*Int. J. Agricult. Stat. Sci.* Vol. 16, Supplement 1, pp. 1715-1721, 2020 www.connectjournals.com/ijass
**DocID**: https://connectjournals.com/03899.2020.16.1715 ISSN : 0973-1903, e-ISSN : 0976-3392

**ORIGINAL ARTICLE**

# EFFECT OF INTEGRATED FERTILIZATION SYSTEM (MINERAL-MANURE AND INOCULANTS) ON GROWTH AND N AND P CONTENT OF BARLEY PLANTS (*HOREDUM VULGARE* L.)

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**Abstract:** Pots experiment was conducted to investigate the influence of integrated application from mineral as artificial ureaphosphate at levels no added, half and full doses with organo manure and inoculants from *Azotobacter* sp. with *Bacillus polymyxa* on parameters of the growth that designed , completed random and analysed at least significant difference of 0.05. After 60 days of planting total dry weight, the recovery percentage both of N and P in plants and their availability total biomass were determined in soil. Results showed that half dose from ureaphosphate with organo and inoculants was superior and effective treatment than the other at parameters from plants dry weights , both N and P recovery in plants compared to full dose with organo and inoculants, moreover available amounts of N and P in soil were 138 mg $N.g^{-1}$ soil and 31.4 mg P $g^{-1}$ soil respectively which did not differ from full dose with organo and inoculants treatment (145 mg $N.g^{-1}$ and 30.38 mg $Pg^{-1}$), respectively. So integrated fertilizer from ureaphosphate and organo with inoculants can be supported growth plant and replaced partly by mineral when completed with organo and biofertilizer as bacterial inoculants.

***Key words*:** Artificial ureaphosphate, Biofertilization, Sustainable agriculture.

**Cite this article**

Z.K. Hasan, N.I. Ashour and H.F. Jasem (2020). Effect of integrated fertilization system (mineral-manure and inoculants) on growth and N and P content of barley plants (*Horedum vulgare* L.). *International Journal of Agricultural and Statistical Sciences*. DocID: https://connectjournals.com/03899.2020.16.715

## 1. Introduction

Nitrogen and phosphorus are essential nutrients for cellular synthesis of enzymes, proteins, chlorophyll, DNA, RNA and water use efficiency for growth [Taiz and Zeiger (2010)]. Nitrogen and phosphorus fertilizers face problems in soils as $NH_3$-volatilization, $NO^{3-}$ leaching or and P-precipitation or adsorption as superphosphate fertilizer then declining their availability [Ayube *et al*. (1999)]. So, the modern researches contained on artificial fertilizer formed from urea and phosphoric acid known as ureaphosphate fertilizer at different molarity according to soil and plants properties [Yassen (1996)]. Studies revealed that significant effect for ureaphosphate on reduction of N and P losses and promoting plant growth [Awad *et al*. (1992)]. So, many researches indicated the clear role of ureaphosphate when it mixed with the manure of cattle at level 20 to 40 ton $ha^{-1}$ [Luo and Sun (1994)], when they revealed that manure cattle can enrich soil fertility by enhancement microbial activity then decrease soil pH [Abdel-Gwad and Zeinab (2006)]. Also, there is biological inoculants of specific of beneficial microoganisms in rhizosphere as *Azotobacter* sp. and *Bacillus* sp. which can be used either N-fixing by *Azotobacter* sp. or dissolving of insoluble phosphorus to soluble by *Bacillus* sp. [Abd-El Gwad *et al*. (2009)], these various species (bacteria) can be alternative partly of chemical application as Garg and Bahla (2008), who referred to effect of manure and inoculants on reducing quantity of chemical application to 1/3 of recommended doses with no side effect on plant dry weight or its uptake of N or P nutrients, moreover that multi applications from bacterial inoculants and organo manure with half dose of fertilizer may prefer to full

***Author for correspondence** **Received** August 02, 2020 **Revised** November 08, 2020 **Accepted** November 26, 2020

dose of chemical for economic and ecological benefits [Al-Naem and Sadiq (2004)]. Many studies contained on intergrated nutrition system when it combined among mineral, organo manure and biological inoculants together.

Potato yield at 100% rate of mineral fertilizer was similar to the yield at the inoculants with 50% mineral and manure [Chen (2006)]. Hence, this study was conducted to compare various levels of artificial ureaphosphate fertilizer with organo manure and bacterial inoculants from *Azotobacor* sp. and *Bacillus polymyxa* on *Horedum vulgare* L. and effect (integrated application) on nitrogen and phosphorus availability in plants and soil.

## 2. Materials and Methods

Soil samples were collected from depth (0- 30cm) Al-Nasyria province, Iraq, silty loam texture, some physical, chemical and biological properties of the soil were determined following standard procedures described by Page *et al*. (1982) and presented in Table 1. Samples were dried and sieved with 2mm mesh then disterilled at 121°C and 15 bar in autoclave. Treatments included three levels of artificial ureaphosphate (up), (no-up, half-up and full-up) at (16%N : 40% P2O5 : 0%$K_2O$) at rate (150 kgha$^{-1}$) urea phosphate was divided into two equal doses, the first dose was applied during planting and the second after month and potash fertilizer was added as $K_2SO_4$ (43% $K_2O$) at the rate of 180 kg ha$^{-1}$ in addition to the manure as (cattle waste) its characteristics were determined following standard procedures described by Page *et al*. (1982) presented in Table 2, which added at 40 ton ha$^{-1}$ with inoculants include nitrogen fixed (*Azotobacter* sp.) and phosphate dissolved (*Bacillus polymyxa*) bacteria, which have isolated and identified from different southern regions of Iraq in Microbiology laboratory of Soil Science and Water Resources Department of Agriculture College, Basrah University, these isolates were mixed with disterilled seeds of barley plant (*Horedum vulgare* L.) before planting, the plants were irrigated at field capacity for 60 days growth and it were harvested then determined dry weight after dried at oven 65°C for 72 hours, it digested with sulfuric and perochloric acides, calculated total N and P content, uptake and recovery according to Page *et al*. (1982). After 60 days of growth, available-N ($NH_4^+ + NO_3^- + NO_2^-$) in soil was extracted with 2M of potassium chloride and determined according to Page *et al*. (1982) and available-P was extracted with 0.5 M of $NaHCO_3$ at (PH = 8.5) as Watanabe and Olsen (1965) and determined as Murphy and Riley (1962). Total biomass of bacteria CFU.g$^{-1}$ as

**Table 1:** Chemo–physical and biological properties of study soil.

| Parameter | | Unit | Value |
|---|---|---|---|
| PH | | 1:2.5 | 7.70 |
| Ece | | dsm$^{-1}$ | 4.30 |
| CEC | | Cmole(+)kg$^{-1}$ | 23.26 |
| Total solid carbonat | | g kg$^{-1}$ | 203 |
| Total -N | | g kg$^{-1}$ | 0.06 |
| Available- N | | mg kg$^{-1}$ | 21.08 |
| Available- K | | mg kg$^{-1}$ | 132.5 |
| Available- P | | g kg$^{-1}$ | 0.015 |
| Organic matter | | g kg$^{-1}$ | 1.76 |
| C : N ratio | | | 41.7 |
| Soluble ions | $Ca^{+2}$ | mmole L$^{-1}$ | 12.2 |
| | $Mg^{+2}$ | | 10.5 |
| | $K^+$ | | 0.89 |
| | $Na^+$ | | 13.37 |
| | $HCO_3^-$ | | 1.76 |
| | $CO_3^=$ | | 0.0 |
| | $CL^-$ | | 28.7 |
| | $SO_4^=$ | | 9.7 |
| Sand | | g kg$^{-1}$ | 234 |
| Silt | | g kg$^{-1}$ | 466 |
| Clay | | g kg$^{-1}$ | 300 |
| Texture | | | Silty loam |
| Total biomass | | CFU g$^{-1}$ soil | $1.1\times10^5$ |
| *Azotobacter* sp. | | | $0.2\times10^2$ |
| *Bacillus* sp. | | | $1\times10^3$ |
| Fungi | | | $3\times10^3$ |

**Table 2:** Main characteristics of organic manure (waste cattle).

| Chemical properties | Unit | Value |
|---|---|---|
| Water content | % | 47.40 |
| PH | | 7.88 |
| E.C | dsm$^{-1}$ | 16.00 |
| Organic matter | % | 36.50 |
| Organic Carbon | % | 23.00 |
| Total-N | % | 1.85 |
| C:N ratio | | 12.43 |

following standard procedure described by Black (1965). Data was analyzed by using SPSS (1998), calculated treatments means at RLSD0.05 by AL-Rawi and Khalaf-Allah (2000).

## 3. Results and Discussion

### 3.1 Plant dry weight

Data in Table 3 showed significant effect $RLSD_{0.05}$ of ureaphosphate (up) levels on dry weights when it increased from 4.50 g $pot^{-1}$ at control (no added) to 7.67 g $pot^{-1}$ at full-up dose, that is referred to a positive role of N and P-nutrients to enhance root growth system then development dry weight plants according to Al-Fathly (2011), in addition to at Table 3, there is a significant effect of organic manure on plant dry weight when increase from 4.81 g $pot^{-1}$ at control (no added) to 6.19, 7.87 and 8.10 g $pot^{-1}$ at applications from organic, biological and mixed them respectively that referred to direct effect of improvement plant nutrient and soil chemo-physical properties, then microorganisms activity as Muhammad *et al*. (2017), who explained that mixed organic with biological inoculants enhanced water holding capacity of soil then mobility of N or P nutrients, the same trend was noticed when bacterial inoculants from *Azotobacter* sp. with *Bacillus polymyxa* where mixed with organo compared to single or one of them as Anjum *et al*. (2007), who referred to the positive role of combination of N-fixing and P-dissolved bacteria when mixed with organo manure then increase nutrients availability at all the stags of life cycle. In addition to the interaction results showed that application of full-up dose with organo and biological inoculants relieved to increase from 3.68 g $pot^{-1}$ at no added- up to 9.78 g $pot^{-1}$ at mixed organo with biological inoculants with full dose of ureaphosphate when increase was 193% compared to no application of ureaphosphate, these results are in close agreement with those found by Khalil (2011). Moreover, the data in Table 3 showed that full-up treatment with organo manure and bioinoculants didn't differ significantly from treatment half-up dose with organo manure and bioinoculants 9.5 g $pot^{-1}$ and 9.78 g $pot^{-1}$, respectively. As Al-Jutheri and Ali (2011), who referred to that application of organo and biological inoculants with 50% of chemical fertilizer didn't differ from application 100% of chemical fertilizer with bacterial inoculants of *Azotobacter* and *Bacillus* bacteria when they were mixed with organic manure.

### 3.2 Nitrogen and phosphorus uptake

The results in Table 4 showed that significant increase of nitrogen uptake in barely plants when it increased from 96.26 mg $pot^{-1}$ at no added (control) to 105.43 mg $pot^{-1}$ at full dose of ureaphosphate as Yassen (1996), who found significant effect of artificial ureaphosphate on nitrogen uptake then *Zea mays* L. growth, in addition to the data showed in Table 4 that significant increase in nitrogen uptake when it increased from 66.60 mg $pot^{-1}$ to 76.29, 83.20 and 195.78 mg $pot^{-1}$ at organo, bioinoculants and mixed them together respectively that agreed with Mahendran and Chandramani (1998), who noticed that the positive role

**Table 3:** Effect of ureaphosphate levels (up) and organo- bio.applications on dry weight (g $pot^{-1}$) of barely plants.

| up-levels | no added | Organo. | bio. | Organo.plus bio. | mean |
|---|---|---|---|---|---|
| no-up | 3.68 | 4.92 | 4.38 | 5.02 | 4.50 |
| half- up | 4.98 | 6.30 | 11.46 | 9.50 | 8.08 |
| full- up | 5.78 | 7.36 | 7.76 | 9.78 | 7.67 |
| Mean | 4.81 | 6.19 | 7.87 | 8.10 | 6.74 |

$RLSD_{0.05}$
up – levels = 2.2 Treats. = 3.57 up-levels*Treats. = 4.2

**Table 4:** Effect of ureaphosphate levels (up) and organo and bio. applications on nitrogen uptake (mg $pot^{-1}$) of barely plants.

| up-levels | no added | Organo. | bio. | Organo.and bio. | mean |
|---|---|---|---|---|---|
| no -up | 35.207 | 58.06 | 108.92 | 182.92 | 96.26 |
| half- up | 5.80 | 73.0 | 105.70 | 204.50 | 114.75 |
| full- up | 88.90 | 97.80 | 35.0 | 200 | 105.43 |
| mean | 66.60 | 76.29 | 83.20 | 195.78 | |

$RLSD_{0.05}$
up – levels = 48.70 Treats . = 55.81 up-levels*Treats. = 58.90

of manure organo with inoculants and chemical application on N uptake and dry weights of sunflower crop. Moreover, the interaction results in Table 4 showed that the best response of N-uptake at mixed organo and bioinoculants application with half dose of ureaphosphate was 204.5 mg pot$^{-1}$, which did not differ significantly from application of full dose of ureaphosphate with organo and bio. at 200.0 mg pot$^{-1}$, that is agreed with Hanafy *et al.* (2002), who conducted that using half dose of chemical fertilizer, which supported with organo and *Azotobacter* and phosphate dissolved bacteria be useful on uptake-N then plant growth.

The results showed in Table 5 that application of various levels of ureaphosphate affected significantly when increase the P- uptake from 34.88 mg pot$^{-1}$ at no added treatment to 86.9 mg pot$^{-1}$ at half dose of ureaphosphate, which did not differ from full-up (84.65 mg pot$^{-1}$). Moreover, the half dose of the ureaphosphate and organo manure interaction recorded best response to obtain significant increase to 143,7 mg pot-1 compared to the least treatment at no application (26 mg pot-1). This results is similar to that reported by Paulo *et al.* (2016), who showed that the strongest positive relation between biological fertilizer (*Azotobacter* sp.) and half chemical urea and some parameters of yield of wheat and soybean plants.

### 3.3 The recovery (%) of nitrogen and phosphorus

The results in Fig. 1 showed that the difference of nitrogen recovery (%) was more than 90% at treatment of organo manure and bioinoculants with half dose of ureaphosphate compared to the rest of another applications were in order of half ureaphosphate with manure organo and bio. > half ureaphosphate with organo > half ureaphosphate with bio. > half ureaphosphate > no added. These results were noticed with Mahmoud and Mohaned (2008), who referred to significant increase in most applications of inoculants mixed with organic and mineral fertilizer as compared with control (no added). The same trend was noticed with the phosphourse recovery (%) in Fig. 2, when it decreased from 62.9% at half ureaphosphate dose with organo manure and bioinoculants to 7.9% at full ureaphosphate dose, these obtained results are in close agreement with those found by Muhammad *et al.* (2017). So the integrated fertilizer from half dose ureaphosphate with organo manure and bioinoculants had positive effect on plant growth when increased nutrients availability (N and P) then improved soil properties, so the high efficiency to protect nutrients either N or P [Faraj (2012)], who referred to positive competition among different microbial activities in soil rhizosphere with partly dose to enhance plant growth.

### 3.4 Available nitrogen and phosphorus nutrients in soil after 60 days planting

To improve soil fertility after 60 days of planting, available nitrogen and phosphourse nutrients in soil were determined, so the available- N in Table 6 showed that

**Table 5:** Effect of ureaphosphate levels (up) and organo and bio. applications on phosphoure uptake (mg pot$^{-1}$) of barely plants.

| up-levels | no added | Organo. | bio. | Organo.and bio. | mean |
|---|---|---|---|---|---|
| no-up | 26.0 | 30.0 | 28.70 | 54.80 | 34.88 |
| half- up | 46.90 | 68.0 | 89.0 | 143.70 | 86.9 |
| full- up | 54.80 | 68.7 | 81.6 | 133.50 | 84.65 |
| mean | 42.57 | 55.57 | 66.23 | 110.67 | |

$RLSD_{0.05}$
up – levels = 20.3 Treats . = 23.4 up-levels*Treats. = 28.7

**Table 6:** Effect of ureaphosphate levels and organo and biological applications on available – N (mg N kg$^{-1}$ soil) after 60 days planting.

| up-levels | no added | Organo. | bio. | Organo.and bio. | mean |
|---|---|---|---|---|---|
| no -up | 18.70 | 22.00 | 26.70 | 42.00 | 27.20 |
| half- up | 63.90 | 80.00 | 89.00 | 138.50 | 93.90 |
| full- up | 76.50 | 40.00 | 99.70 | 145.00 | 90.30 |
| mean | 53.03 | 47.33 | 71.57 | 111.50 | |

$RLSD_{0.05}$
up – levels = 5.91 Treats . = 3.76 up-levels*Treats. = 8.42

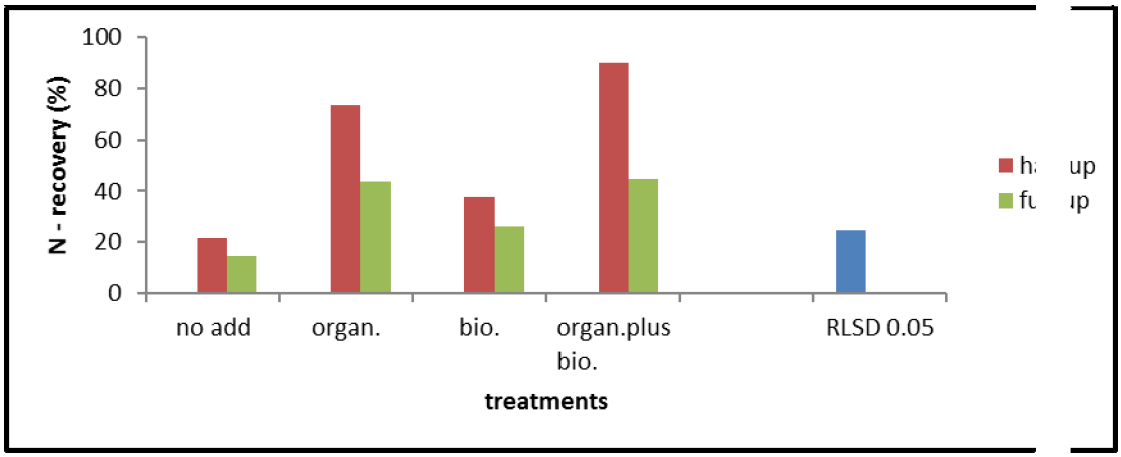


**Fig. 1:** Effect of ureaphosphate levels and organo and biological application on nitrogen recovery (%) of barely plants

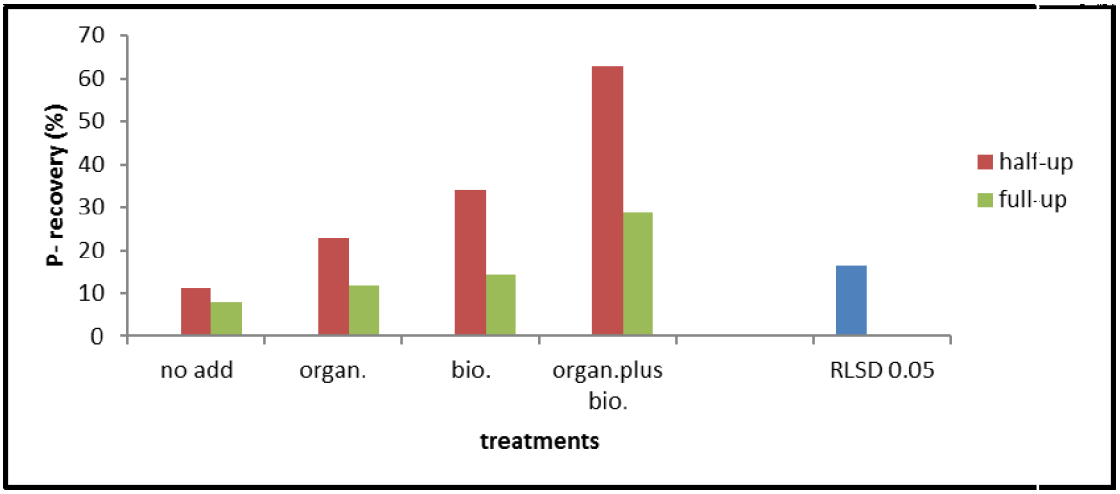


**Fig. 2:** Effect of ureaphosphate levels and organo and biological application on phosphourse recovery (%) of barely plants

significant effect ($RLSD_{0.05}$) of treatment organo manure and inoculants with full dose of ureaphosphate was 145 mg N $kg^{-1}$soil, compared to organ manure and bioinoculants only (no added), which was 18.7 mg N $kg^{-1}$ soil further more the treatment of organo manure and inoculants with full dose didn't differ from treatment of organ manure and inoculants with half dose of ureaphosphate, which was 138.5mg N $kg^{-1}$ soil, that is agreed with El-Komy (2005).

The results in Table 7 revealed to phosphourse availability in soil after planting when significant increase was from 8.03 mg $Pkg^{-1}$ soil at no added to 31.37 mg $Pkg^{-1}$ at treatment the organo manure and bioinoculants with half dose of ureaphosphate which didn't differ from the treatment of organo manure and bioinoculants with full dose of ureaphosphate which was 30.83 mg P $kg^{-1}$ soil that is agreement with Paulo *et al.* (2016), who observed positive role of half chemical fertilizer (as urea ) with manure and combined inoculants to improve availability of phosphate in soil.

So the results of this study indicated high availability of N and P nutrients to improve growth barley plants and reducing of nitrogen and phosphourse deterioration after 60 days planting when increase their bioavailability in soil and made fertilizers management by using integrated application of mineral, organo and biological inoculants to enhance parameters of crop and soil fertility.

### 3.5 Total number of bacterial inoculants after 60 days planting

The data in Fig. 3 showed that significant interaction relation between mixed the *Azotobacter* sp. and *Bacillus polymyxa* on total number of bacteria after 60 days of planting during adding full dose of ureaphosphate which was $9 \times 10^{10}$ $cfug^{-1}$ soil. The same results were noticed by Al-Jutheri and Ali (2011), who found no differences between half dose and full dose of chemical fertilizer when it supported with combination of organo manure with bioinoculants on

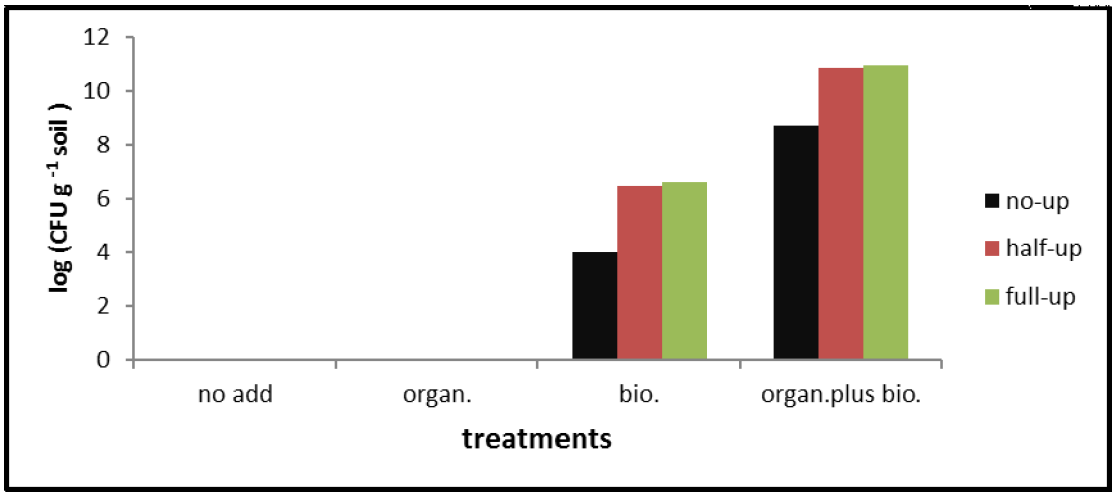


**Fig. 3:** Effect of ureaphosphate levels and organo and biological application on total number of bacterial inoculants (cfu $g^{-1}$ soil) after days planting

**Table 7:** Effect of ureaphosphate levels and organo and biological applications on available -P (mg P $kg^{-1}$ soil) after 60 days planting.

| up-levels | no added | Organo. | bio. | Organo.and bio. | mean |
|---|---|---|---|---|---|
| no -up | 8.03 | 9.16 | 10.09 | 19.90 | 11.79 |
| half- up | 15.04 | 19.53 | 13.11 | 31.37 | 19.76 |
| full- up | 14.17 | 18.21 | 23.85 | 30.83 | 21.77 |
| mean | 21.41 | 15.63 | 15.68 | 27.37 | |

$RLSD_{0.05}$
up – levels = 2.91 Treats . = 1.76 up-levels*Treats. = 3.42

total number of inoculants, at early stages of growth bacteria may depend on itself by fixing nitrogen and dissolving phosphourse in rhizosphere when limiting quantities of mineral nutrient (at half-up dose) as Al-Shybani (2005), but at full dose of ureaphosphte bacteria may depend on chemical application of ureaphosphte dose without need to loss more energy either N- fixation or P-dissolving as Faraj (2012), who referred to decrease total number of bacteria with full dose of chemical application moreover, the application of organo manure and bioinoculants together which gave $6\times10^{9}$cfu $g^{-1}$ soil compared to inoculants (bioinoculants only at $2.8\times10^{5}$cfu $g^{-1}$ soil) that is referred to positive role of dual bacterial inoculations during increasing biomass and another hand the highest ability for N-fixation and P-dissolving especially with adequate amounts of organo manure in soil. So it can be concluded that mixed organic manure and bioinoculants can partly substitute mineral fertilizers especially at half dose of ureaphosphte with organo manure and bioinoculants as Anjum *et al*. (2007), who referred to improve total number of bacteria with limited chemical amounts fertilizer in soil grown cotton crop.

## Acknowledgement

The authors would like to extend their appreciation to Department of Soil Science and Water Resources, College of Agriculture, University of Basrah for their financial support and place provided to this work.

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