# AN ENVIRONMENTALLY FRIENDLY METHOD of FERTILIZER APPLICATION in AGRICULTURE; ANHYDROUS AMMONIA APPLICATION

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**Abstract -** This research was conducted to determine the differences between the traditional method and anhydrous ammonia method, which are not yet widely used in world agriculture. Methods were compared in terms of environmental factors, yield and yield parameters and fertilizing costs. The anhydrous ammonia method was found to be more advantageous than the traditional method in terms of all the parameters examined. As a result of the research, it is suggested to increase the use of anhydrous ammonia for nitrogen fertilizer applications.

**Keywords -** Environmentally, Anhydrous ammonia, Fertilizer, Nitrogen, Wheat,

## I. INTRODUCTION

Approximately 2 971 000 tones of nitrogenous fertilizer are used in Turkey to meet the annual requirement of 661 000 tones of pure nitrogen in cereal production (Colakoglu et. al., 2005). Nitrogenous fertilizers used in our country are urea, ammonium nitrate, ammonium sulphate. Urea contains 46% nitrogen and ammonium nitrate 26-33%, ammonium sulphate 21% but Anhydrous ammonia ($NH_3$) contains 82.2% nitrogen. It is rich in nitrogen (Akar et al., 2014).

Anhydrous ammonia will stay in liquid form when stored under its own pressuren which is dependent on temperature. Anhydrous ammonia is heavier than air. At 21º C, AA will create a tank pressure of about 8 kilograms per square centimeter (Hanna, 2001).
Physical and chemical properties of Anhydrous ammonia, which create problems for the application and storage of AA. It can be also caused damage on the human body (Nowatzki, 2011). Special tools and equipment are needed at the storage and application stages due to the chemical properties. Therefore, the use of the Anhydrous ammonia for fertilizer is undeveloped in our country agriculture (Akar et al., 2015).
The main target of the study; the anhydrous ammonia method and the traditional method used to meet the nitrogen requirement of the plants are compared in terms of environmental factors, yield and yield parameters and economic factors.

## II. MATERIAL and METHODS

### Anhydrous ammonia (AA)

Anhydrous ammonia fertilizer was used as nitrogenous fertilizer. AA contains 82.2% nitrogen. Chemical formula is $NH_3$. Anhydrous ammonia is classified as a hazardous substance (Wyckoff, 2009). Chemical and physical properties of AA are shown in Table 1.

| | |
|---|---|
| Color | Colorless |
| Odor | Strong |
| Boiling Point | -33 $^oC$ at 1 atm |
| Melting point | -78 $^oC$ |
| Ph | App. 12.0 (neat) |
| Critical Temper. | 133$^o$ C |
| Critical Pressure | 1636 psi |

**Table.1 Physical and Chemical Properties of Anhydrous Ammonia**

### Anhydrous ammonia equipment

In this work, Anhydrous ammonia equipment developed by us was used. Anhydrous ammonia application equipment with a tank capacity 0.5 $m^3$ is shown in Figure 1 and technical specifications of Anhydrous Ammonia application equipment are shown in Table 2.

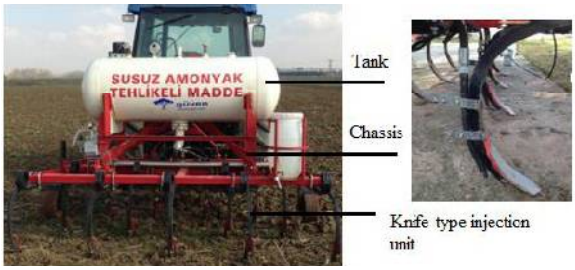



**Figure 1. Anhydrous Ammonia application equipment**

| | | |
|---|---|---|
| Capacity | 500 | $m^3$ |
| Working width | 2200 | mm |
| Tynes | 13 | number |
| Weight | 450 | kg |
| Tank operating | 10 | bar |
| pressure | 16 | bar |
| Tank test pressure | | |

**Table.2 Technical specifications of Anhydrous Ammonia application equipment**

AA remains in liquid form under high pressure and turns to a gas under atmospheric pressure when applied to the soil. It must be kept in special pressurized. So, the tanks were made of pressure-

resistant. Convex type was made to increase resistance to pressure. Injection unit has been selected as a type of traditional knife (Hanna et. al., 2005). Chassis consist of three rows of 4-4-5. Totally, it has been 13 tines cultivator with coil springs. We set spacing of 50 cm. Ammonia application is made only of the front 4 tines (Akar et al., 2014; Tan et. al., 2016).

**Trials**

Field experiments were made in wheat farming. Two different methods in field experiments were applied. Experiments were conducted for two years.

- **AM Method (Anhydrous ammonia application method)**

AA was applied once before the sowing of wheat. AA was injected 15-20 centimeters beneath the soil surface to ensure maximum absorption by the soil. Wider spacing in the Anhydrous ammonia application equipment was selected as a 50 centimeters (Maxwell et. al., 1984).

- **TM method (Traditional method)**

This method is the method used by local farmers. In TM methods, N fertilizer used by farmer both years were recorded (Table 3). The producers have done nitrogen fertilization three times in wheat farming. In the TM method, more fertilizer was used than in the AM method.

| Application periods | I | II |
|---|---|---|
| I | 10 kg urea (% 46) | 10 kg TSP + 10 kg urea |
| II | 18 kg urea (% 46) | 20 kg urea (% 46) |
| III | 23 kg CAN (% 26) | 25 kg nitrate (% 26) |
| Fertilizer | 51 kg | 55 kg |
| Total N rate | 18.9 kg da$^{-1}$ | 20.3 kg da$^{-1}$ |

**Table 3. Total nitrogen amounts at TM Methods**

The amounts of nitrogen used at both methods were determined according to soil analysis. The nitrogen amounts used in the methods are given in Table 4.

| Year | Method | | Total N rate (Kg da$^{-1}$) | Cultivation date. | Harvest date |
|---|---|---|---|---|---|
| I | Anhydrous ammonia | AM | 18 | October28, 2014 | June 12, 2015 |
| | Traditional | TM | 18.9 | | |
| II | Anhydrous ammonia | AM | 18 | November12,2014 | June 29, 2015 |
| | Traditional | TM | 20.3 | | |

**Table 4. Total N rate used in methods**

## RESULTS AND DISCUSSION

The amounts of nitrogen used at both methods are given in table 5. The amount of nitrogen to be used according to soil analysis for wheat agriculture was determined as 18 kg da$^{-1}$at both years. In the AM method, 22 kg da$^{-1}$ of anhydrous ammonia fertilizer ($NH_3$) was used to meet this need in both year. In TM method, nitrogen fertilizer was used 51 kg in the first year and 55 kg in the second year of the experiments. For these applications, fertilization was applied by farmers in three different periods. However, anhydrous ammonia fertilizer was applied in one period. According to the AM method in the TM method, more fertilizer was used the 29 kg in the first year and 33 kg in the second year. Three period fertilization is to cause more field fur and more fuel use.

| Methods | I | II |
|---|---|---|
| | AM | |
| | 22 Kg Anhydrous ammonia (%82.2) | 22 Kg Anhydrous ammonia (%82.2) |
| Total fertilizer | 22 Kg da$^{-1}$ | 22 Kg da$^{-1}$ |
| Total N rate | 18 Kg da$^{-1}$ | 18 Kg da$^{-1}$ |
| | TM | |
| | 10 kg urea (% 46) | 10 kg TSP + 10 kg urea |
| | 18 kg urea (% 46) | 20 kg urea (% 46) |
| | 23 kg CAN (% 26) | 25 kg nitrate (% 26) |
| Total fertilizer | 51 Kg da$^{-1}$ | 55 Kg da$^{-1}$ |
| Total N rate | 18.9 Kg da$^{-1}$ | 20.3 Kg da$^{-1}$ |
| Difference | 29 Kg | 33 Kg |

**Table 5. The amounts of nitrogen fertilizer used in wheat production (two years)**

One of the major factors causing the environmental pollution and the natural balance to deteriorate is the agricultural activities where chemical substances are used intensively. The use of too much fertilizer also increases the environmental pollution. The fertilizer applied to the soil above the amount of fertilizer determined by soil analysis causes various negative effects on the soil, air and water environments by mixing with the environment by washing away from the soil, surface flows and evaporation (Anonymus,2017).

Effects of methods on yield and yield components (plant height, The number of tillering, spike length, number of kernel per spike, kernel weight per spike, thousand-kernel weight, grain yield) were evaluated. The effects of the methods on yield and yield components in wheat farming are given in table 6.In AM methods had higher plant height 103.56 cm, 87.9 cm in first year and second year, respectively. Maximum plant height was observed in AM method while minimum plant height was observed in TM method both years.

Maximum thousand grain weight was observed in AM methods (58.36 and 33.46 g) while minimum thousand grain weight was observed (57.38 and 33.03

g) in TM both year. The highest grain yield was calculated in the AM method. Similar results were found by Woli et. al. (2014) and wyckoff (2009). Grain yields in first year were 892.15 kg·da$^{-1}$ and 728.78 kg·da$^{-1}$ in AM and TM methods, respectively. In the second year, grain yield were 744.33 kg·da$^{-1}$ in the AM method and 695.44 kg·da$^{-1}$ in the TM method.

| | I | II | |
|---|---|---|---|
| Methods | **AM** | | |
| Plant height | 103.56 | 87.9 | cm |
| The number of tillering | 3.3 | 2.53 | number |
| Spike length | 8.54 | 8.18 | cm |
| Number of kernel per spike | 42.56 | 44.90 | number/spike |
| Kernel weight per spike | 2.41 | 1.59 | g/spike |
| Thousand seed weight | 58.36 | 33.46 | g |
| **Grain yield** | **892.15** | **744.80** | kg·da$^{-1}$ |
| | **TM** | | |
| Plant height | 93.48 | 86.76 | cm |
| The number of tillering | 1.46 | 1.86 | number |
| Spike length | 8.11 | 7.31 | cm |
| Number of kernel per spike | 33.80 | 37.46 | number/spike |
| Kernel weight per spike | 1.93 | 1.28 | g/spike |
| Thousand seed weight | 57.38 | 33.03 | g |
| **Grain yield** | **728.33** | **695.44** | kg·da$^{-1}$ |

**Table 6. Yield and Yield Parameters**

These results demonstrate that has a significant effect of Anhydrous ammonia on yield and yield parameters. The economic analyzes of the methods in wheat farming are given in table 7.

| Year | I | II | |
|---|---|---|---|
| Methods | **AM** | | |
| Cost per unit | 0.27 | 0.34 | $/Kg |
| Fertilizer Cost | 24.3 | 24.3 | $/da |
| Total Fertilizing Cost | 31.3 | 31.3 | $/da |
| | **TM** | | |
| Cost per unit | 0.34 | 0.40 | $/Kg |
| Fertilizer Cost | 27.85 | 29.55 | $/da |
| Total Fertilizing Cost | 42.85 | 41.55 | $/da |

**Table 7. Economic Analysis**

The fertilizer costs between the methods are clearly shown in Table 7. AM method is calculated as the most economical method according to TM method. AA has proven to be a reliable and cost effective source of N (Wyckoff,2009). According to the AM method TM method, 11.55 $ in the first year and 13.25 $ in the second year of the experiments are more economically calculated.

## CONCLUSIONS

The results show that, the AM method is primarily an environmentally friendly method. It has much more advantages in terms of yield and yield parameters and fertilizing costs than the TM method. On the other hand, while nitrogen fertilization in AM method is done once, in TM method are done 3 times. This situation are to cause more field fur and more fuel use and it causes the emission of harmful gases to the environment. As a result; The use of anhydrous ammonia has been identified as a method to be recommended in terms of environmental factors, yield factors and economic factors in nitrogen fertilizer applications.

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