

EFFECT OF ANHYDROUS-AMMONIA INJECTION ON PLANT AND SOIL MICRO-ORGANISMS BIOLOGICAL ACTIVITIES

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ABSTRACT

Agricultural practices such as seedbed preparation systems and fertilization especially Anhydrous-Ammonia had a great impact on plant and soil microbial community which were sensitive indicators of changes in soil. A field experiment was carried out at the research farm of Rice Mechanization Center (RMC), Meet El-Deyba, Kafr El-Sheikh Governorate, during growing the winter wheat season 2015-2016 to study the interaction effect of anhydrous-ammonia injection and seedbed preparation systems on wheat growth/yield and soil micro-organisms biological activities. Anhydrous-Ammonia was injected in soil with two levels, of 75 Kg N/fed (A.A.1), and 94 Kg N/fed (A.A.2) which represent 100% and 125% of nitrogen recommended dose and granulated urea, (control) 46.5% at three doses according to agronomy recommendations. While, the applied seedbed preparation systems were Heavy system, HS (Moldboard plough one pass followed by Chisel plough twice and laser leveling), Moderate system, MS (Chisel plough one pass followed by Rotary twice and laser leveling) and Conventional system, CS (Chisel plough twice and wooden leveling). However, the used different wheat cultivars were Gemmiza 11 and Shandweel. Soil micro-organism biological activity, wheat plant growth activity and wheat yield and its components were measured and determined to realize the objective of this investigation. The Soil micro-organism biological activity and wheat plant growth activity were done at different three times of 4 days, 1 month after Anhydrous-Ammonia injection and after wheat crop harvesting. The obtained results indicated that:

- The population and activity of soil micro-organisms increased as the length of time increased compared with applied Urea fertilizer. Approximately, one month after A.A.1 injection, the populations of a*

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bacterial group were increased by an average of 57.8 and 58.6% while, the fungi group was increased by an average of 53.5 and 55.2% compared with 65.1 and 66.0% for actinomycetes group during growing Gemmiza 11 and Shandweel wheat cultivars, respectively.

- *Using MS seedbed preparation system gave the highest values of the total grain yield of 18.5, 29.6 and 24.1 Ardb/Fed. were obtained for Gemmiza wheat cultivars compared with 17, 24.8 and 20.3 Ardb/Fed. for Shandweel wheat cultivars under applied fertilizer levels of Urea, A.A.1 and A.A.2, respectively.*
- *Finally, from mentioned above and analyses of yield and its components, the authors recommended the wheat farmers in Egypt using MS seedbed preparation system and applied fertilizer level A.A.1 to get high wheat yield and maintain the soil in a good biological state.*

1. INTRODUCTION

Across recent decades many of the scientific literature reported that the plant roots grow in a complex environment containing billions of soil organisms, such as bacteria and fungi. Most of the mineral fertilizers which added to soil consist of concentrated soluble nutrients that will impact short-term microbial activity. Soil biological processes are responsible for supplying approximately 65% of the available phosphorus in the soil and 75% of the plant available nitrogen. They play a crucial role in promoting plant health, water dynamics and maintaining an adequate supply of plant nutrients for crop growth. Some of the processes soil organisms contribute to nutrient retention, nutrient cycling, water-holding capacity and water infiltration, degradation of pollutants, and disease suppression. They also increase the biological diversity of the soil and improve soil structure. Like all organisms, there are many factors had impacts on soil environment or food sources of soil microorganisms such as time of adding fertilizers, soil temperature, soil pH, a prevalence of food source and other factors such as time between fertilizer patches, rate, formulation of fertilizer, and depth of adding fertilizer to soil. The biological parameters have great value as early and sensitive indicators due to changes in soil properties by different management strategies such

as tillage and fertilization. The number of populations of microorganisms in soil was significantly higher under reduced tillage with average percentage ranged from 20 to 30 % than under conventional tillage in both depths ranges 0-15 and 15-30 cm. **(Buunemann and Mc Neil 2004; Mijangos et al., 2005; Gajda (2008); Lupway et al., 2010; Benke et al., 2012; Coyne and Mikkelsen, 2015).**

One of the main targets of the conservation tillage systems is to ensure that organic matter accumulates near the soil surface due to maintain crop residue on the soil. The accumulation of organic matter providing the microbes with energy in the form of carbon compounds and increases soil microbial activity. However, the microbial activity tends to be slower in conservation tillage systems than that obtained into the soil by conventional tillage. In addition tillage collapses the pores and changes the water holding, gas, and nutrient exchange capacity of the soil. Reducing soil disturbance increases the diversity and population of soil organisms. These soils release nutrients gradually and have better soil structure than full width tillage systems **(The Pennsylvania State University Annual Brochure, 1996)**.

The interaction of tillage and N rate of two N sources had a significant effect on plant P and N uptake, especially at the early growth stages with both N sources. Moreover, the less disturbing tillage systems enhanced to increase about 15-40% in the soil biological activity, on average, than conventional tillage system. Microbial biomass N and C content, activity of dehydrogenase and arylsulfatase, fluorescein diacetate hydrolysis and microbial respiration rate are considered as an useful indicators of soil quality and sensitivity parameters of soil biological activity to tillage applied in monitoring all conditions alter soil environment **(Al-Kaisi and Kwaw-Mensah, 2007; Gajda et al., 2013)**.

Many researchers studied the importance of nitrogen fertilizer for plants and its interaction effects between soil micro-organisms activities and plant growth. Its results concluded that the nitrate NO_3 and ammonium NH_4 are the main inorganic nitrogen sources taken up by roots of higher plants. Upon uptake, NO_3 can be reduced either within the shoot or root and excess amounts can be stored in different plant tissues like vacuoles. Because of its toxicity effects on crops when taken up in large amounts,

NH_4 is normally assimilated within the roots. Crops fertilized by NH_4 should be capable of regulating both external and internal acidic pH to avoid 'ammonia syndrome' resulting from ionic imbalances. However, mixed N nutrition occurring in the presence of both NH_4 and NO_3 is capable of supporting better crop growth than sole application of either N (**Barry et al., 1990; Cramer and Lewis, 1993; Marschner, 1995; Gerendas et al., 1997; Mehrer and Mohr, 1989 and Britto and Kronzucker, 2002**).

Urea and anhydrous ammonia are good N fertilizer sources. The injury of anhydrous ammonia and urea can be reduced by applying with good injection depth, good soil conditions and proper management. **Sawyer (2010)**. The anhydrous ammonia NH_3 (A.A.) is one of the most inexpensive, commercially available N fertilizers. This product is a flammable and toxic alkaline gas that is stored as a liquefied gas. Injection of anhydrous ammonia (A.A.) into soil causes high ammonia concentrations and high pH in the retention zone of ammonia around the point of injection. These conditions might increase erosion and decrease soil productivity because they can cause loss of soil structural stability, hydrolysis of organic C and inhibition of microbial activity. Also, it causes an initial loss of wet aggregate stability in the NH_3 retention zone, but this loss is likely to be recovered when microbial activity resumes (**Miller and Cramer, 2004 and Kumar and Maiti, 2013**).

Inorganic fertilizers had a positive or negative effect on soil microorganisms. Also, those effects on soil microorganisms described as direct or short-term impacts due to contact with inorganic fertilizer however, indirect or long-term effects caused by the chemical changes for the soil environment or food sources of soil microorganisms. A drastic reduction in soil bacteria was shown in soil sampled on the day of application, but the populations did not go to zero. As the length of time increased after application, there was an increase in the bacterial population in comparison with the injection zone that had no A.A. applied in it. Approximately five weeks after ammonia injection, there were no major differences in the bacteria number between the sets of plots, which had either 0 or 100 lb N/A applied. While, the effect A.A. had on soil fungi was a bit more long lasting than with the bacteria. This effect is still

being a net negative effect in the row at 31 days after application (**Gupta, 2016 and Vitosh 2017**).

The wheat yield responses to applied nitrogen (N) were small or negative in a drought but larger (17 kg grain kg⁻¹N fertilizer) in favorable seasons. There was no consistent difference between A.A. and urea effects on yield, grain protein or efficiency of fertilizer-N recovery, and there were no consistent differences arising from banding depth or application time. Anhydrous ammonia and urea caused transient changes in microbial activity and populations within fertilizer bands, but both products had little effect on microbes in the soil between the bands. The longest lasting effect was on microbial diversity, which remained low at 7 months after A.A. banding (**Hosseini and Gooshchi, 2013 and Angus et al., 2014**).

Nowadays, the use of Anhydrous-Ammonia in fertilizing wheat crop was recommended under Egyptian conditions and its application area going to increase year by year. Increasing N levels significantly increased each of spike length, 1000-grain weight and grain and straw yields of wheat plants due to increasing nitrogen level up to 105 kg N/fed (**Abd El-Hameed and Omar, 2006; Mahmoud et al., 2006 and Abdelkhalek et al., 2015**). Therefore, the main target of this investigation is to study the interaction effect of different seedbed preparation systems and anhydrous-ammonia injection on wheat plant growth/yield and soil micro-organisms activities.

2. MATERIALS AND METHODS

2.1. Experimental Field Layout

The experimental field was carried out at the research farm of Rice Mechanization Center (RMC), Meet El-Deyba, Kafr El-Sheikh Governorate during growing the winter wheat season of 2015. The experiment was established as split-split plot design with three factors at three replicates. First factor of seedbed preparation system was assigned to main plots with three levels, the second factor of fertilization was assigned to split plot with three levels however, the third factor was two wheat cultivars (Gemmiza 11 and Shandweel) which were assigned to sub-split plots. The experimental field area was 2.3 Fedden (103m*94m) which were divided into 54 equal plots. The soil mechanical analysis, soil acidity (pH) and electric conductivity (EC) of experimental field were

done in the soil science lab. of the Agricultural Faculty, Kafr El-Sheikh University as shown in the Table (1).

Table (1): Soil mechanical analysis, acidity (pH) and electric conductivity (EC) of experimental field.

Soil depth, cm	Soil mechanical analysis			Soil texture	EC	pH
	Sand,%	Silt, %	Clay,%			
0-20	34.4	18.5	47.1	Clay	3.6	8.77
20-40	40.4	20.5	39.1	Clay		
40-60	47.9	10.5	41.6	Clay		

2.2. Study Parameters:-

The experiment was arranged in split-split plot design as followed.

a- **Main plots** were used for seedbed preparation system as follow:

- **Heavy system, (HS):** Moldboard plough one pass followed by Chisel plough twice and laser leveling,
- **Moderate system, (MS):** Chisel plough one pass followed by Rotary twice and laser leveling,
- **Conventional system, (CS):** Chisel plough twice and wooden leveling.

b- **Sub-main plots** which act Fertilization levels with Anhydrous-Ammonia and urea:

- **Urea-** fertilization with Granulated urea 46.5% at three doses with total 75 kg N/fed,
- **A.A.1-** fertilization with 75 kg N/fed of Anhydrous-Ammonia with 80% Nitrogen,
- **A.A.2-** fertilization with 93.75 kg N/fed of Anhydrous Ammonia with 80% Nitrogen.

c- **Sub-sub plots** which act two wheat cultivars of Gemmiza 11 and Shandweel.

The anhydrous ammonia was injected into the soil after seedbed preparation as well as granule urea was applied with suggested levels mentioned above and creeping using wooden leveler to maintain anhydrous ammonia inside soil. The injected soil was left for 4 days and drilled with recommended rate of wheat grains with both wheat cultivars of (Gemmiza 11 and Shandweel) under study.

2.3. Study Measurements:-

To realize the main objective of this investigation at any given study parameters, three different groups of measurements were done as follows:

1st group: Soil micro-organism biological activity by counting the number of soil bacteria, fungi, and Actinomycetes.

2nd group: Determining the nitrogen content in soil and wheat plant.

3rd group: Wheat yield and its components and harvest index.

The Soil micro-organism biological activity and wheat plant growth activity were done at different three times of 4 days, 1 month after Anhydrous-Ammonia injection and after wheat crop harvesting.

2.3.1. Collection of the soil samples.

Soil sample were taken at three times during wheat growing season. Frist time was immediately after anhydrous ammonia injection or urea applying, second time was after 1 month from planting, and last time was after harvesting time. Three soil samples were randomly collected from different places inside each replicate to give a representative soil samples to a depth of 0–10 cm and mixed together to give a composite sample. After that it were transported to the laboratory. All samples of soils were air-dried at room temperature for 48 h, sieved to <2mm, and stored at room temperature for estimation and microbiological analysis at Sakha Microbiological lab, Soil, Water and Environmental Res. Inst., Kafr El-Sheikh Governorate.

2.3.2. Determination of soil microorganisms activities.

The biological activity of microorganism was assayed by plate count technique using specific media for each group of soil. The total count of microorganisms was determined using soil extract agar for Bactria, Martin's medium for Fungi and Jensen's medium for counting soil actinomycetes (Allen, 1959).

2.3.3. Determination of nitrogen in soil and in plant.

Available nitrogen in soil was extracted by 1.0 M K_2SO_4 and determined by Mg O and devarda alloy using the same collected soil samples for microbiological analysis according to Kjeldahl method **Jackson (1967)**. For determination of nitrogen content in plant materials were digested as described by **Chapman and Pratt (1960)**. The digested materials were distilled by Microkjeldahl method and the nitrogen content (%) of distillate was determined by titration according **Black et al. (1965)**.

2.3.4. Crop yield, its components and crop index

Total obtained grain yield for each variable under study was determined and calculated by kg/Fedden. Also, yield component such as number of

Panicle/m², straw and grain weight, gram/m², panicle length cm, plant length cm, number of grain/panicle and weight of 1000 grain (gram) were measured and calculated for each treatment at harvesting time for two wheat cultivars of (Gemmiza 11 and Shandweel) under study. Also, harvest index for each treatment under study was determined and calculated for two wheat cultivars of Gemmiza 11 and Shandweel under study. Harvest index (HI) used as an indicator for productive efficiency and it is could be defined as the ratio between the total weight of harvested grains and the total weight of biomass yield.

2.4. Data analysis

The results were analyzed using the CoStat Version 6.400 win exe. software program. The treatment means were analyzed using split- split plot for analysis of variance ANOVA and significant differences between the means were determined by the LSD test. The differences were considered statistically significant when $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Soil micro-organism biological activity.

Soil micro-organisms such as bacteria, fungi, actinomycetes and etc. play an important role for transform gaseous nitrogen to biologically available ammonium, which is consider as an important source of nitrogen in soil ecosystems. Therefore, the obtained results of the seedbed preparation systems, Anhydrous Ammonia and Urea fertilization levels and interaction effects between them were summarized and discussed as follows:

a- Bacteria

In general, the obtained results indicated that the highest and the lowest values of bacteria counting in soil were recorded for moderate and conventional seedbed preparation systems (MS and CS), respectively at any given fertilization levels and measuring time as shown in Fig.(1). However, the differences between values of bacteria counting in soil for each seedbed preparation system were found to be very lower at any given fertilization level. Also, the results cleared that the values of bacteria counting in soil were highly decreased when using A.A.1 or A.A.2 instead of urea fertilizer at any given seedbed preparation systems

and measuring time. In other words the Anhydrous-Ammonia Injection to the soil with two applied levels of A.A.1 and A.A.2 decreased the total number of soil bacteria compared with urea application at planting time for any given seedbed preparation systems. However, the second level of A.A.2 was found very toxic for soil bacteria compared with A.A.1 at planting time and at any given seedbed preparation system. After 1 month of planting, the number of total soil bacteria was recovered and highly increased at any applied fertilizer levels and seedbed preparation systems compared with planting time. However when counting the total number of soil bacteria after wheat harvesting was found to be slightly decreased than 1 month after planting and still higher than at planting time.

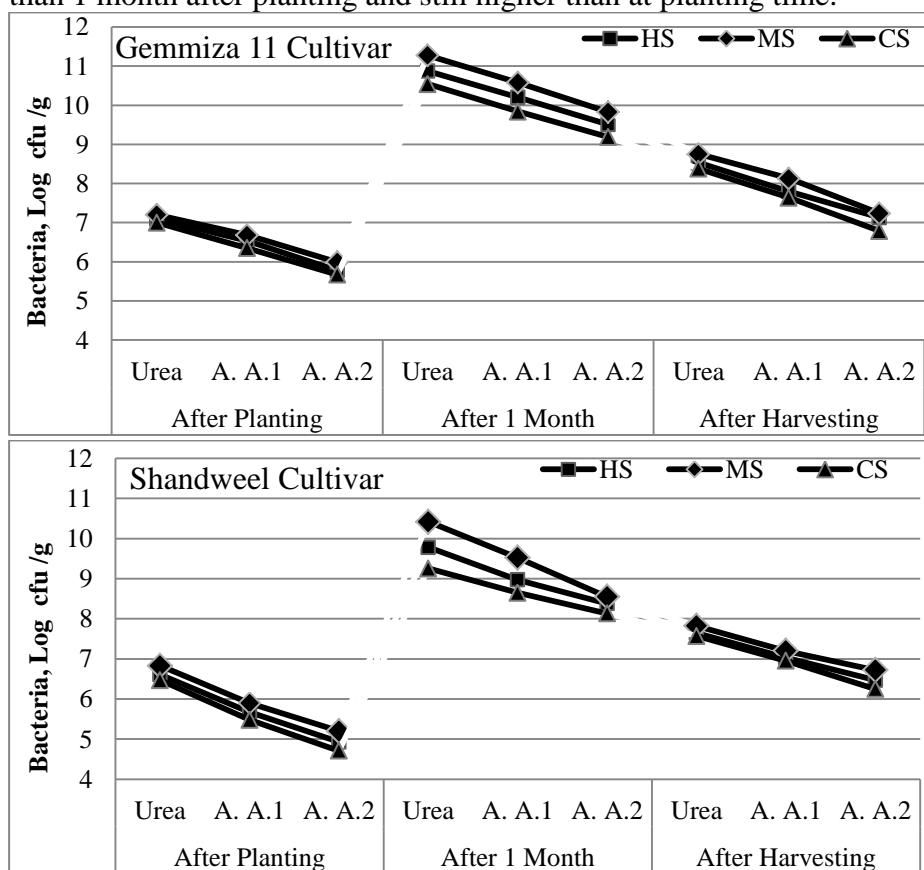


Fig.(1): Effect of different seedbed preparation systems and applied fertilizer levels on total soil bacteria.

The total number of bacteria in soil for urea fertilizer at different seedbed preparation systems HS, MS and CS at planting time were 7.10, 7.20 and

7.00 Log cfu/g compared with A.A.1 fertilizer which gave 6.54, 6.68 and 6.35 Log cfu/g and 5.78, 5.99 and 5.67 Log cfu/g for A.A.2 fertilizer for Gemmiza 11 wheat cultivar, respectively. Also, the results illustrated that the response of Shandweel wheat cultivar was gave the same trends of bacteria counting in soil at any given seedbed preparation systems and applied fertilizer levels under study. However the total number was found to be slightly lower than that obtained for Gemmiza 11 wheat cultivar. The total number of bacteria in soil for urea fertilizer at different seedbed preparation systems HS, MS and CS at planting were 6.61, 6.83 and 6.47 Log cfu/g compared with A.A.1 fertilizer which gave 5.67, 5.90 and 5.48 Log cfu/g and 4.93, 5.20 and 4.71 Log cfu/g for A.A.2 fertilizer respectively, for Shandweel wheat cultivar.

Data analysis results of variance for bacteria counting in soil under different seedbed preparation systems (HS, MS and CS) and applied fertilizer levels of a urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) under study showed that highly significant differences between applied fertilizer levels, significant differences between seedbed preparation systems and no significant differences between interaction between seedbed preparation systems and applied fertilizer levels at probability 5% for bacteria counting in soil at planting. The least significant difference (LSD) value between applied fertilizer levels was 0.082 however, the least significant difference (LSD) value between seedbed preparation systems was 0.203.

However, after 1 month the results cleared highly significant differences between seedbed preparation systems, applied fertilizer levels and its interaction at probability 5% for bacteria counting. The least significant difference (LSD) value for seedbed preparation systems, and applied fertilizer levels were 0.101 and 0.053 respectively, at probability 5%. The statistical analysis of variance after harvesting cleared that there was no significant differences between seedbed preparation systems, highly significant differences between applied fertilizer levels and no significant differences between its interaction. The least significant difference (LSD) value for fertilizer level was 0.071 at probability 5%.

b- Fungi

Fungi represent one component of soil microorganisms which play critical roles in nutrient cycling and soil structure maintenance. The fungi

have several beneficial effects on their host plants, such as support of nutrient uptake, enhanced resistance against drought or root pathogens (Heijden et al., 2015). The results of laboratory assay for counting fungi in soil indicated that the moderate seedbed preparation system, MS gave the highest values comparing with the conventional seedbed preparation system, CS which record the lowest values at any given fertilization levels and measuring time as shown in Fig.(2). However, the differences between values of fungi counting in soil for each seedbed preparation system were found to be very lower at any given fertilization level.

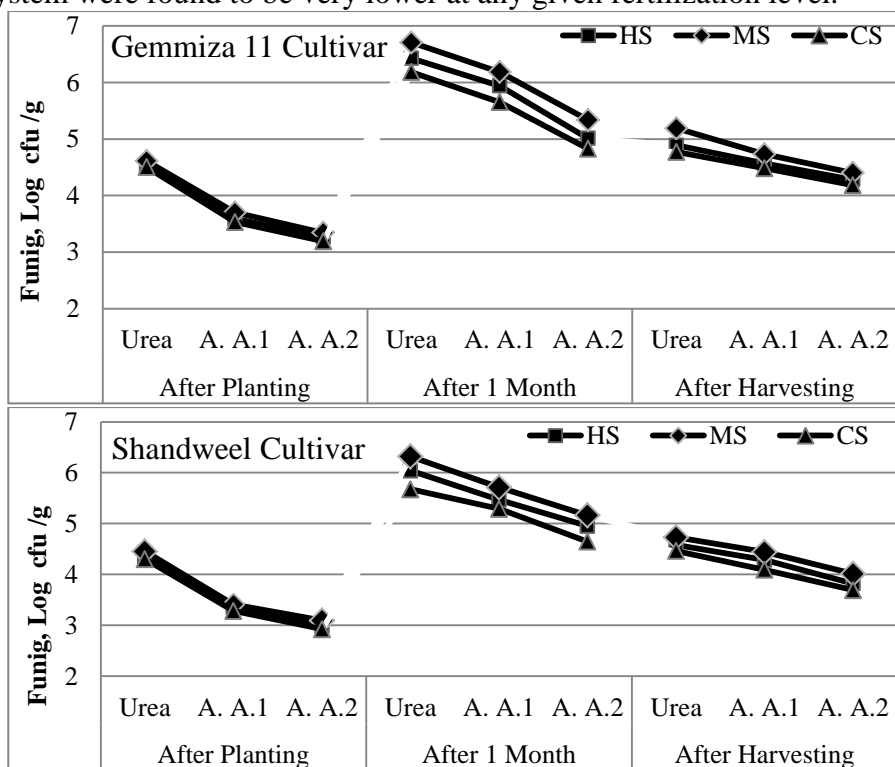


Fig.(2): Effect of different seedbed preparation systems and applied fertilizer levels on the total soil fungi.

As shown of the results illustrated in Fig.(2) it could be cleared that the Anhydrous-Ammonia Injection to the soil with two applied levels of A.A.1 and A.A.2 decreased the total number of soil fungi compared with urea application at planting time for any given seedbed preparation systems. However, the decrement percentage in total soil fungi was

higher with the second level of A.A.2 compared with first level of A.A.1 at planting time and at any given seedbed preparation system. After 1 month of planting the soil fungi was recovered and highly increased under any given seedbed preparation systems and applied fertilizer levels compared with its values at planting time. However when counting the total number of soil fungi after wheat harvesting was found to be slightly decreased than 1 month after planting and still higher than at planting time. The total number of fungi in soil for urea fertilizer at different seedbed preparation systems HS, MS and CS at planting were 4.53, 4.61 and 4.50 Log cfu/g compared with A.A.1 fertilizer which gave 3.59, 3.70 and 3.53 Log cfu/g, while, it were 3.27, 3.37 and 3.19 Log cfu/g for A.A.2 fertilizer, respectively for Gemmiza 11 wheat cultivar.

Also, the results indicated that the response of Shandweel wheat cultivar was gave the same trends of fungi counting in soil at any given seedbed preparation systems and applied fertilizer levels under study. However the total soil fungi number was found to be slightly lower than that obtained for Gemmiza 11 wheat cultivar. The total number of fungi in soil for urea fertilizer at different seedbed preparation systems HS, MS and CS at planting were 4.35, 4.45 and 4.30 Log cfu/g compared with A.A.1 and A.A.2 fertilizer which gave 3.34, 3.41, 3.28, 2.98, 3.09 and 2.92 Log cfu/g respectively, for Shandweel wheat cultivar.

Data analysis results of variance for the total soil fungi under different seedbed preparation systems (HS, MS and CS), applied fertilizer levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them showed that significant differences between seedbed preparation systems, highly significant differences between applied fertilizer levels, and no significant differences between its interaction at probability 5%. The least significant difference (LSD) value between seedbed preparation systems and applied fertilizer levels were 0.059 and 0.046 respectively. However, after 1 month the results cleared significant highly differences between seedbed preparation systems, applied fertilizer levels and no significant differences between its interactions at probability 5%. The least significant difference (LSD) value for seedbed preparation systems, and applied fertilizer levels were 0.0585 and 0.0665 respectively, at probability 5%. Statistical analysis of

variance after harvesting cleared that there was highly significant differences between seedbed preparation systems, applied fertilizer levels and no significant differences between its interactions. The least significant difference (LSD) value for seedbed preparation systems and applied fertilizer levels were 0.071 and 0.046 respectively, at probability 5%.

c- Actinomycetes

The actinomycetes are a group of soil microorganisms which are mineralize organic matter to increase soil fertility and agricultural production. The obtained results indicated that the highest and the lowest values of soil actinomycetes were recorded for moderate and conventional seedbed preparation systems (MS and CS), respectively at any given applied fertilizer levels as shown in Fig.(3). However, the differences between values of soil actinomycetes for each seedbed preparation system were found to be very lower than values obtained between applied fertilizer levels at any given estimation time.

As shown in data illustrated Fig.(3) it could be cleared that the Anhydrous-Ammonia Injection to the soil with two applied levels of A.A.1 and A.A.2 decreased the total number soil actinomycetes compared with urea application at planting time for any given seedbed preparation systems. However, the highest decrement percentages in the total soil actinomycetes were found with the second level of A.A.2 at planting time under any given seedbed preparation system. After 1 month of planting, the soil actinomycetes were recovered and highly increased at any applied fertilizer levels and seedbed preparation systems compared with at planting time. However when counting the total number of soil actinomycetes after wheat harvesting was found to be slightly decreased than 1 month after planting and still higher than at planting time.

The total number of soil actinomycetes when applying urea fertilizer to the soil were 4.31, 4.54 and 4.22 Log cfu/g compared with 3.86, 3.92 and 3.67 Log cfu/g when applying A.A.1, while, it were 3.16, 3.27 and 3.00 Log cfu/g, when applying A.A.2 under different seedbed preparation systems of HS, MS and CS, respectively at planting time for Gemmiza 11 wheat cultivar. Also, the results indicated that the response of Shandweel wheat cultivar was gave the same trends of actinomycetes counting in soil

at any given seedbed preparation systems and applied fertilizer levels under study. However the total fungi number was found to be slightly lower than that obtained for Gemmiza 11 wheat cultivar.

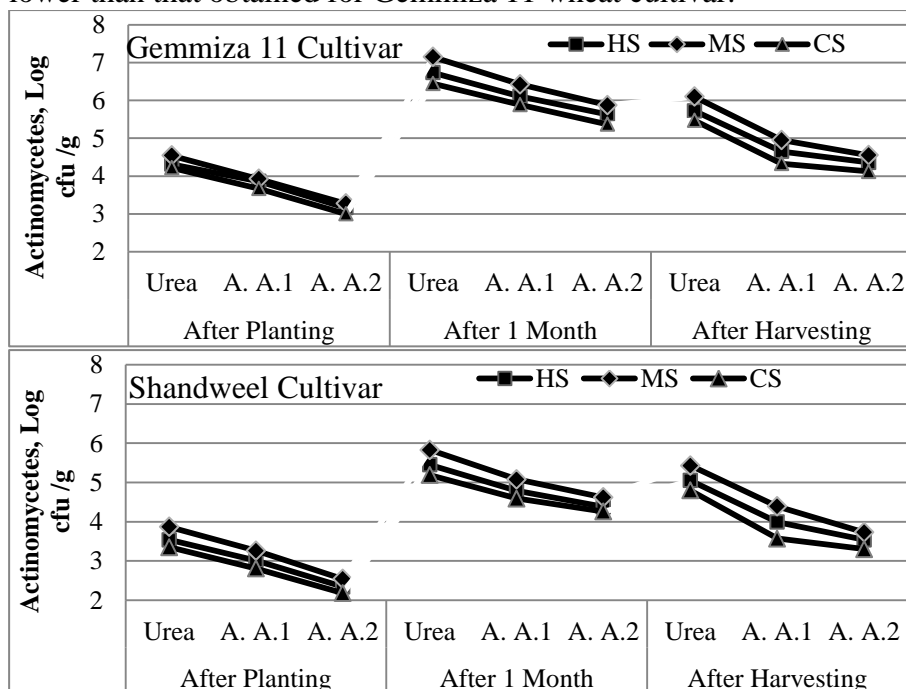


Fig.(3): Effect of different seedbed preparation systems and applied fertilizer levels on total soil actinomycetes.

Data analysis results of variance for soil actinomycetes counting under different seedbed preparation systems (HS, MS and CS), applied fertilizer levels of urea & Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them showed a highly significant differences between applied fertilizer levels, no significant differences between seedbed preparation systems and significant differences between its interaction at probability 5% for soil actinomycetes counting at planting. The least significant difference (LSD) value between applied fertilizer levels and seedbed preparation systems are 0.044 and 0.326 respectively. However, after 1month the results cleared significant differences between seedbed preparation systems, highly significant differences between applied fertilizer levels and highly significant differences between its interactions at probability 5% for soil actinomycetes counting. The least significant difference (LSD) value for applied fertilizer levels and seedbed

preparation systems are 0.211 and 0.428 respectively, at probability 5%. The statistical analysis of variance after harvesting cleared that there was no significant differences between seedbed preparation systems, applied fertilizer levels and its interaction.

3.2. Plant growth activity.

Nitrogen is a basically important element in biologically activity and nutrient cycling processes. It is containing constituents of organic molecules often confer bioactivity to these molecules (**Hossien and Gooshchi, 2013**). Therefore, the nitrogen content in soil and in a wheat plant was taken as indicators for wheat plant growth activity under different seedbed preparation systems (HS, MS and CS), applied fertilizer levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them in this investigation. The obtained results were summarized and discussed as follows:

a- Nitrogen content in soil

In general, the nitrogen content in the soil was highly affected with applied fertilizer levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) after planting directly. The treatments were injected with 93.75 kg N/fed of Anhydrous-Ammonia gave the highest values of the nitrogen content in the soil followed by the treatments were injected with 75kg N/fed of Anhydrous-Ammonia and treatments applied with 75kg N/fed of urea (46.5% N) under any given seedbed preparation systems when estimated after planting directly in this investigation. However, the values of nitrogen content in the soil after 1 month of planting and after harvesting were highly decreased compared with that values after planting directly.

Also, the obtained results illustrated in Fig. (4) indicated that, the moderate seedbed preparation system, MS gave the highest values of nitrogen content in the soil followed by heavy seedbed preparation system, HS and the conventional seedbed preparation system, CS, after planting directly. However, this trend was changed after 1 month of planting and after harvesting. The moderate seedbed preparation system, MS recorded the lowest values of nitrogen content in the soil followed by heavy seedbed preparation system, HS and the conventional seedbed preparation system, CS. However, the differences between values of nitrogen in soil for each

seedbed preparation system were found to be very lower at any given fertilization level. Nitrogen content in soil for Gemmiza 11 wheat cultivar after 1 month of planting under different applied fertilizer levels of urea, A.A.1 and A.A.2 were 14.00, 13.40, and 14.50 ppm respectively, under heavy seedbed preparation system, HS and 21.25, 20.38 and 22.18 ppm respectively, under moderate seedbed preparation system, MS and 32.05, 31.40 and 33.36 ppm respectively, under conventional seedbed preparation system, CS. However, it were, 13.30, 12.90 and 13.56 ppm respectively, under heavy seedbed preparation system, HS and 20.55, 19.75 and 21.20 ppm respectively, under moderate seedbed preparation system, MS and 31.49, 30.99 and 32.27 ppm respectively, under conventional seedbed preparation system, CS for Shandweel wheat cultivar at the same estimation time.

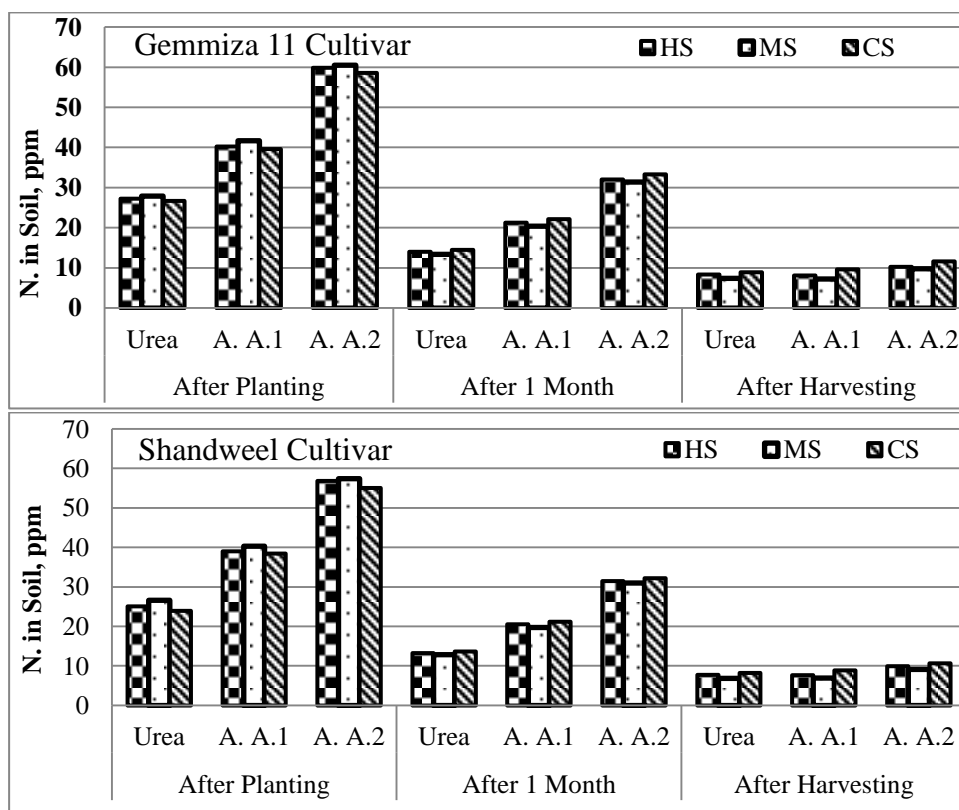


Fig. (4): Effect of different seedbed preparation systems and applied fertilizer levels on nitrogen content in soil.

Data analysis results of variance for nitrogen content in soil under different seedbed preparation systems (HS, MS and CS), applied fertilizer levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them showed highly significant differences between applied fertilizer levels, significant differences between seedbed preparation systems and no significant differences between its interaction at probability 5% after planting directly. The least significant difference (LSD) value between fertilizer levels and seedbed preparation systems were 0.33 and 0.91 respectively. However, after 1 month the results cleared no significant differences between seedbed preparation systems, applied fertilizer levels and its interaction at probability 5%. The statistical analysis of variance for nitrogen in soil after harvesting cleared that there was highly significant differences between seedbed preparation systems, applied fertilizer levels and its interaction. The least significant difference (LSD) value for seedbed preparation systems and fertilizer level were 0.71 and 0.059 respectively, at probability 5%.

b- Nitrogen content in wheat plant.

Laboratory analysis of nitrogen content on plants indicated that the first level of applied fertilizer, urea achieved the lowest values of nitrogen content in plant under any given seedbed preparation system for both two wheat cultivars under study. While, the second level of applied Anhydrous-Ammonia fertilizer recorded the highest values of nitrogen content in plant under any given seedbed preparation system for both two wheat cultivars under study. The seedbed preparation system of MS recorded high values for nitrogen content in plant comparing with seedbed preparation systems of HS and CS under different levels of applied fertilizer for Gemmiza 11 cultivar. However, the seedbed preparation of CS achieved the highest values of nitrogen content in plant comparing with seedbed preparation systems of HS and MS under different levels of fertilizer for Shandweel cultivar due to the Shandweel cultivar voracity of nitrogen which deposited in plant.

The highest value of nitrogen content 0.60% was obtained under seedbed preparation system of MS and applied fertilizer level A.A.2 for wheat cultivar Gemmiza 11 and the lowest value of nitrogen content was 0.25 %

under soil preparation system CS and applied fertilizer level urea for wheat cultivar Shandweel.

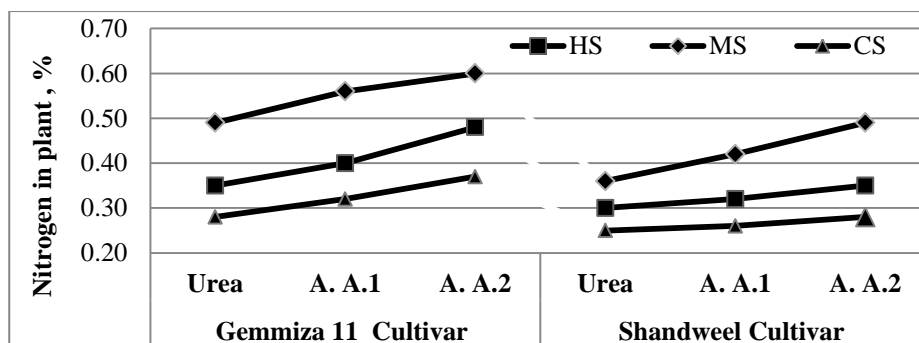


Fig.(5): Effect of different seedbed preparation systems and applied fertilizer levels on nitrogen content in wheat plant.

The statistical analysis results of variance for nitrogen content in plant under different seedbed preparation systems (HS, MS and CS), applied fertilizer levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them showed significant differences between seedbed preparation systems, highly significant differences between applied fertilizer level and its interaction at probability 5%. The least significant difference (LSD) value for fertilizer levels and seedbed preparation systems were 0.012 and 0.102 respectively.

3.3. Crop yield and its components.

The differences in yield components for both wheat cultivars of Gemmiza 11 and Shandweel, Panicle/m², panicle length, cm; plant length, cm; number of grain/panicle, weight of 1000 grain, g; grain weight, g/m²; straw weight, g/m²; and its statistical analysis of variance under different study treatments are listed in Table (2). The obtained data cleared that seedbed preparation system of MS with applied fertilizer level of A.A.1 recorded the highest values of total grain yield 29.6 and 24.8 Ardb/Fed for Gemmiza 11 and Shandweel wheat cultivars, respectively comparing with two other seedbed preparation systems of HS and CS and applied fertilizer levels of Urea and A.A.2. However, the seedbed preparation system of CS under applied fertilizer level of A.A.2 recorded the lowest values of total grain yield 13.7 and 12.4 Ardb/Fed for Gemmiza 11 and Shandweel wheat cultivars, respectively comparing with two other

seedbed preparation systems of HS and MS and applied fertilizer levels of Urea and A.A.1.

Table (2): Total grain yield and its component for Gemmiza 11 and Shandweel wheat cultivars.

Gemmiza 11 wheat cultivar											
System	Fertilizer levels	Panicles Number/m ²	Panicle length, cm	Number of grain /pencil	Weight of 1000 grains, g	Grain weight, g./m ²	Plant length, cm	Straw weigh, g./m ²	Straw &rain weight, g./m ²	Total yield Ardb/Fed	Harvest Index
HS	Urea	172	14.20	65.43	48.66	547.6	97.3	755.3	1302.9	15.3	0.42
	A.A.1	187	16.03	82.70	55.71	861.5	100.9	786.2	1647.7	24.1	0.52
	A.A.2	198	15.74	71.50	50.26	711.5	102.5	911.5	1623.0	19.9	0.44
MS	Urea	177	14.38	74.20	50.31	660.7	98.9	812.6	1473.3	18.5	0.45
	A.A.1	190	16.56	98.30	56.61	1057.3	101.7	882.4	1939.7	29.6	0.55
	A.A.2	205	16.34	77.30	54.39	861.9	106.5	1021.2	1883.1	24.1	0.46
CS	Urea	170	13.50	64.00	44.91	488.6	95.4	729.4	1218.0	13.7	0.40
	A.A.1	180	15.90	82.30	54.26	803.8	94.2	753.6	1557.4	22.5	0.52
	A.A.2	189	15.06	70.50	48.08	640.6	101.9	891.8	1532.4	17.9	0.42
Shandweel wheat cultivar											
HS	Urea	170	11.7	70.3	40.81	487.7	77.1	759.1	1246.8	13.7	0.39
	A.A.1	189	13.9	78.1	48.06	709.4	94.5	865.6	1575.0	19.9	0.45
	A.A.2	201	13.2	73.5	42.02	620.8	93.9	897.7	1518.5	17.4	0.41
MS	Urea	179	12.1	79.1	42.91	607.6	86.1	821.5	1429.1	17.0	0.43
	A.A.1	197	14.14	85.3	52.76	886.6	94.9	990	1876.6	24.8	0.47
	A.A.2	204	13.5	77.5	45.91	725.8	95.1	1077	1802.8	20.3	0.40
CS	Urea	160	11.6	70.5	39.31	443.4	76.1	720	1163.4	12.4	0.38
	A.A.1	179	13.7	75.7	45.11	611.3	94.2	770	1381.3	17.1	0.44
	A.A.2	193	13.1	71.5	40.61	560.4	94.1	810	1370.4	15.7	0.41
Seedbed prep. system	*	ns	*	*	**	ns	ns	**	*	ns	
Fertilizer levels	***	***	***	***	***	***	***	***	***	***	
Cultivars	ns	**	ns	**	**	**	ns	*	*	*	
SB.P.S* F.L.	ns	ns	ns	*	**	ns	***	***	*	***	
LSD for SB.P.S	8.197	0.751	5.657	2.053	30.028	4.11	0.775	102.83	2.269	0.033	
LSD for F.L.	1.84	0.125	2.038	0.543	19.511	2.27	0.076	13.151	0.753	0.019	
LSD for cultivars	-	0.613	-	1.676	24.518	-	-	88.86	1.853	0.027	

In regards of yield components for Gemmiza 11 wheat cultivar, the results summarized in Table (2) indicated that the Seedbed preparation of

MS with applied fertilizer level of A.A.1 recorded the highest values for panicles number/m²; number of grains/panicle; weight of 1000 grain, panicle length; grains weight/m²; plant length and straw weight/m² in comparison with two others seedbed preparation systems of HS and CS and applied fertilizer levels of Urea and A.A.2.

However, the Seedbed preparation of CS with applied fertilizer level of A.A.2 recorded the lowest values for panicles number/m²; number of grains/panicle; weight of 1000 grain, panicle length; grains weight/m²; plant length and straw weight/m² in comparison with two others seedbed preparation systems of HS and MS and applied fertilizer levels of Urea and A.A.1. The same trends of yield components results were obtained for Shandweel wheat cultivar, however these values were found to be lower than that obtained for Gemmiza 11 wheat cultivar.

3.4. Harvest index

The obtained results of harvest index are illustrated in Fig.(6) and cleared that the Gemmiza 11 wheat cultivar achieved the highest value of harvest index (0.55) comparing with that obtained for Shandweel wheat cultivar (0.47) under MS seedbed preparation system and A.A.1 applied fertilizer level. However, the lowest values of harvest index were 0.39 and 0.38 for Gemmiza 11 and Shandweel wheat cultivars, respectively under CS seedbed preparation system and Urea applied fertilizer level.

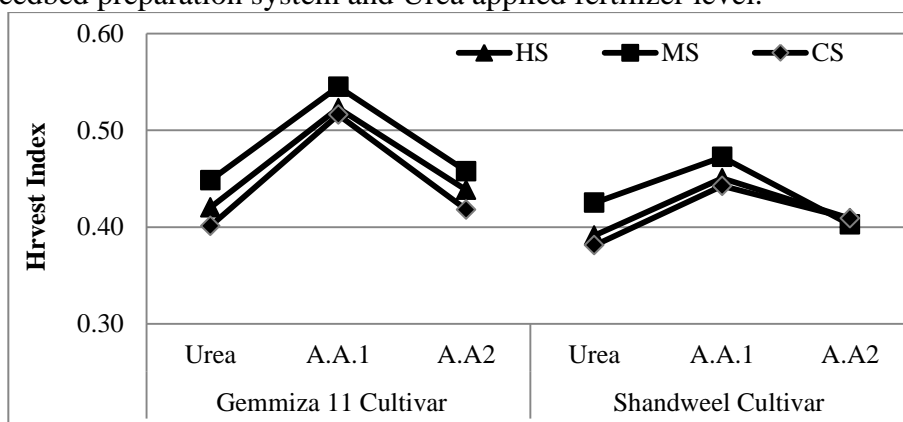


Fig. 6: Effect of different seedbed preparation systems and applied fertilizer levels on wheat crop index.

The statistical analysis results of variance for harvest index under different seedbed preparation systems (HS, MS and CS), applied fertilizer

levels of urea and Anhydrous-Ammonia (Urea, A.A.1 and A.A.2) and the interaction between them showed no significant differences between seedbed preparation systems, highly significant differences between fertilizer level and its interaction at probability 5%. The least significant difference (LSD) value for fertilizer levels and seedbed preparation systems were 0.019 and 0.033 respectively.

CONCLUSIONS AND RECOMMENDATIONS

From the previous results and discussion it could be concluded that:

- The obtained results indicated that there is a significant defect on the population and activity of soil micro-organisms after directly injection of Anhydrous-Ammonia to the soil, especially in the retention zone of ammonia around the point of injection. However the population of soil micro-organisms did not go to zero and this effect was found to be more lower with A. A.1 than that obtained with A. A.2 under any given seedbed preparation system and wheat cultivars.
- Applying MS seedbed preparation system improve the soil conditions which rapidly helped the population and biological activity of soil micro-organisms to recover and increase than that obtained with other two seedbed preparation systems using any given applied fertilizer levels and wheat cultivars under study.
- The population and activity of soil micro-organisms increased as the length of time increased compared with applied Urea fertilizer. Approximately, one month after A.A.1 injection, the populations of bacterial group were increased by an average of 57.8 and 58.6% while, the fungi group was increased by an average of 53.5 and 55.2% compared with 65.1 and 66.0% for actinomycetes group during growing Gemmiza 11 and Shandweel wheat cultivars, respectively.
- The highest values of nitrogen content were recorded in the soil under MS seedbed preparation system and applied fertilizer level of A.A.1 for both wheat cultivars under study.
- Using MS seedbed preparation system and applied fertilizer level of A.A.1 gave the highest values of the total grain yield of 18.5, 29.6 and 24.1 Ardb/Fed were obtained for Gemmiza wheat cultivars compared with 17, 24.8 and 20.3 Ardb/Fed. for Shandweel wheat cultivars under applied fertilizer levels of Urea, A.A.1 and A.A.2, respectively.

- Finally, from all points mentioned above and analyses of yield and its components, the author recommended the wheat farmers in Egypt using MS seedbed preparation system and applied fertilizer level A.A.1 to get high wheat yield and maintain the soil in a good biological state.

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الملخص العربي

تأثير حقن الأمونيا السائلة علي النشاط الحيوي للنبات والكائنات الحية الدقيقة بالتربة

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يعتبر مجتمع الكائنات الحية بالتربة مؤشرا حيويا يعكس مدى التغيرات والتحوللات التي تحدث بالتربة وتتأثر بشكل مباشر بالممارسات الزراعية مثل نظم إعداد مهد البذرة و التسميد و خاصة حقن الأمونيا السائلة التي انتشر استخدامها في مصر في الآونة الأخيرة بشكل واضح وعلی المستوى التطبيقي. ولهذا كان الهدف العام من هذا الدراسة هو تقدير تأثير حقن الأمونيا السائلة علي النشاط الحيوي للنبات والكائنات الحية الدقيقة بالتربة تحت نظم إعداد مهد البذرة ومعدلات إضافة من الأمونيا السائلة مقارنة بتطبيق الأسمدة التقليدية بجرعاتها الموصي بها مثل اليوريا. أجريت هذه الدراسة بالمزرعة البحتة بمركز ميكنة الأرز- ميت الديبة (فرع معهد بحوث الهندسة الزراعية بكفر الشيخ) خلال الموسم الشتوي ٢٠١٥-٢٠١٦ لزراعة صنف الفصح جمانة ١١ و شندويل. في هذه التجربة تم استخدام ثلاث نظم لإعداد مهد البذرة (لخدمة التربة) وهي:

- ١- نظام الخدمة الثقيلة (وجه بمحراث قلاب + وجه بمحراث حفار + تسوية بالليزر)
 - ٢- نظام الخدمة المتوسطة (وجهين بمحراث حفار + وجه بمحراث دوراني + تسوية بالليزر)
 - ٣- نظام الخدمة التقليدي (وجهين بمحراث حفار + تسوية عادية بالزحافة الخشبية)
 - ٤- تطبيق ثلاث مستويات من التسميد النتروجيني وهي حقن التربة بالأمونيا السائلة بمعدل ٧٥ كجم نيتروجين/ف (A. A. 1) و ٩٥ كجم نيتروجين/ف (A. A. 2) وإضافة اليوريا المحببة ٤٦.٥% على ثلاثة دفعات طبقا للتوصيات الزراعية في هذا الشأن.
- ولتقييم تأثير تلك العوامل والتفاعلات بينها في المعاملات تحت الدراسة تم تقسيم مؤشرات الدراسة على ثلاث مجموعات من القياسات وهي:-
- دراسة التأثير المباشر على عدد الكائنات الحية بالتربة كمؤشر للنشاط الحيوي بالتربة بواسطة العد البكتيري ، والعد الفطري، والعد للاكتينيات معمليا لعينات التربة.
 - تقدير نسبة النتروجين في التربة والنبات.

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- تقدير الإنتاجية الكلية للمحصول، مكونات المحصول ودليل الحصاد كمؤشر للتأثير المباشر على النشاط الحيوي للنبات . وقد تم إجراء هذه القياسات على ثلاثة فترات زمنية مختلفة هي:
- ١- عند الزراعة (بعد حقن الأمونيا ب ٤ أيام) ٢- بعد شهر واحد من الزراعة ٣- بعد الحصاد مباشرة . وقد أوضحت النتائج المتحصل عليها ما يلي :-
- يزداد تعداد ونشاط الكائنات الحية بالتربة بزيادة طول الوقت بعد حقن الأمونيا مقارنة باليوربا فيعد شهر من حقن الأمونيا بالمستوي A.A.1 كانت متوسط نسبة زيادة أعداد البكتريا بالتربة ٥٧.٨ ، ٥٨.٦% فى حين كانت متوسط نسبة زيادة أعداد الفطريات بالتربة ٥٣.٢ ، ٥٥.٢% مقارنة بمتوسط زيادة أعداد الاكتينيات بالتربة ٦٥.١ ، ٦٦% أثناء نمو صنفى قمح مميزة ١١ و شندويل على الترتيب .
- استخدم نظام إعداد مهد البذرة المتوسط أعطي أعلى قيم لمتوسط إنتاج المحصول ب ١٨.٥ ، ٢٩.٦ ، ٢٤.١ أردب للقدان لصنف القمح مميزة ١١ مقارنة ب ١٧ ، ٢٤.٨ و ٢٠.٣% لصنف قمح شندويل تحت تطبيق مستويات التسميد اليوريا المحببة ٤٦.٥% وحقن الأمونيا بمستويين A.A.1 و A.A.2 على الترتيب.
- ومما ذكر بعالية و من تحليل نتائج المحصول و مكوناته يوصى المؤلفون مزارعي القمح بمصر باستخدام نظام الخدمة المتوسط لإعداد مهد البذرة ومستوي التسميد الثاني من حقن الأمونيا للحصول على أعلى إنتاجية من القمح وفى نفس الوقت المحافظة على التربة في حالة بيولوجية جيدة