|
| pH              | 7.7       | dS m⁻¹     |
| E.Ce            | 3.54      | g kg⁻¹     |
| Organic matter  | 9.9       |           |
| Avai Nitrogen   | 23.04     | mg kg⁻¹    |
| Avai Phosphours | 13.02     |           |
| Avai Potassium  | 62.20     |           |
| sand            | 249.80    | gm kg⁻¹    |
| silt            | 480.20    | Silty loam |
| clay            | 270.00    |           |

2.2 Collect plant samples

The samples of Capers and palm bast were collected from Al Samawah (Bandar) orchards. The studied part was taken from each plant (caper seed, palm bast) as shown in Table (2). The samples washed with tap water and distilled water to remove dust and brush on large filter papers in the dark and at lab temperature with continuous movement to prevent rotting until completely dry. The plant parts were ground with an electric grinder and passed through 1 mm sieve and kept in nylon bags in dry places.

| Common name | Scientific Name | Plant part | Sampling date | Location       |
|-------------|-----------------|------------|---------------|----------------|
| capers      | Capparis spinosa L. | seeds      | October-2018  | Samawaa-Bander |
| Date palm   | Phoenix dactylifera | Bast       | Feb-2018      | Samawaa-Sweer  |

2.3 Preparation of the aqueous extract of the studied plants

According to [7] a ratio of 1:10 was used instead of 1:100 plant sample: water) extract was prepared. 10 g of dry grinding sample mixed with 100 ml of distilled water in 500 ml beaker and shaking for six hours at 160 rpm. Then the mixture was passed through a piece of cloth to separate the large plankton, then the solution was taken and passed through Whatman filter paper more than one time to obtain a clear solution. The entire solution was collected and kept at a -20° C as the original stock solution.

2.4 Study treatment

The study included the following treatment:

- Nitrogen level: Three levels of nitrogen fertilizer (100, 150 and 200 kg N per ha)were used as urea fertilizer (46% N).
- Chemical compounds and plant extracts (Urea fertilizer was used in six treatments.includes:
  - Urea only
  - Urea treated with capers seed extract
  - Urea treated with palm bast extract
  - Urea treated with the chemical inhibitor (dimyethyl pyrezol phosphate) DMPP Commercial fertilizer which containing 21% nitrogen.
  - urea treated with the chemical inhibitor (Dicyandiamide) DCD-
  - Urea treated with the chemical inhibitor ATS Ammonium Thio Sulfate)
Plant extracts were added in 100 ml Kg⁻¹ (extract: fertilizer).

| Property          | Palm bast | Coper seeds | Unite       |
|-------------------|-----------|-------------|-------------|
| pH                | 5.9       | 6.4         | ........     |
| EC                | 1.4       | 2.8         | dS m⁻¹      |
| Organic matter    | 14.0      | 16.5        | g kg⁻¹      |
| Total Nitrogen    | 23.4      | 29.4        | mg kg⁻¹     |

### 2.5 Preparing and preparing agricultural land

An area of 1250 m² was divided into 54 plots experimental units with dimensions of 3 x 2 m. The experimental units were divided into three replicates, 18 experimental units for each duplicate, separating each duplicate an irrigation channel so that each experimental unit separately. The entire amount of Phosphorus and potassium fertilizer (80 kg P ha⁻¹ and 120 kg K ha⁻¹) applied before planting, While as Fertilizer treatments applied as two batches, the first on after a week of sowing and the second one month after the first batch.

### 2.6 Estimation of the form of soil inorganic nitrogen (NO₃⁻, NO₂⁻ and NH₄⁺)

Soil samples were collected from a depth of 0-30 cm, after 10, 20, 40 and 60 days from treatment date. The soil samples were air dried, and ground to pass through a 2 mm sieve and analyzed, the inorganic nitrogen forms was determined by using conventional chemical analysis by Kjeldahl method according [8].

### 2.7 Plant analyzes

#### 2.7.1 Dry weight and grain weight

Shoot system of Wheat were harvested and air dried, then according to the dry weight of each experimental unit and then according to the hectare, then the grains were separated and calculated for the experimental units and then per hectare.

#### 2.7.2 The nitrogen concentration in the plant

Plant samples were taken from each experimental unit, washed with distilled water, air dried, the samples were ground and mixed well to homogeneous, 0.2 gm of the dry plant sample powder passed through 0.5 mm sieve holes were taken and digested using concentrated sulfuric and perchloric acid, then quantitatively transferred to a 100 cm³ vial and completed The volume with distilled water is thus available for N nutrient quantification. Nitrogen was estimated using a microchloride device according to the Bremner method as reported in [9].

#### 2.7.3 Nitrogen absorbed in the plant

According to the nitrogen absorbed in the plant, according to the following law:

\[ \text{N absorbed in the plant} = \text{nitrogen concentration in the plant,} \% \times \text{the plant's dry weight} \]

### 2.8 Statistical analysis

The experiment was designed as a factor experiment according to the RCBD design. All the variables were compared using the Genstat-Version5 program and the results were compared using the least significant difference to determine the type and levels of significance between the averages and the different treatments at a probability level of 5%.
3. Results and Discussion

3.1 The amount of ammonium

Table (4) shows significant differences in the amount of ammonium in the soil for the inhibitory treatments of urea fertilizer by both types of water and chemical plant extracts. The amount of ammonium in the soil was (37.35, 36.02) mg kg\(^{-1}\) soil for the treatments of capers seed extract and the chemical compound DMPP Respectively, while the lowest amount of ammonium in soil for urea treatment was 25.38 mg / kg\(^{-1}\) soil. It is clear that the treatment of caper seed extract significantly outperformed the amount of ammonium in the soil with the treatment of DMPP over all other chemical treatments and plant extracts. The amount of ammonium in soil treated with plant extracts or the chemical compound added to urea fertilizer exceeds its quantities in soil treated with urea only due to the ability of these extracts to inhibit the nitrification process, which led to the accumulation of ammonium ion in the soil. These results are agree with [10, 11], which that showed the plant extracts to urea fertilizer or encapsulating the fertilizer with these extracts led to the inhibition of nitrification in the soil. [12] showed that the accumulation of ammonium in soils treated with plant extracts is due to the affect of these extracts on metabolic compounds such as the enzymes that responsible for oxidation of the ion, thus increasing the accumulation of ammonium ion in the soil. The higher amount of ammonium in soils treated with capers seed extracts compared with soils treated with chemical compounds may be due to the plant extracts containing more than one substance that has affects on bacteria which responsible for the nitrification compared to the chemical compound alone, these results are agreed with [5].

From Table (4) shows an significantly increase in the amount of ammonium in the soil by increasing the N levels which are reached (46.38 32.52 20.73) mg kg\(^{-1}\) soil for the 200, 150 and 100 kg of nitrogen ha\(^{-1}\) respectively. These results are agreed with [6,11]. The effect of the interaction of nitrogen addition, aqueous plant extracts, and chemical compounds encapsulated with urea on the amount of ammonium in the soil Table (4). The statistical analysis mentioned to a significant differences between the different treatments. The results also showed that increased nitrogen fertilizer led to an increase in the amount of ammonium. The caper seed extract interaction with 200 kg N ha\(^{-1}\) of nitrogen fertilizer surpassed over all other treatments and the amount of ammonium reached 54.35 mg kg\(^{-1}\) soil. The results of this study agree with the results of [3,13] which showed an increase in the amount of absorbable nitrogen with an increase in the levels of nitrogen added treated with inhibitors of the nitrification.

| Treatment                   | Fertilizer N Kg per ha | mean   | R.L.S.D |
|-----------------------------|------------------------|--------|---------|
|                             | 100                    | 150    | 200     |
| urea                        | 15.5                   | 26.6   | 34.55   | 25.38   |
| Copers seed                 | 24.65                  | 33.06  | 54.35   | 37.35   |
| Palm bast                   | 21.05                  | 31.2   | 43.31   | 31.85   |
| DCD                         | 22.45                  | 33.76  | 48.78   | 34.99   | 1.86    |
| ATS                         | 19.67                  | 34.32  | 46.54   | 33.51   |
| DMPP                        | 23.1                   | 35.52  | 49.46   | 36.02   |
| mean                        | 20.73                  | 32.52  | 46.38   |         |
| R.S.L.D                     | 1.54                   |        | 2.23    |         |

3.2 The amount of nitrates

The results of the soil analysis showed that there was no accumulation of nitrite in the soil during the periods of sample collection, so only nitrates were mentioned. Table (5) indicates the average amounts of nitrate in the soil during the study period for caper seed extract treatments that achieved the lowest nitrate amount of 11.52 mg kg\(^{-1}\) soil, which did not differ significantly with the chemical compound DMPP whose nitrate amount was 12.38 mg kg\(^{-1}\) soil. When the nitrate amount of urea treated soil was only 18.35 mg kg\(^{-1}\) soil. It is clear from the above results that the treatment of caper seed extract and the chemical compound DMPP significantly reduced the amount of nitrate in the soil over the rest of the treatments of aqueous plant extracts. The reason for reducing the amount of nitrate is due to the release ammonium and the ability of those extracts and chemical compounds to stop the oxidizing organisms of ammonium or affect the enzyme pathways responsible for these transformations, and thus have the ability to inhibit the nitrification process and thus increase the accumulation of ammonium.
ammonium in the soil and reduce the formation of nitrates. [11] indicated that the decrease in the amount of nitrate in the soil because these aqueous plant extracts contain more than one substance is effective in nitrifying bacteria. These results are consistent with the results of Kiran and Patra (2003), who indicated that the decrease in the amount of nitrate in the soil because these aquatic plant extracts contain more than one substance affecting nitrification bacteria. The results are also in agreement with the results [4,14]. Table (5) indicates that the increase in the amount of nitrogen added by increasing the nitrogen level from 100 to 150 to 200 kg N ha$^{-1}$ led to an increase in the amount of nitrate in the soil, as the amount of nitrate reached 11.39, 13.81 and 16.30 mg kg$^{-1}$ soil, respectively. The results are similar to those of [5].

Table (5) shows the effect of the interaction of aqueous plant extracts and chemical compounds with nitrogen fertilizer levels, as the table indicates that nitrate levels in the soil increase with increasing nitrogen fertilizer levels and for all treatments of aqueous plant extracts, chemical compounds and urea treatment only (without inhibitor). The highest rate of nitrate at the nitrogen level 200 kg N ha$^{-1}$ for soils treated with urea only, was 23.03 mg kg$^{-1}$ soil, with a significant difference from all interactions, while the lowest average amount of nitrate in soil for the treatment of caper seed extract was at the nitrogen level 100 kg N ha$^{-1}$ amounted to 8.90 mg kg$^{-1}$ soil, which differed significantly from all treatments of plant extracts and chemical compounds interfering with nitrogen fertilizer levels except for the chemical compound DMPP treatment at the level of 100 kg N ha$^{-1}$, which amounted to nitrate of 9.99 mg kg$^{-1}$ soil. It is also noted from the table that the treatment of caper seed extract was superior in reducing the amount of nitrate on the soil of the rest of the treatments and for all levels of Nitrogen fertilizer

**Table 5.** The effect of aquatic plant extracts and chemical compounds added to urea fertilizer on the amount of nitrates in soil (mg kg$^{-1}$ soil).

| Treatment       | Fertilizer N Kg per ha | L.S.D  |
|-----------------|------------------------|--------|
|                 | 100                    | 150    | 200    | mean |  |
| urea            | 14.04                  | 18     | 23.03  | 18.35|  |
| Copers seed     | 8.9                    | 10.54  | 13.13  | 11.52|  |
| Palm bast       | 11.43                  | 14.41  | 17.1   | 14.31|  |
| DCD             | 12.32                  | 12.98  | 15.54  | 13.61| 0.98|
| ATS             | 11.67                  | 13.53  | 14.98  | 13.39|  |
| DMPP            | 9.99                   | 13.4   | 14.06  | 12.38|  |
| mean            | 11.39                  | 13.81  | 16.3   | 1.24 |  |

### 3.3 Dry weight of the plant

Table (6) shows the effect of aqueous plant extracts and chemical compounds added to urea fertilizer on the weight of the dry matter, as it led to an increase in the dry matter of wheat plants. The highest dry weight of caper seed extract treatment was (4,936) kg ha$^{-1}$, which was significantly superior to that of plants treated with chemical inhibitor all other treatments, while the lowest dry weight was for urea only, which amounted to 3307 kg ha$^{-1}$ The reason for the superiority of aqueous plant extracts and chemical compounds added to urea in increasing the weight of the dry matter is due to the increase in the efficiency of the fertilizer and its reflection on plant growth by inhibiting nitrification and thus reducing nitrogen loss from the soil, which leads to an increase in the amount available for the plant. The results agree with the results of [15], which were mentioned that the addition of nitrification inhibitors with urea fertilizer led to a significant increase in wheat yield and protein content. [16] indicated that adding amber rice plant extracts with urea fertilizer increased the dry matter weight of maize plant compared to the non-addition treatment. The reason for the superiority of some aquatic plant extracts in increasing the weight of the dry matter is that these extracts have more than one inhibitory compound, and their action is collectively, and their inhibitory effect on the nitrification process is greater than the individual compounds, which led to an increase in the amount of available nitrogen in the soil compared to the chemical compound containing an inhibitory one substance. These results are in agreement with the results of [5], who showed the superiority of caper and pomegranate extracts over the chemical compound DCD in increasing the dry matter weight of barley.

From Table 6, the level of 200 kg N ha$^{-1}$ was significantly superior in the amount of dry matter to the levels of 150 and 100 kg N ha$^{-1}$, whose amount of dry matter amounted to 5142 kg ha$^{-1}$. The increase in the dry weight of plants by increasing the level of the added fertilizer is due to the increase in vegetative growth through its direct effect on the photosynthesis process as it enters into the composition of the chlorophyll molecule. The results are in agreement with the results of many
researchers, including [17, 18], who indicated that the increase in the level of nitrogen has a significant positive effect on increasing plant growth. While as [19] shows that the dry matter weight increases with an increase Nitrogen fertilizer levels because it is included in the composition of the components of the plant mass and encourages the process of cell division. Table (6) shows the effect of interaction of types of aquatic plant extracts and chemical compounds with nitrogen fertilizer levels on the dry matter weight of wheat plants. The results in the table showed that the dry matter weight of plants treated with 200 kg N ha\(^{-1}\) in the form of urea and caper seed extracts achieved the highest dry matter weight of 5888 kg ha\(^{-1}\), while it was the lowest at the level of 100 kg N ha\(^{-1}\) added in the form of urea only, which amounted to 2808 kg ha\(^{-1}\). The results are in agreement with [19]. Those who did not note the presence of significant differences for the interactions of plant and chemical extracts with nitrogen fertilizer levels in increasing the dry matter weight of cultivated plants, explaining the reason for the role of nitrogen in increasing plant growth.

### Table 6. The effect of aquatic plant extracts and chemical compounds added to urea fertilizer on the dry matter weight of wheat plant (kg ha\(^{-1}\)).

| Treatment   | Fertilizer N Kg per ha | mean | L.S.D |
|-------------|------------------------|------|-------|
|             | 100                    | 150  | 200   |       |
| urea        | 2808                   | 3395 | 3709  | 3307  |
| Copers seed | 3614                   | 5308 | 5888  | 4936  |
| Palm bast   | 3254                   | 4605 | 5413  | 4424  |
| DCD         | 2845                   | 4732 | 4843  | 4140  | 146   |
| ATS         | 3116                   | 4876 | 5303  | 4278  |
| DMPP        | 3500                   | 5113 | 5578  | 4730  |
| mean        | 3372                   | 4671 | 5142  |       |
| L.S.D       | 117                    |      | 196   |

### 3.4 The nitrogen concentration in the plant

Table (7) shows that the treatment of urea with aqueous plant extracts and chemical compounds led to a significant increase in nitrogen concentration in wheat plants (with a probability level of 0.05) compared to its concentration in urea-treated plants only. The highest rate of nitrogen concentration at caper seed extract and DMPP was (25.31 and 24.80) gm kg\(^{-1}\) dry matter, respectively, while the lowest nitrogen concentration was in urea treatment only and reached 17.56 gm kg\(^{-1}\) dry matter. The reason for the superiority of aqueous plant extracts in increasing nitrogen concentration in The plant indicates that plant extracts contain metabolic secondary compounds that inhibit the nitrification process, which leads to the availability of nitrogen in the soil and thus increases its absorption by the plant. This result agrees with [20] who indicated that treatment of urea fertilizer with plant extracts or metabolites increased the nitrogen content in the wheat plant.

Table (7) shows that there was no significant difference in the nitrogen concentration of wheat for the levels 150 and 200 kg N ha\(^{-1}\), which amounted to (24.76, 23.30) gm \(\text{kg}^{-1}\) dry matter, respectively, while these two levels were significantly superior to the level of 100 kg N ha\(^{-1}\), which was the concentration 21.03 Gm kg\(^{-1}\) dry matter. The results are in agreement with [16, 21], who indicated that the nitrogen concentration increased by increasing the nitrogen fertilizer level. Table (7) shows the effect of the interaction of types of aquatic plant extracts and chemical compounds with nitrogen fertilizer levels on the total nitrogen concentration in the plant.

The addition of different levels of nitrogen did not affect the nature of the effect of the plant extracts or the chemical compound on the nitrogen concentration in the leaves, as the table indicates that the nitrogen concentration for the two treatments of the plants treated with capers and DMPP at a level of (200) kg N ha\(^{-1}\) significantly outperformed the other plant and chemical treatments. The highest values of nitrogen concentrations were (27.57 and 27.34) gm-1 dry matter. The lowest values were obtained at the level of 100 kg N ha\(^{-1}\) and it was when urea was treated only and it reached 15.65 gm kg\(^{-1}\) dry matter.
Table 7. The total nitrogen concentration in shoot system (g, kg⁻¹ dry matter).

| Treatment      | Fertilizer N Kg per ha | mean | L.S.D  |
|----------------|------------------------|------|--------|
|                | 100 | 150 | 200    |      |
| urea           | 15.65 | 18 | 19.02 | 17.56 |
| Copers seed    | 24.08 | 26.3 | 27.57 | 25.31 |
| Palm bast      | 21.12 | 23.4 | 24.46 | 22.99 |
| DCD            | 19.78 | 22.6 | 23.8 | 22.06 | 1.19 |
| ATS            | 22.57 | 22.43 | 26.21 | 23.71 |
| DMPP           | 23 | 24.06 | 27.34 | 24.8 |
| mean           | 21.03 | 23.3 | 24.76 |      |
| L.S.D          | 1.08 |      |        | 1.61 |

3.5 Nitrogen uptake

Table (8) indicates that there was a significant effect of adding aqueous plant extracts and chemical compounds with urea fertilizer on the total nitrogen uptake by wheat plants, and the highest levels of nitrogen absorbed were for the treatments of caper seed extract and DMPP (121.61 and 117.97) kg N ha⁻¹ compared to the treatment of urea only (Without inhibitor), the nitrogen uptake had the lowest value (68.89) kg N ha⁻¹. The reason for the superiority of aqueous plant extracts and the chemical compound in increasing the nitrogen uptake by wheat plants compared to the treatment of urea (without an inhibitor) is due to the use of nitrification inhibitors that increase the efficiency of nitrogen use because of their delay in the decomposition of urea fertilizer and its low rates of loss, which allows the plant to absorb a large part of it in different ways.

Table (8) shows the effect of nitrogen fertilizer levels on the nitrogen uptake by wheat plants, as it is noted that the nitrogen uptake increased significantly and at a level (probability of 0.05) with an increase in nitrogen fertilizer levels added to the soil. The nitrogen uptake by wheat plant was (70.65, 112.02 and 124.84) kg N ha⁻¹ for levels (100, 150 and 200) kg N ha⁻¹, respectively. The results are consistent with what was obtained by [22] that the nitrogen uptake increases with the increase in nitrogen levels and the results of [16], who noticed an increase in the nitrogen uptake by the corn with the increase in the levels of fertilizer added.

Table 8. Effect of aqueous plant extracts and chemical compounds added to urea fertilizer on the amount of nitrogen absorbed by wheat plants (kg N ha⁻¹).

| Treatment      | Fertilizer N Kg per ha | mean | L.S.D  |
|----------------|------------------------|------|--------|
|                | 100 | 150 | 200    |      |
| urea           | 50.84 | 67.8 | 88.04 | 68.89 |
| Copers seed    | 85.92 | 129.9 | 149 | 121.6 |
| Palm bast      | 68.72 | 103.1 | 116.8 | 96.13 |
| DCD            | 61.65 | 118.5 | 123.4 | 101.2 | 7.21 |
| ATS            | 73.59 | 121.3 | 132.6 | 109.2 |
| DMPP           | 83.03 | 131.7 | 139.2 | 118 |
| mean           | 70.65 | 112 | 124.8 |      |
| L.S.D          | 1.08 |      |        | n.s |

3.6 Seeds weight

Table (9) shows the effect of aqueous plant extracts and chemical compounds added to urea fertilizer on the weight of grains of wheat plants. The addition of the study treatments led to an increase in grain production, and the highest rates of grain weights were obtained for the treatments of caper seed extract and DMPP (2331 and 2230) kg ha⁻¹, respectively, which were significantly superior to the urea treatment only, whose grain yield was 1582 kg ha⁻¹. The reason for the superiority is due to the fact that it inhibited the nitrification process in different proportions between them, which slowed down the
decomposition of urea in the soil and reduced nitrogen losses, thus increasing the available nitrogen in the soil, and increasing its absorption. Which leads to an increase in plant growth and an increase in its productivity. The results are in agreement with the results of [23] who showed an increase in the productivity of wheat grain for the treatment of urea fertilizer treated with inhibitors compared to the composted soil.

Table (9) shows that the weight of the grains increased significantly with an increase in the levels of nitrogen fertilizer, and the grain weight rates reached (1709, 2043 and 2104) kg ha\(^{-1}\) for levels of 100, 150 and 200 kg N ha\(^{-1}\), respectively. The increase in the productivity of the wheat plant as a result of the increase in the level of nitrogen fertilizer is due to the high amount of nitrogen absorbed into the plant and thus its role in increasing plant growth and building cells and turning it into protein in grains and increasing their weight. The results are consistent with the results of [24], who obtained an increase in the productivity of rice grains significantly at the level of nitrogen fertilizer. Table (9) shows the effect of the interaction of types of aquatic plant extracts with nitrogen fertilizer levels on the grain weight of wheat plants. The results indicate a significant increase in grain weight with an increase in the levels of nitrogen fertilizer added for all study treatments.

Table (9) shows the effect of the interaction of types of aquatic plant extracts with nitrogen fertilizer levels on the grain weight of wheat plants. The results also show that the grain weight of plants at the level of 150 kg N ha\(^{-1}\) in the form of urea and plant extracts, regardless of their plant source, either chemically superior to the weight of grains of treated plants 200 kg N ha\(^{-1}\) added in the form of urea only. The results showed that the highest grain weight was when the caper seed extract and the chemical compound DMPP were treated at the level of 200 kg N ha\(^{-1}\), which amounted to 2628 and 2441 kg ha\(^{-1}\), respectively, while the lowest grain weight appeared when treating only urea added at a level of 100 kg N ha\(^{-1}\). It reached 1380 kg ha\(^{-1}\). [25] reported a significant increase in shoot size, dry weight and yield of maize plants when treated with nitrification inhibitors compared to urea fertilizer without an inhibitor.

Table 9. The effect of aquatic plant extracts and chemical compounds added to urea fertilizer on grain weight of wheat plants (kg ha\(^{-1}\)).

| Treatment       | Fertilizer N Kg per ha | mean | L.S.D |
|-----------------|------------------------|------|-------|
|                 | 100  | 150  | 200  |      |
| urea            | 1380 | 1600 | 1766 | 1582 |
| Copers seed     | 1870 | 2497 | 2628 | 2331 |
| Palm bast       | 1613 | 1955 | 1822 | 1796 |
| DCD             | 1800 | 1865 | 1965 | 1876 |
| ATS             | 1765 | 1922 | 2004 | 1897 |
| DMPP            | 1831 | 2419 | 2441 | 2230 |
| mean            | 1709 | 2043 | 2104 |      |
| L.S.D           | 104  | 157  |      |      |

Conclusions

- Plant aqueous extracts and chemical compounds added to urea fertilizer caused inhibition of the nitrification process.
- The fertilizer level of 150 kg N ha\(^{-1}\) treated with aqueous extracts of the studied treatments exceeded the level of 200 kg N ha\(^{-1}\) for the comparison treatment for all the studied properties, and this provides about one third of the amount of fertilizer.
- The possibility of using urea fertilizer treated with aqueous extracts of caper seed, a successful alternative to using coating urea fertilizer which imported from another countries.

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