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استجابة نباتات القمح النامية في أرض رملية حديثة الاستصلاح للتسميد الحيوى والعضوى والمعدنى

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الملخص العربي

أقيمت تجربة حقلية في مركز جنوب التحرير . محافظة البحيرة . مصر خلال الموسمين الزراعيين الشتويين ٢٠٠٨/٢٠٠٩ ، ٢٠٠٩/٢٠١٠ بهدف دراسة استجابة نبات القمح للتسميد الحيوي (بدون تلقيح والتلقيح بخليط من البكتريا المثبتة للنتروجين والبكتريا المذيبة للفوسفات) ومعدلات من سماد المزرعة (صفر ، ١٥ ، ٣٠ م٣/فدان) وكذلك التسميد المعدني لكل من النتروجين والفوسفور بمستويات صفر ، $N_{30}P_{15}$, $N_{60}P_{30}$, $N_{90}P_{45}$ كجم/فدان والتفاعل بينهما على نمو وإنتاج محصول القمح ومكوناته والكمية الممتصة من النتروجين والفوسفور والبوتاسيوم بواسطة الحبوب والقش وكذلك محتوى الحبوب من البروتين .

ويمكن إيجاز النتائج المتحصل عليها فيما يلى :

- أدى التلقيح بالمخصب الحيوي إلى زيادة معنوية في محصول الحبوب والقش وكذلك مكونات المحصول بالإضافة إلى زيادة محتوى الحبوب من النتروجين والفوسفور والبوتاسيوم وكذلك محتوى الحبوب من البروتين وذلك مقارنة بالكنترول (بدون تلقيح).
- كانت هناك استجابة معنوية لمحصولي الحبوب والقش لنبات القمح وكذلك محتواهما العنصري من النتروجين والفوسفور والبوتاسيوم وكذلك محتوى الحبوب من البروتين لإضافة السماد العضوي وكانت الزيادة متدرجة مع زيادة معدلات الإضافة.
- أدت إضافة التسميد المعدني من عنصري النتروجين والفوسفور إلى زيادة معنوية في المحصول ومكوناته وتحققت أفضل النتائج مع المستوى الأعلى من الإضافة .

- حقق التفاعل بين التسميد الحيوي ومعدلات التسميد العضوي وكذلك المعدني زيادة معنوية في المحصول ومكوناته وكذلك الكمية الممتصة من النتروجين والفوسفور والبوتاسيوم ومحتوى الحبوب من البروتين .
- أظهرت النتائج أن إضافة ٦٠ كجم نتروجين و ٣٠ كجم فوسفور مع التسميد الحيوي أعطى نتائج أفضل من التي تم الحصول عليها عند إضافة المستوى الأعلى من التسميد المعدني (٩٠ كجم نتروجين + ٤٥ كجم فوسفور) بدون التسميد الحيوي . لذلك فإن التوصية باستخدام التسميد الحيوي والمعدني معا تؤدى إلى التقليل من الكمية المستخدمة من السماد المعدني وبالتالي تجنب التلوث البيئي الذي تحدثه الإضافة الزائدة من التسميد المعدني .
- أدت إضافة السماد العضوي إلى تحسين خواص التربة حيث انخفضت قيم pH التربة بينما زاد محتوى التربة من المادة العضوية وعناصر النتروجين والفوسفور والبوتاسيوم وتحققت أفضل النتائج مع المستوى الأعلى من الإضافة.

ومن هذه النتائج يمكن القول أنه يمكن زيادة محصول القمح تحت ظروف الأرض الرملية وذلك بتلقيح الحبوب بالمخصب الحيوي وإضافة ٣٠ متر مكعب من سماد المزرعة مع إضافة خليط من التسميد المعدني لكل من النتروجين والفوسفور .

RESPONSE OF WHEAT PLANTS GROWING ON NEWLY RECLAIMED SANDY SOIL TO BIO, ORGANIC AND MINERAL FERTILIZERS

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ABSTRACT: ***A field experiment was carried out at South-Tahrir Sector, Al-Behira Governorate, Egypt, during the two growing successive winter seasons of 2008/2009 and 2009/2010 to study the effect of bio, organic and mineral fertilization applied individually or combined on wheat growth, yield and its attributes as well as NPK uptake by wheat grain and straw, grain protein content and on some chemical properties and availability of N, P and K of the tested soil. Biofertilization treatments were without inoculation and inoculation with a mixture of non-symbiotic N fixing and phosphate dissolving bacteria, three rates of farmyard manure (FYM) (0, 15 and 30*** m^3***/fed) and four mineral NP-fertilizers levels (NoPo,*** $M_{30}P_{15}$, $N_{60}P_{30}$ ***and*** $N_{90}P_{45}$ ***kg/fed) and their interaction. A split split plot design with three replicates was used. The obtained results could be summarized as follow:***

1- Grain inoculation with the bio-fertilizer resulted in a significant increases in wheat grain and straw yields and its attributes as well as N, P and K uptake by both grains and straw and grain protein content as compared with the uninoculated treatment.

2- Grain and straw yields of wheat as well as their NPK contents and grain protein content significantly augemented by the application of FYM. Increasing the FYM rate gradually increased the quantity and quality of wheat yield.

3- Application of mineral NP-fertilizers led to significant increase of all studied characteristics. The high level of NP fertilizer gave the highest increments for all the plant parameters.

4- Application of bio-fertilizer, FYM and mineral NP-fertilizers in combination at the highest rates gave the better nutritive content compared with the control.

5- Different application of FYM improved the soil properties, where reduced soil pH and increased organic matter content and availability of NPK, especially at high application rate. However, bio-fertilizer and mineral NP fertilizers had a little effect.

6- Application of NP fertilizers at level $N_{60}P_{30}$ kg/fed with bio-fertilizer gave the results better than those obtained when plants were fertilized by the high level ($N_{90}P_{45}$ kg/fed) alone without biofertilizer. So, it could be recommended that, addition of bio-fertilizer had binficial influence on reducing the amounts of NP fertilizer must be used.

7- It could be concoluded that, inoculation of wheat grains with a mixture of N fixing and phosphate dissolving bacteria, application of 30 m^3FYM/fed as well as $N_{90}P_{45}$ kg/fed was the best formula for achieving the best and high quality of wheat yield.

Key Words*: Bio-fertilizer, Inoculation, FYM, Mineral fertilizers, Wheat plant, Available nutrients.*

INTRODUCTION

The newly reclaimed soils in Egypt such as sandy and sandy calcareous soils, are characterized by poor in their fertility, organic matter and plant nutrients beside they have inadequate water retention. The productivity for different crops was lower .

Soil management practices of sandy soils are usually carried out through addition of natural organic or mineral soil amendments that have became one of the most important practices for improving physical, chemical and biological properties as well as fertility status of these soils.

Application of biofertilizer is considered today as a promising alternative for mineral fertilizers and supports an effective tool for desert development under less polluted environments, decreasing agricultural costs, maximizing crop yield due to proving them with an available source and growth promoting substances (Hegazi *et al.,* 1998 and Amer, *et al.,* 2002). Seed inoculation of wheat verities with phosphate solubilizing and phytohormone-produced by a chroococcum showed a better response overe the control. Nitrogen fixing bacteria are useful organisms commercially because of their agricultural applications as inoculants (Peix, *et al.,* 2001).

Several free-living bacteria species can fix atmospheric nitrogen such as Azotobacter and Azospirillum. In this concern, Ahmed (1995) reported that wheat grains inoculated with Azotobacter and Azospirillum resulted in increases in plant height, percentage of fruitful tillers, number of spikes, weight of spikes and grain yield/plant. El-Sebasy and Abd El-Maaboud (2003) reported that, inoculation of wheat grains with Azotobacter and Azospirillum significantly increased grain yield and nitrogen uptake. Safwat *et al.,* (2001) mentioned that, inoculation of wheat by Azospirillum increased total yield and yield components. Ibrahim *et al.,* (2005) suggested that, the importance or the superiority of the applied N-biofixation was not only taken as a criterion for increasing the income for crop or rationalize of costly mineral N-fertilizers, but also for minimizing the possibly adverse effects on both human thealth and environmental risks resulted from mineral N-fertilizers.

Appling phosphate bio-fertilizers to soil increased soluble phosphate, plant growth, dry matter, protein and N and P contents of maize plants (El-Sawah *et al.,* 1995). Sherif *et al.,* (1997) pointed out that, phosphate dissolving bacteria presses the ability to bring insoluble phosphate to be in soluble forms secreting organic acids such as formic, acetic and lactic acids. Such acids lower the pH and bring about the dissolution of bonds forms of phosphate and render them available for growing plants.

Also, Ashour (1998) added that, the promoting effect of bio-fertilizer is due to the active bacteria in phosphorein which is capable of transforming the tri-calcium phosphate to mono-calcium phosphate. Nassar *et al.,* (2000) pointed out that, plant growth, seed and straw yields as well as N, P and K contents in various organs of faba bean plants were highly significantly increased with seed inoculation with phosphate dissolving bacteria (PDB).

It is known that, organic matter application to soil improves soil properties and consequently the plant growth. Among the types of organic matter, farmyard manure could be one the most economical ways to increase organic matter content in soil. Khalil *et al.,* (2000) indicated that the application of FYM increased plant growth and dry matter production.

Organic fertilizers considered as an important source of humus, macro and microelements carrier and at the same time increase the activity of the usefull microorganisms (El-Gizy, 1994). Dahdouh *et al.,* (1999) found that, organic manures play an important role in nutrients solubility which activate physiological and biochemical processes in plant leading to increase the plant growth and nutrients uptake.

Nitragen is one of the major nutrients for various plants especially wheat and other cereals as sake of producing the economic yield. Its essential role may by attributed one or all these reasons:

1- Nitrogen is constituent of all proteins and nucleic acids and hence of all protoplasm (Russell, 1973).

2- Nitrogen enhances the meristematic activities concequently, increasing the cell size that manifested in internode elongation (Osman *et al.,* 2000).

3- Nitrogen increases the nutrients uptake capacity of photosynthesis assimilation in building metabolits, its translocation and accumulation in the sink (Fathi *et al.,* 2003 and Nassar *et al.,* 2004).

Next to nitrogen, phosphorus is a vital nutrient for plants and microorganisms, where it is present in all living cells, utilized by plants to form nucleic acids (DNA and RNA), exerts a very important role in energy storage and transfer in the plant through energy rich linkages (ADP and ATP) and play a fundamental role in large number of enzymatic reactions that depend on phosphorylation. Hence, P stimulates early growth, strong root formation, nodulation and fruit setting; hastens maturity and promotes seed and protein yields of legumes (Nassar, 2005).

Wheat is the most important cereal crop in Egypt. Increasing its production is essential national target to fill the gab between production and consumption. Therefore, several attempt were carried out to increase its total production. This goal could be achived by growing more productive cultivars and improving the agronomic factors.

The objective of the present work is to study the impact of bio and organic fertilizers individually or in combination with NP mineral fertilizers on some chemical properties of newly cultivated sandy soil and its production of wheat plant.

MATERIALS AND METHODS

A field experiment was carried out at South-Tahrir Sector, Al-Behira Governorate Egypt, during the two growing successive winter seasons of 2008/2009 and 2009/2010 under sprinkler irrigation system to investigate the response of wheat plants growing on sandy soil to bio, organic and mineral fertilizers. The experiment included 24 treatments which were arranged in a split-split plot design with three replicates. The main plots were occoupied by two treatments of bio-fertilizers (BF), with and without addition. The sub main plots were organic manure (FYM) which applied at the rates of 0, 15 and 30 m^3/fed. The sub sub plots were NP fertilizer levels which were applied at the rates of (NoPo, $N_{30}P_{15}$, $N_{60}P_{30}$ and $N_{90}P_{45}$ kg/fed). The plot area was 10.5m^3.

The plots were sown by grains of wheat cv. Sakha, 93 at 15 and 17 November in the two seasons. Wheat grains, just before planting, were inoculated with a mixture of a non-symbiotic N fixing (Azospirillum Lipoforum and Polyxmo) which called cerialine and phosphate dissolving bacteria (Bacillus megatherium), which called phospharine. Coating of wheat grains were conducted as recommended by Ministry of Agricultural, Giza, Egypt. Both ceria line and phospharine are produced by Bio-fertilizers Unit, General Organization of Agriculture Equalization Fund. Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

Nitrogen fertilizer in the form of ammonium sulphate (20.6% N) was applied at the rate of 0, 30, 60 and 90 kg N/fed in two equal doses before the first and second irrigations in both seasons. Phosphorus fertilizer in the form of super phosphate (15.5% P_2P_5) was applied before seeding at the rate of 0, 15, 30 and 45 kg P_2P_5/fed. All plots were received potassium fertilizer in the form of potassium sulphate (48% K_2O) at the rate of 50 kg/fed in two equal doses before the first and second irrigations in both seasons. The normal practices for growing wheat plants were followed as recommended for the region. Soil samples at 0-30 cm depth were taken before the performance of the experiment. Some physical and chemical properties of the experimental soil were determined according to Black (1965); Jackson (1973) and Page *et al.,* (1982) as shown in Table (1). The chemical properties of the used

farmyard manure were also determined and the obtained data were presented in Table (2).

Table 1

Table 2

At harvesting stage, twenty plants from every plot were randomly chosen to determine some yield attributes namly plant height, number of spikelets/ spike, spike length, grain weight/ spike, grain weight/ plant and 1000 grain weight. However, grain and straw yields were recorded on plot basis. Then, the corresponding values per faddan were estimated as ardab (150 kg) and ton/fed for grains and straw yields respectively. Nitrogen, phosphorus and potassium percentage of both wheat grains and straw were determined in wet digested extract using the methods described by Chapman and Pratt (1961). Crude protein in grain (kg/fed) was determined by multiplying the values of N content in grains (kg/fed) by 5.7 according to A.O.A.C. (1985).

After harvesting soil samples were collected from the surface layer of each plot (0-30 cm), air dried, crushed, sieved through a 2 mm sieve and then analyzed for pH, EC, organic matter and available nutrients (N, P and K) according to the previous methods.

The obtained data were statistically analyzed using the combined analysis of the two winter seasons, according to Gomez and Gomaz (1984). The significant differences among means were tested using the least significant differences (L.S.D.) at 5% level of significance.

RESULTS AND DISCUSSION

A-Effect of biofertilizers:

Data obtained in Table (3) revealed that, all the studied yield attributes i.e. plant height (cm), spike length (cm), No. of spikelets/ spike, grain weight/spike (g), grain weight/ plant (g) and 1000 grain weight (g) were significantly increased by using biofertilizer.

The enhancing impacts of wheat grains inoculation with N-fixing and phosphate dissolving bacteria as a biofertilizers on the yield attributes reflected on both grain and straw yields/ fed, where there were positive relationships between both grain and straw yields and soil treated with the investigated biofertilizers. In this respect, wheat grain inoculation significantly increased all growth characters comparing with those of the uninoculated plants. Such results may be due to the beneficial effect of biofertilizers on yield and its attributes which caused N-fixation and produced promoting substances such as indol lactic acids, gibberellins, pyridoxine and others which stimulate plant growth and subsequently affect yield attributes as well as mineralization of certain macro and micronutrients (El-Demerdash *et al.,* 1992). Similar finding were reported by Hussein and Radwan (2001) and El-Gizawy (2009) who recorded that inoculated wheat

grains with bio-fertilizer significantly increased the grain yield/fed and yield components compared with non biofertilizered treatments. Mahmoud and Mohamed (2008) concluded that biofertilizers cerealien and phosphorien stimulated wheat growth and yield.

The contents of N, P and K in wheat grains and straw and grain protein content gave also the same trends, where they were significantly increased with the using of the biofertilizers. The positive effect of biofertilizer inoculation upon nutrients uptake and grain protein yield could be described to the high efficiency of bacteria presence in this biofertilizers to fix atmospheric nitrogen and/or to produce some biologically active substances e.g. IAA, gibberellin and cytokinins. Such substances would help in increasing the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (Awad, 1998). Salama (2006) found that application of biofertilizers significantly increased the N, P and K content in grains and straw in wheat plant as compared with uninoculation treatment (control).

B : Effect of Farmyard Manure :

Data in Table (3) also, showed the effect of FYM on grain and straw yields, yield attributes and NPK contents for both wheat grains and straw and grain cured protein. All studied parameters were significantly increased by application of FYM. Increasing FYM rate gradually increased the quantity of wheat yield. The highest rate of FYM (30 m^3/fed) was the superior treatment for increasing yield attributes and wheat yield. The positive impacts of FYM on yied and its attributes are mainly due to improving the soil physical and chemical properties, preparing the suitable bed for germination and development of plant growth which reflect on resultant yield. Moreover, FYM is considered as an important source of humus, macro and micronutrients carrier and in the same time increase the activity of the useful microorganisms. Similar results were gained by Ali *et al.,* (2005), El-Shouny (2006) and Ewais, Magda, *et al.,* (2010). Concerning the effect of FYM on increasing NPK uptake by grain and straw yields as well as grain curde protein, this may be due to the decomposition of organic manure which suppling more available nutrients and formation of organic and inorganic acids leading to reduce soil pH which in turn enhanced the solubility and availability of N, P and K. These beneficial effects are in agreement with those reported by El-Kouny *et al.,* (2004) and Ewais Magda *et al.,* (2010). Moreover, Hassan and Mohey El-Din (2002) reported that increasing NPK concentration and uptake by wheat plants with FYM application may be attributed to the mineralization of organic matter and slow releaseing of minerals in an available form from organic manure, or may be due to the effect of several organic acids produced during manure decomposition, which solublize the native P in the soil and partly due to the formation of a coating on $CaCO_3$ which did not allow to react with soil P and thus P

availability increased and consequently the content in plant increased. The bicarbonate ions released from O.M. decomposition might also increase P availability through ion exchange phenomenon, as well as displacement of phosphate by organic anions formed break down of O.M.
Table 3

C : Effect of NP Fertilizers Levels :

It is evident from the results in Table (3) that all, studied of growth characters were significantly increased by increasing NP fertilizer levels. Application of $N_{90}P_{45}$ kg/fed significantly increased grain and straw yields and yield attributes compared with lower fertilizer levels and the control. The highest NP rate ($N_{90}P_{45}$ kg/fed) was the superior treatment for increasing yield attributes and wheat yield. This might be due to the well utilization of NP fertilizer in metabolisum and meristimic activity which improved growth characters and yield components. The present results indicated clearly the vital role of N and P in plant life and its contribution in increasing the grain yield. Such results clarified that N and P are essential for cell division and elongation as well as the root growth and dry matter content of wheat plant (Marschner, 1995). Similar result was obtained by Hussein and Radwan (2001) who found that the largest grain and straw yields/fed. were obtained by the application of full recommended rate of nitrogen and phosphorus fertilizer (70 kg N/fed + 15.5 kg P_2O_5/fed). Knapp and Knapp (1978) using four fertilitzation treatments i.e. ON and OP, ON and 20 kg/ha P, 22 kg/h N and oOP and 22 kg/ha N + 20 kg/ha P and reported that nitrogen alone had little effect on yield when compared to unfertilized wheat and when N was applied with P the results were similar to those from P alone. Singh *et al.,* (1993) and Behera (1995) reported that application of 100% of the recommended fertilizer (120, 60 and 40 kg N, P and K/ha) recoded higher grain and straw yields of wheat plants than the 50% of the recommended fertilizer and the control.

It is evident from the results in Table (3) that the contents of N, P and K in wheat grain and straw and grain protein content were increased by increasing NP fertilizer levels. Application of $N_{90}P_{45}$ kg/fed significantly increased NPK uptake as well as grain curde protein compared with lower fertilizer levels and control. The highest NP rate ($N_{90}P_{45}$ kg/fed) was more effective. This findings are in harmony with those obtained by Abd El-Hady *et al.,* (2006), El-Gizawy (2009) and Ewais Magda *et al.,* (2010).

Interaction Effect :

1 : Biofertilizer x FYM (A x B):

Data in Table (4A) showed the interaction effect between biofertilizer and FYM on both wheat grain and straw yield, their attributes, NPK contents and grain curde protein. The highest values were obtained when grain inoculation with biofertilizer and the application of FYM at the rate of 30 m^3/fed. However, the lowest values were recorded when the plants were untreated with biofertilizer and/or FYM.

2 : Biofertilizer x NP fertilizer levels (A x B):

Data recorded in Table (4B) indicated that, wheat grain and straw yields and plant characters were significantly responded to biofertilizer NP fertilizer levels. In this concern, the highest increaments for all examined parameters were observed by inoculation grain wheat with biofertilizer and the high level of NP fertilizer ($N_{90}P_{45}$ kg/fed). This can be attributed to saving the bacteria of biofertilizer to nitrogen and phosphorus by fixing and desoliving process and avoiding N losses from mineral N fertilizer. Morover, biofertilizer inoculation help converting an organic form of nutrients such as N to mineral N and increased soulable phosphorus. This led to increase in the uptake of nutrients from the soil by root of plant and hence promates plant growth, leading to an increase in yields. Similar results were obtained by Hussien and Radwan (2001) and Ewais Magda *et al.,* (2010).

The data in Table (4B) also showed that, application of the third level of NP fertilizer ($N_{60}P_{30}$) with inoculation gave the values greater than those values obtained when plants were fertilized by the high level of NP ($N_{90}P_{45}$ kg/fed) alone without inoculation. So, we recommended that addition of biofertilizer had beneficial influence on reducing the amounts of mineral NP fertilizer. This may be due to the important role of biofertilizer through nitrogen fixation and increased soluable phosphate. El-Sawah (2000) noticed that, there is a significant increase in N, P and K content of maize plant when grain were inoculated (Azospirillum brasilense and Bacillus megatherium) with a low dose of mineral N fertilizers were applied.

3 : FYM x NP fertilizer levels (B x C):

Concerning the impact of interaction between FYM and NP levels on wheat grain and straw yields and plant parameters, data in Table (4C) noticed that, the maximum significant values were attained by the addition of 30 m^3 FYM with the highest level of NP fertilizer ($N_{90}P_{45}$ kg/fed). On the other hand, the lowest values were obtained by the untreated soil (control). The stimulatory effect of organic manure may be due to the effect of

micronutrients and growth regulators present in organic manure which may have activated the cell division as well as meristematic activity in the kernel. Similar results were obtained by Soliman (2007) and Ewais Magda (2010) who found that, the application of organic matter and N increased plant growth and consequently the yield.

Table 4 a , b

Table 4c

4 : Biofertilizer, FYM and NP fertilizer levels (AxBxC):

Regarding the effect of interaction among biofertilizer inoculation, FYM and NP fertilizer levels on wheat grain and straw yields and plant parameters under studied, data in Table (5) cleary showed that all aforementioned characters were significantly increased by the interaction effect between the three tested factors. The highest levels gave the highest values.

Effect of the Studied Treatments on Soil Properties:

I : Soil reaction (pH):

Data in Table (6) showed that, the pH values of the studied soil were gradually decreased as a result of bio-fertilizer inoculation, FYM and NP fertilization. The highest decrease was attained with FYM followed by NP fertilizer, where application of bio-fertilizer inoculation had a little effect. This decrement is more pronounced under the highest rate FYM (30 m^3/fed). This finding is expected where the organic acids produced during organic matter decomposition led to decrease soil pH. Similar results were also observed by Salem (2003), Nassar *et al.,* (2004), El-Ewaddy (2005) and Shaban and Attia (2009).

The data also showed that the pH values of the studied soil were more affected by the combined treatment of bio-fertilizers inoculation, FYM and mineral NP fertilizer compared to the other treatments. The treatment of biofertilizer inoculation plus 30 m^3 FYM/fed and high level of mineral NP fertilizer ($N_{90}P_{45}$ kg/fed) achieved the highest decrease in soil pH values (7.52 and 7.47) after the first and the second season respectively. The obtained data may be explained on the base of some products of added mineral fertilizers transformation in the soil have a acidic effect. Also, most of active products of the used bio-fertilizer characterized by acidic effects. These results are in agreement with those found by Shaban and Omar (2006), Nader *et al.,* (2008) and Shaban and Attia (2009).

II : Electrical conductivity (EC):

Data in Table (6) showed that, values of soil salinity increased by increasing addition of organic manure (FYM) up to 30 m^3/fed.

Concerning the effect of both bio-fertilizer inoculation and mineral NP fertilizer levels on salinity, the obtained data indicated that the values of soil

salinity were slightly affected. This results are in full agreement with those reported by El-Fayoumy and Ramadan (2002) and El-Eweddy (2005).

III : Organic matter (OM) content (%):

Values of organic matter contents (%) are listed in Table (6). Data showed that, the organic matter content in soil was affected by the three different factors (bio-fertilizer inoculation, FYM and mineral NP fertilizer).

Table 5

Table 6

Organic matter content showed superiority in soil that received FYM at 30 m^3/fed compared with the control. It reached as mean values of 0.48% and 0.56% after the first and the second season respectively.

The combined treatments involving bio-fertilizer inoculation plus 30 m^3 FYM/fed under the high level of mineral NP fertilizers ($N_{90}P_{45}$ kg/fed) exhibited higher content of organic matter in the treated soil with mean value 0.55% and 0.65% after the first and the second season, respectively. This may be due to either the higher initially organic matter in the added FYM (39.16%) which builds up the organic matter in soils or the increase of root growth of wheat plants because of the applied mineral and bio-fertilizer, which contribute organic matter content increase (Ouedraogo *et la.,* 2001).

IV : Available N,P and K:

A : Available nitrogen (N):

The content of available nitrogen increased in the soil treated with biofertilizer, compared to untreated one (Table 7). Hence, the inoculation of wheat grain gave the mean values of available N reached 52.55 mg/kg and 63.28 mg/kg after the first and the second seasons, respectively. This increase may be due to the root nodules which tended to increase all available nutrients in soil. These results are in harmony with those obtained by Massoud (2006) and Shaban and Attia (2009).

Soil available N showed superiority in soils that received FYM at 15 and 30 m^3/fed as compared with the control. The increase in availability of nitrogen may be attributed to the influence of FYM on reduction of pH values, FYM is a good source for N, P and K, it is also contained micronutrients for plant growth. Such results were in a good agreement with those reported by El-Sedfy *et al.,* (2008) and El-Shouny *et al.,* (2009).

The availability of N in soil was increased by increasing NP fertilizers up to $N_{90}P_{45}$ kg/fed. Application of high levels of NP fertilizers ($N_{90}P_{45}$ kg/fed) gave the highest available N.

Available nitrogen (mg/kg) of the studied soil was affected by the combined treatments of FYM and inorganic NP fertilizers than when applied alone. On the contrary, highly increments of available nitrogen were obtained from soil treated with three combination. The treatment of inoculated wheat

grains with bio-fertilizer, plus 30 m^3 FYM and high level of mineral NP fertilizers ($N_{90}P_{45}$ kg/fed) achieved the highest available nitrogen with mean values of 66.17 mg/kg and 76.73 mg/kg after the first and the second seasons, respectively. These results are in similar to those found by Abeer and Hanaa (2008) who found that the bio-fertilizer inoculation generally increased the concentration of N, P and K in soil as compared to control. Shaban and Omar (2006) reported that soil available N increased as the levels of mineral N increased especially with bio-fertilization (Azospirillum brasilense No_{40}).

B : Available phosphorus (P):

Data in Table (7) depict the effect of adding bio-fertilizer, FYM and mineral NP fertilizer on availability of soil P at the end of harvesting stages in the first and the second seasons. It was clear that, all of the used soil fertilizers greatly increased the availability of soil P as compared to untreated soil plots (control). In this connection, the treatment of FYM (30 m^3/fed) gave the highest available P. It reached as mean values of 9.0 mg/kg and 9.61 mg/kg after the first and the second seasons, respectively. This is may be due to the influence of FYM decomposition in reducing soil pH values by organic and inorganic acids, which increase the availability of soil P. Such results were in good agreement with those reported by El-Sadfy *et al.,*(2008).

Regarding the effect of biofertilizer on the availability of soil P, data in Table (7) reveald that the inoculated grain wheat with biofertilizer recorded the highest available P in soil. The mean values were 8.76 mg/kg and 9.49 mg/kg after the improvement of available P due to inoculation treatment which can be attributed to the favorable effect of Bacillus megatherium phosphate solubilizing bacteria survived longer around mycorrhizol roots of wheat plants and acted synergistically with mycorrhiza (Azcon *et al.,* 1976).

Regarding the effect of inorganic NP fertilizers on availability of soil P, data in Table (7) recorded the highest available P in soil with mean values 7.98 mg/kg and 8.23 mg/kg after the first and the second seasons, respectively. It was found that under second season more pronounced values of available P were realized than first one.

In regard to the effect of interaction among the two factors AB , AC , BC and/or three factors biofertilizer on available P, data in Table (7) revealed that, the interaction among the two factors AB , AC , BC and three factors (ABC) showed high increment in available P. Application of biofertilizer inoculation under 30 m^3 FYM with high level of NP fertilizers ($N_{90}P_{45}$ kg/fed) recorded the highest values of soil content of P. Similar results were reported by El-Safdy *et al.,* (2008) and Shaban and Attia (2009).

C : Available potassium (K):

With respect to potassium availability data presented in Table (7) revealed that the highest mean values of available K (61.13 mg/kg and 64.70 mg/kg)

were attained for the soil treated with FYM after the first and the second seasons, respectively. The effect of organic materials on the increase of potassium availability may be due to the decomposition of organic matter and release of nutrients in the available form (Awad *et al.,* 2003). The results apper that both biofertilizer inoculation and inorganic NP fertilizer had a little effect on available potassium values.

Table 7

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استجابة نباتات القمح النامية في أرض رملية حديثة الاستصلاح للتسميد الحيوى والعضوى والمعدنى

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أقيمت تجربة حقلية في مركز جنوب التحرير ـ محافظة البحيرة ـ مصر خلال الموسمين الزراعيين الشتويين ٢٠٠٨/٢٠٠٩ ، ٢٠٠٩/٢٠١٠ بهدف دراسة استجابة نبات القمح للتسميد الحيوي (بدون تلقيح والتلقيح بخليط من البكتريا المثبتة للنتروجين والبكتريا المذيبة للفوسفات) ومعدلات من سماد المزرعة (صفر ، ١٥ ، ٣٠ م³/فدان) وكذلك التسميد المعدني لكل من النتروجين والفوسفور بمستويات صفر ، $N_{30}P_{15}$, $N_{60}P_{30}$, $N_{90}P_{45}$ كجم/فدان والتفاعل بينهما على نمو وإنتاج محصول القمح ومكوناته والكمية الممتصة من النتروجين والفوسفور والبوتاسيوم بواسطة الحبوب والقش وكذلك محتوى الحبوب من البروتين .

ويمكن إيجاز النتائج المتحصل عليها فيما يلى :

- **أدى التلقيح بالمخصب الحيوي إلى زيادة معنوية في محصول الحبوب والقش وكذلك مكونات المحصول بالإضافة إلى زيادة محتوى الحبوب من النتروجين والفوسفور والبوتاسيوم وكذلك محتوى الحبوب من البروتين وذلك مقارنة بالكنترول (بدون تلقيح).**
- **كانت هناك استجابة معنوية لمحصولي الحبوب والقش لنبات القمح وكذلك محتواهما العنصري من النتروجين والفوسفور والبوتاسيوم وكذلك محتوى الحبوب من البروتين لإضافة السماد العضوي وكانت الزيادة متدرجة مع زيادة معدلات الإضافة.**

- أدت إضافة التسميد المعدني من عنصري النتروجين والفوسفور إلى زيادة معنوية في المحصول ومكوناته وتحققت أفضل النتائج مع المستوى الأعلى من الإضافة .
- حقق التفاعل بين التسميد الحيوي ومعدلات التسميد العضوي وكذلك المعدني زيادة معنوية في المحصول ومكوناته وكذلك الكمية الممتصة من النتروجين والفوسفور والبوتاسيوم ومحتوى الحبوب من البروتين .
- أظهرت النتائج أن إضافة ٦٠ كجم نتروجين و ٣٠ كجم فوسفور مع التسميد الحيوي أعطى نتائج أفضل من التي تم الحصول عليها عند إضافة المستوى الأعلى من التسميد المعدني (٩٠ كجم نتروجين + ٤٥ كجم فوسفور) بدون التسميد الحيوي . لذلك فإن التوصية باستخدام التسميد الحيوي والمعدني معا تؤدى إلى التقليل من الكمية المستخدمة من السماد المعدني وبالتالي تجنب التلوث البيئي الذي تحدثه الإضافة الزائدة من التسميد المعدني .
- أدت إضافة السماد العضوي إلى تحسين خواص التربة حيث انخفضت قيم pH التربة بينما زاد محتوى التربة من المادة العضوية وعناصر النتروجين والفوسفور والبوتاسيوم وتحققت أفضل النتائج مع المستوى الأعلى من الإضافة.

ومن هذه النتائج يمكن القول أنه يمكن زيادة محصول القمح تحت ظروف الأرض الرملية وذلك بتلقيح الحبوب بالمخصب الحيوي وإضافة ٣٠ متر مكعب من سماد المزرعة مع إضافة خليط من التسميد المعدني لكل من النتروجين والفوسفور .

Table (1): Some physical and chemical characteristics of the studied soil

A : Physical properties :

Particle size distribution %				Texture class	Bulk density (g/cm^3)	Total porosity (%)	Hydraulic conductivity (m/day)
Coarse sand	Fine Sand	Silt	Clay				
75.67	17.80	3.41	3.12	Sandy	1.71	35.47	2.76

B : Chemical properties :

Total $CaCO_3$ (%)	O.M. (%)	PH (1:2.5) (soil/ water, suspension)	EC (dSm^{-1})	Soluble ions soil paste extract meq/L								Available nutrients (mg/kg)		
				Cations				Anions						
				Ca^{++}	Ma^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$	N	P	K
0.50	0.25	7.90	0.39	1.32	0.87	1.28	0.24	--	1.42	0.89	1.40	25.0	4.30	46.5

Table (2): Some characteristics of farmyard manure .

pH 1:5 (manure: water susp.)	EC $(dSm^{-1})^1$	Organic matter (%)	Organic corbon (%)	Total N (%)	C/N ratio	Available nutrients				
						(Mg/kg)		µg/kg soil		
						P	K	Fe	Mn	Zn
7.63	3.06	39.16	22.71	1.33	17.1	17	89	371	47	21

Table (3): Effect of biofertilizer, FYM and mineral NP fertilizers on yield, yield components as well as chemical composition of wheat plant. (combined analysis of 2008/2009 and 2009/2010 growing seasons).

Factors	Yield components						Yield/fed		Chemical compositions (kg/fed)						
	Plant height (cm)	Spike height (cm)	No. of spikelents /spike	Grain weight /spike (g)	Grain weight /plant (g)	1000 grain weight (g)	Grains (ardab)	Straw (ton)	Nitrogen		Phosphorus		Potassium		Grain crude protein
									Grains	Straw	Grains	Straw	Grains	Straw	
Biofertilizer :															
Uninoculation	84.68	8.36	15.09	2.28	34.93	40.03	13.03	3.133	37.64	20.06	8.20	8.64	8.94	50.99	214.54
Biofertilizer	92.75	9.00	17.54	2.35	41.76	43.56	14.25	3.376	44.42	22.61	10.77	12.06	10.60	59.47	253.19
L.S.D. 0.05	1.81	0.22	0.29	0.07	1.45	0.82	0.37	0.14	1.86	1.53	1.34	2.82	1.13	3.26	4.32
Farmyard manure (m^3/fed)															
0	81.9	7.68	15.12	2.17	33.39	37.89	12.48	2.760	33.97	15.81	7.60	7.75	7.92	44.29	193.62
15	85.05	8.80	16.41	2.35	38.88	41.11	13.90	3.340	40.99	21.70	9.65	10.36	9.94	56.82	233.64
30	88.71	9.56	17.41	2.43	42.77	44.62	14.51	3.720	48.13	26.48	11.21	12.93	11.45	64.58	274.33
L.S.D. 0.05	0.75	0.09	0.12	0.03	0.60	0.34	0.15	0.06	0.77	0.63	0.56	1.72	0.47	1.35	2.66
NP fertilizers (kg/fed)															
NoPo	68.59	7.33	14.03	2.17	30.80	36.90	10.25	2.658	27.56	13.57	5.85	6.78	6.27	40.65	157.09
$N_{30}P_{15}$	80.70	8.50	15.94	2.30	37.00	41.72	13.25	3.231	38.70	19.19	8.65	9.43	8.74	52.61	220.59
$N_{60}P_{30}$	94.24	9.34	17.25	2.37	41.23	45.17	14.91	3.512	46.29	24.19	10.76	11.99	11.04	60.75	263.85
$N_{90}P_{45}$	94.37	9.73	18.04	2.44	44.34	46.23	16.12	3.704	51.59	28.38	12.53	13.20	13.04	66.91	294.09
L.S.D. 0.05	0.56	0.06	0.09	0.015	0.28	0.19	0.11	0.04	0.67	0.63	0.26	0.45	0.26	1.04	1.98

Table (4): Yield components, grain and straw yields as well as some chemical composition of wheat plants as affected by:

A : Biofertilizer x FYM rates interaction (AB):

Inocul-ation	Mineral NP fertilizer kg/fed	Yield components						Yield/fed		Chemical compositions kg/fed						
										Nitrogen		Phosphorus		Potassium		Grain crude protein
		Plant height (cm)	Spike height (cm)	No. of spikelents /spike	Grain weight /spike (g)	Grain weight /plant (g)	1000 grain weight (g)	Grains (ardab)	Straw (ton)	Grains	Straw	Grains	Straw	Grains	Straw	
	0	75.87	7.31	13.91	2.10	29.64	34.44	11.71	2.603	30.46	14.30	6.38	6.09	7.08	40.35	173.62
Uninoculation	15	80.28	8.59	15.43	2.32	36.03	41.96	13.50	3.223	37.55	20.38	8.69	8.49	9.27	52.42	214.03
	30	84.68	9.19	15.93	2.44	39.12	43.69	13.90	3.575	44.91	25.50	9.54	11.34	10.49	60.21	255.98
	0	87.93	8.05	16.33	2.25	37.14	41.35	13.26	2.953	37.48	17.32	8.82	9.42	8.77	48.24	213.63
Biofertilizer	15	89.83	9.02	17.40	2.38	41.73	44.27	14.31	3.457	44.43	23.03	10.61	12.24	10.62	61.22	253.25
	30	92.75	9.94	18.89	2.43	46.42	45.07	15.13	3.876	51.35	27.47	12.89	14.53	12.42	68.95	292.69
L.S.D. 0.05		1.06	0.13	0.17	0.04	0.85	0.48	0.21	0.08	1.09	0.89	0.78	1.65	0.66	1.91	2.19

Table (4) Con.

B : Inoculation x mineral NP fertilizer (AC)

Inocul-ation	Mineral NP fertilizer kg/fed	Yield components						Yield/fed		Chemical compositions kg/fed						
										Nitrogen		Phosphorus		Potassium		Grain crude protein
		Plant height (cm)	Spike height (cm)	No. of spikelents /spike	Grain weight /spike (g)	Grain weight /plant (g)	1000 grain weight (g)	Grains (ardab)	Straw (ton)	Grains	Straw	Grains	Straw	Grains	Straw	
	NoPo	64.12	6.88	12.96	2.11	27.88	34.71	9.51	2.470	24.77	12.20	4.82	5.35	5.65	36.28	141.18
Uninoculation	$N_{30}P_{15}$	74.86	8.30	14.88	2.30	34.38	41.08	12.69	3.100	35.98	18.18	7.46	7.97	8.03	48.86	205.12
	$N_{60}P_{30}$	89.70	9.10	15.86	2.34	37.39	44.50	14.33	3.361	42.11	22.71	9.17	9.86	10.11	56.20	240.04
	$N_{90}P_{45}$	92.43	9.50	16.66	2.39	40.06	45.49	15.61	3.601	47.75	27.09	11.02	11.38	12.00	62.63	272.21
	NoPo	73.06	7.78	15.09	2.23	33.73	39.09	11.00	2.847	30.35	14.88	6.88	8.21	6.69	45.02	173.01
Biofertilizer	$N_{30}P_{15}$	86.53	8.70	16.99	2.31	39.63	42.36	13.81	3.358	41.41	20.20	9.83	10.90	9.46	56.36	236.07
	$N_{60}P_{30}$	98.78	9.58	18.65	2.40	45.07	45.84	15.49	3.663	50.47	25.67	12.35	14.12	11.98	65.30	287.67
	$N_{90}P_{45}$	102.31	9.95	19.42	2.49	48.63	46.96	16.63	3.807	55.43	29.67	14.04	15.02	14.09	71.19	315.98
L.S.D. 0.05		0.79	0.08	0.13	0.02	0.40	0.27	0.16	0.06	0.95	0.89	0.36	0.63	0.37	1.47	1.83

Table (4): Yield components, grain and straw yields as well as chemical composition of wheat plants as affected by:
C : FYM rates x mineral NP fertilizer interaction (BC):

FYM m^3/fed	NP fertilizer level kg/fed	Yield components						Yield/fed		Chemical compositions kg/fed						
		Plant height (cm)	Spike height (cm)	No. of spikelents /spike	Grain weight /spike (g)	Grain weight /plant (g)	1000 grain weight (g)	Grains (ardab)	Straw (ton)	Nitrogen		Phosphorus		Potassium		Grain crude protein
										Grains	Straw	Grains	Straw	Grains	Straw	
	NoPo	62.37	6.13	12.48	1.94	24.66	2.056	8.86	2.056	20.78	8.44	4.38	4.51	4.60	29.20	118.44
0	$N_{30}P_{15}$	78.70	7.85	14.90	2.19	32.85	2.732	12.29	2.732	32.29	14.15	6.95	7.06	7.19	41.93	184.05
	$N_{60}P_{30}$	91.40	8.21	16.31	2.25	36.95	3.054	13.93	3.054	39.70	18.08	8.83	9.03	9.29	50.21	226.31
	$N_{90}P_{45}$	95.14	8.51	16.79	2.32	39.10	3.212	14.87	3.212	43.19	22.57	10.24	10.43	10.64	55.84	246.17
	NoPo	69.65	7.46	14.26	2.25	32.12	2.754	10.51	2.754	26.60	13.49	5.96	7.09	6.48	42.63	151.64
15	$N_{30}P_{15}$	79.95	8.46	16.02	2.32	37.31	3.216	13.28	3.216	37.75	18.78	8.55	8.93	8.67	52.77	215.20
	$N_{60}P_{30}$	94.12	9.38	17.35	2.39	41.45	3.570	15.25	3.570	45.66	24.88	11.06	11.99	11.24	61.87	260.285
	$N_{90}P_{45}$	96.50	9.92	18.04	2.49	44.63	3.819	16.56	3.819	53.93	29.67	13.05	13.45	13.38	70.01	307.42
	NoPo	71.75	8.39	15.35	2.32	35.59	3.166	11.39	3.166	35.30	18.77	7.22	8.74	7.73	50.13	201.20
30	$N_{30}P_{15}$	83.45	9.19	16.89	2.41	40.86	3.744	14.18	3.744	46.06	24.63	10.45	12.31	10.37	63.13	262.54
	$N_{60}P_{30}$	97.21	10.42	18.10	2.48	45.29	3.912	15.54	3.912	53.50	29.62	12.40	14.95	12.61	70.17	304.97
	$N_{90}P_{45}$	100.47	10.76	19.30	2.54	49.31	4.081	16.94	4.081	57.66	32.91	14.30	15.73	15.11	74.88	328.69
L.S.D. 0.05		0.74	0.08	0.12	0.02	0.38	0.25	0.90	0.05	0.90	0.84	0.34	0.60	0.35	1.38	1.53

Table (5): Yield components, grain and straw yields as well as chemical composition of wheat plants as affected by:
D: Bio-fertilizers inoculation x FYM rates x mineral NP fertilizers levels (ABC):

Inocul-ation	FYM rates m^3/fed	Mineral NP fertilizer kg/fed	Yield components: Plant height (cm)	Spike height (cm)	No. of spikelents /spike	Grain weight /spike (g)	Grain weight /plant (g)	1000 grain weight (g)	Yield/fed: Grains (ardab)	Straw (ton)	Chemical compositions kg/fed: Nitrogen Grains	Nitrogen Straw	Phosphorus Grains	Phosphorus Straw	Potassium Grains	Potassium Straw	Grain crude protein
Uninoculation	0	NoPo	54.24	5.02	10.69	1.77	18.95	27.96	8.02	1.881	18.16	7.08	3.68	3.00	4.21	24.64	103.51
		$N_{30}P_{15}$	73.12	7.84	14.15	2.17	30.81	39.35	11.54	2.578	29.88	12.63	5.88	5.58	6.63	38.16	170.31
		$N_{60}P_{30}$	86.20	8.00	15.23	2.21	33.71	43.14	13.09	2.876	35.01	16.67	7.26	7.19	8.24	46.35	199.55
		$N_{90}P_{45}$	89.94	8.37	15.60	2.25	35.09	44.27	14.22	3.080	38.97	20.84	8.70	8.62	9.26	52.25	222.12
	15	NoPo	65.87	7.38	13.73	2.23	30.72	37.30	9.69	2.525	23.73	11.78	4.84	5.55	5.76	37.54	135.26
		$N_{30}P_{15}$	74.14	8.07	15.05	2.29	34.46	41.23	12.92	3.090	34.56	17.51	7.62	7.30	8.07	48.70	196.99
		$N_{60}P_{30}$	89.62	9.22	16.11	2.36	38.01	44.23	15.13	3.515	41.91	23.89	10.21	9.83	10.66	58.46	238.88
		$N_{90}P_{45}$	91.50	9.70	16.86	2.42	40.93	45.10	16.25	3.763	50.00	28.36	12.11	11.28	12.60	64.99	285.00
	30	NoPo	72.25	8.24	14.48	2.35	33.97	38.87	10.84	3.004	32.42	17.92	5.96	7.51	6.99	46.67	184.79
		$N_{30}P_{15}$	77.34	9.01	15.46	2.44	37.88	42.68	13.63	3.642	43.52	24.40	8.89	11.04	9.39	59.73	248.06
		$N_{60}P_{30}$	93.30	10.08	16.24	2.47	40.47	46.13	14.77	3.694	49.42	27.58	10.05	12.56	11.45	63.79	281.69
		$N_{90}P_{45}$	95.86	10.44	17.54	2.51	44.17	47.11	16.36	3.962	54.30	32.09	12.26	14.26	14.15	70.66	309.51
Inoculation	0	NoPo	70.51	7.25	14.28	2.12	30.37	36.89	9.71	2.231	23.40	9.81	5.09	6.02	4.99	33.76	133.38
		$N_{30}P_{15}$	84.28	7.87	15.65	2.22	34.90	40.15	13.04	2.887	34.70	15.68	8.02	8.55	7.76	45.70	197.79
		$N_{60}P_{30}$	96.60	8.43	17.40	2.30	40.20	43.66	14.78	3.232	44.40	19.49	10.41	10.88	10.34	54.07	253.08
		$N_{90}P_{45}$	100.34	8.65	17.99	2.39	43.11	44.71	15.52	3.345	47.41	24.30	11.79	12.25	12.02	59.43	270.23
	15	NoPo	73.44	7.55	14.79	2.27	33.53	40.03	11.34	2.983	29.48	15.21	7.08	8.64	7.20	47.72	168.03
		$N_{30}P_{15}$	85.77	8.86	17.00	2.35	40.16	43.06	13.65	3.343	40.95	20.05	9.48	10.57	9.28	56.84	233.41
		$N_{60}P_{30}$	98.63	9.55	18.60	2.42	44.90	46.34	15.37	3.626	49.42	25.87	11.91	14.15	11.83	65.28	281.69
		$N_{90}P_{45}$	101.51	10.14	19.23	2.51	48.33	47.64	16.87	3.875	57.87	30.99	13.99	15.62	14.17	75.04	329.85
	30	NoPo	75.25	8.55	16.22	2.30	37.30	40.36	11.95	3.329	38.18	19.63	8.48	9.98	8.48	53.60	217.62
		$N_{30}P_{15}$	89.56	9.38	18.33	2.38	43.84	43.87	14.74	3.846	48.60	24.87	12.01	13.58	11.35	66.54	277.02
		$N_{60}P_{30}$	101.12	10.76	19.96	2.50	50.11	47.52	16.32	4.131	57.59	31.67	14.75	17.34	13.77	76.56	328.26
		$N_{90}P_{45}$	105.09	11.08	21.06	2.57	54.45	48.55	17.52	4.201	61.03	33.74	16.34	17.21	16.08	79.11	347.87
L.S.D at 0.05			1.05	0.12	0.18	0.02	0.53	0.36	0.22	0.08	1.27	1.18	0.48	0.85	0.50	1.95	1.42

Table (6): Effect of biofertilizer, FYM and mineral fertilizers on some chemical properties of the investigated soil.

Inoculation	FYM m^3/fed	PH values					EC dS/m^{-1}					Organic matter %				
		Mineral NP fertilizers season														
		NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean	NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean	NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean
		2008/ 2009 season														
Uninoculation	0	7.88	7.85	7.84	7.82	7.82	0.39	0.40	0.43	0.45	0.44	0.22	0.23	0.25	0.27	0.24
	15	7.75	7.70	7.68	7.65	7.70	0.46	0.48	0.51	0.55	0.50	0.33	0.35	0.37	0.39	0.36
	30	7.63	7.60	7.56	7.53	7.58	0.58	0.59	0.63	0.67	0.61	0.43	0.45	0.47	0.50	0.46
	Mean	7.75	7.72	7.69	7.67	7.71	0.47	0.49	0.52	0.55	0.51	0.32	0.34	0.36	0.38	0.35
Inoculation	0	7.86	7.84	7.82	7.80	7.83	0.40	0.43	0.45	0.48	0.44	0.25	0.27	0.29	0.31	0.28
	15	7.72	7.68	7.66	7.63	7.67	0.55	0.58	0.62	0.64	0.60	0.40	0.42	0.45	0.49	0.44
	30	7.60	7.57	7.54	7.52	7.55	0.67	0.73	0.75	0.77	0.73	0.47	0.49	0.52	0.55	0.50
	Mean	7.72	7.69	7.67	7.65	7.68	0.54	0.58	0.60	0.63	0.59	0.37	0.39	0.42	0.45	0.40
2009/ 2010 season																
Uninoculation	0	7.80	7.77	7.76	7.74	7.77	0.37	0.40	0.45	0.47	0.42	0.17	0.21	0.22	0.24	0.21
	15	7.67	7.65	7.63	7.62	7.64	0.47	0.52	0.55	0.57	0.52	0.36	0.41	0.43	0.45	0.41
	30	7.55	7.53	7.51	7.50	7.52	0.61	0.63	0.65	0.70	0.64	0.50	0.52	0.54	0.55	0.52
	Mean	7.67	7.65	7.63	7.62	7.64	0.48	0.51	0.55	0.58	0.53	0.34	0.38	0.39	0.41	0.38
Inoculation	0	7.79	7.76	7.75	7.73	7.76	0.44	0.46	0.49	0.52	0.47	0.20	0.27	0.31	0.33	0.27
	15	7.65	7.63	7.62	7.60	7.63	0.55	0.62	0.65	0.66	0.62	0.44	0.47	0.49	0.51	0.47
	30	7.65	7.50	7.49	7.47	7.50	0.73	0.74	0.76	0.79	0.79	0.58	0.61	0.63	0.65	0.61
	Mean	7.53	7.63	7.62	7.60	7.63	0.57	0.60	0.63	0.65	0.61	0.40	0.45	0.47	0.50	0.46

Table (7): Available nutrients in soil (mg/kg) as affected by inoculation, FYM and mineral NP fertilizers after harvesting wheat.

Inoculation	FYM m^3/fed	N					P					K				
		Mineral NP fertilizers (kg/fed)														
		NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean	NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean	NoPo	$N_{30}P_{15}$	$N_{60}P_{30}$	$N_{90}P_{45}$	Mean
		2008/ 2009 season														
Uninoculation	0	25.10	27.20	28.20	29.03	27.43	4.11	4.50	5.03	5.22	4.71	40.5	42.3	44.5	45.8	43.27
	15	30.60	31.00	31.33	32.15	31.24	6.02	6.43	6.54	6.81	6.45	44.5	53.9	60.2	63.7	55.57
	30	33.47	35.42	36.81	37.45	35.76	7.13	7.35	7.70	7.92	7.52	55.2	58.5	63.1	65.8	60.65
	Mean	29.72	31.20	32.11	32.87	31.47	5.75	6.09	6.42	6.65	6.22	46.73	51.56	55.93	58.43	53.16
Inoculation	0	35.36	40.36	45.87	48.73	42.58	5.55	5.73	6.63	7.05	6.24	40.7	42.8	44.8	46.3	43.65
	15	50.56	52.23	53.60	54.68	52.76	9.01	9.35	9.82	10.11	9.57	45.4	54.3	61.7	64.2	56.40
	30	57.38	61.35	64.37	66.17	62.31	10.13	10.44	10.57	10.80	10.48	55.7	59.7	64.2	66.9	61.62
	Mean	47.76	51.31	54.61	56.52	52.55	8.23	8.50	9.00	9.32	8.76	47.26	52.26	56.90	59.13	53.89
2009/ 2010 season																
Uninoculation	0	20.22	23.05	25.11	27.13	23.87	3.53	3.76	4.11	4.44	3.96	36.5	36.9	38.1	39.0	37.62
	15	33.13	35.21	36.82	38.44	35.90	6.42	6.55	6.72	6.93	6.65	46.8	55.4	61.3	64.4	56.37
	30	40.01	42.15	44.30	45.03	42.87	7.44	7.59	7.81	7.98	7.70	61.3	62.4	65.3	67.4	64.10
	Mean	31.12	33.47	35.41	36.86	34.21	5.79	5.97	6.21	6.45	6.10	48.20	51.56	54.90	56.93	52.69
Inoculation	0	51.51	52.33	54.06	55.71	53.40	5.83	6.33	7.03	7.55	6.68	37.3	38.2	39.6	39.9	38.75
	15	58.33	61.14	63.31	65.44	62.05	9.88	10.03	10.43	10.58	10.23	47.3	56.7	63.1	65.2	58.07
	30	71.66	73.04	76.13	76.73	74.39	11.03	11.44	11.73	11.95	11.53	62.4	64.0	66.6	68.2	65.30
	Mean	60.50	62.17	64.50	65.96	63.28	8.91	9.27	9.73	10.02	9.48	49.00	52.96	56.43	57.76	54.04