Various source of supply of nitrogen (chemical, animal and biological) on growth, yield and product quality potatoes (*Solanum tuberosum* L.)

Behrooz Salehi¹, Jahanfar Daneshian², Mohammad Reza Ardakani³, Mohammad Hossein Arzanesh⁴ and Amir Hossein Shirani Rad²

1. Department of Agronomy, College of Agriculture Takestan Branch, Islamic Azad University, Takestan, Iran
2. Scientific Member, Seed and Plant Improvement Institute, Karaj, Iran
3. Faculty of Agriculture and Natural Resources, Karaj Branch, Islamic Azad University, Karaj, Iran
4. Assistant Prof. of Soil and Water Research Center, Golestan, Iran

**Corresponding Author email:** Isalehi_222@yahoo.com

<table>
<thead>
<tr>
<th>Paper Information</th>
<th>A B S T R A C T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received: 10 January, 2014</td>
<td>Application of bio-fertilizers in crop production with the aim of eliminating or substantially reducing the use of chemical inputs in order to increase the quality and yield stability is of great importance. In order to influence the quantity and quality of potatoes influenced by chemical fertilizers, manure and biological examined. Treatments, nitrogen fertilizer + manure as the first factor with five levels: lack of fertilizer, 100% N, 66% N + 33% manure, 33% N + 66% manure and 100% manure and the second factor seed inoculation (tuber) with biofertilizers with four levels: non-consumers of bacteria, Azospirillum, Pseudomonas and Azospirillum + Pseudomonas in the form of a factorial experiment in a randomized complete block design with three replications of 2011 and 2012 years of field research in the field University Abhar were evaluated. The results of the interaction (nitrogen + manure) × biofertilizers showed that the least amount of nitrate (22.43 mg.kg⁻¹) caused by the interaction of 100% manure × Azospirillum, The highest percentage of protein (8.17%) for the interaction of 100% manure in conditions of not using of bacteria, The highest tuber dry matter percentage (26.67%) for the interaction of treatment (66% N + 33% manure) × (Azospirillum + Pseudomonas), The highest percentage of starch (17.88 %), Protein yield (1096 kg.ha⁻¹), Tuber yield (73.08 ton. ha⁻¹) and biological yield (110.80 ton. ha⁻¹) of the interaction (66% N + 33% manure) × Pseudomonas. Therefore, the results obtained than Pseudomonas in a more positive effect Azospirillum and the combination of Azospirillum + Pseudomonas in the quantitative and qualitative parameters of potatoes are used in agriculture and potatoes is recommended. The results of this experiment indicate that biological fertilizers alone can not be replaced by chemical fertilizers and implementation of integrated plant nutrition and the use of nitrogen fertilizer, manure and bio-ecological approach can be used as a sustainable agricultural systems to reduce the use of chemical fertilizers and increase the productivity and sustainability of crop production inputs achieved.</td>
</tr>
<tr>
<td>Accepted: 24 March, 2014</td>
<td></td>
</tr>
<tr>
<td>Published: 20 April, 2014</td>
<td></td>
</tr>
</tbody>
</table>

**Key words:** Biofertilizer, Manure, Potato, Product quality, Sustainable agriculture.

**Introduction**

Management of fertilizer is a important factor in the success of plant cultivation and identification of biological fertilizers in between consistent with the nature and suitable for the growth and development of the plants may be variations of the effects on the qualitative and quantitative indicators have the product (Astaraie and Koocheki, 1996). Nitrogen is one of the essential elements for plant growth and is one of the main components of proteins. When the plant is in the unusual conditions, including excessive consumption of nitrogen fertilizers on the growth of the production of protein in the form of reduced non-protein nitrogen in the plant accumulates. Nitrate is one of the forms of non-protein that excessive consumption of food rations in it causing toxicity (Hernandes, 2000). The use of chemical fertilizers as the quickest way possible to compensate for the lack
of nutrients and soil fertility (Sharifi Ashoorabadi et al., 2002). The other hand the high cost of chemical fertilizers and soil pollution and water quality in agricultural production and reduced use of chemical fertilizers leads to complicated issues such as nitrate accumulation in agricultural products suffering from lack of oxygen and the formation nitrosamine compounds are carcinogens, toxic compounds and the lack of appropriate food is produced (Malakouti, 1996). However, could not be a matter of fertilizers from agricultural ecosystem stability is necessary because omitted in agriculture, to ensure sufficient income and food security. In this connection, the use of biofertilizers, along with several important for optimum use of fertilizers in maintaining fertility and biological activity of the soil structure, cation exchange capacity, and maintaining the water and soil physical and chemical structure. In recent years the FAO1 plans the development of integrated systems of food is recommended (Malakouti, 1996). According to the research of synthesis of organic fertilizers with biological resources and results has increased the efficiency of agricultural production in that way its own organic agriculture and ultimately turns towards sustainable agriculture (Zarea Fazibadi, 1998; Samar and Malakouti, 1998; Mohammadzadeh and Mevaechchi Langroodi, 1998; Malakouti, 1996). In many experiments by researchers in relation to organic farming and sustainable agriculture generally done in these fields is usually less attention to production quality (Francis et al., 1990). Despite the importance of the concentration of nitrate on human health is more than the standard level, the studies are very limited in our country. Therefore, with regard to the consumption of fertilizers and the necessity of practice of doing research on the use of alternative methods of chemical fertilizer consumption since the potato is one of the high efficiency and crop plants as well as the use of chemical inputs consumed. This study aims to investigate the effect of biological factors along with chemical fertilizers and manure on yield and some quantitative and qualitative traits in potato Agria cultivar in Abhar - Khorramdarreh was conducted.

Materials And Methods
After preparation of the operations of land two soil samples from the farm and manure production and was sent to the laboratory. Each plot consisted of four rows a length of 8 meters with a constant row distances of 75 cm and 25 cm plant spacings. Distance Plots from each other 1.5 meter acts as a protective to prevent interference with other bacteria and repeat interval of 3 meters was used to facilitate irrigation. For this experiment were used Solanum tuberosum var. Agria. From 60 to 70 grams of spermatic tubers as planting depth of 12 cm (Khajehpour, 2005; Abbasi, 2007; Shiril, 2007), were cultured at 16 in June. For this purpose the treatments, the certain amount of cow manure and decayed and powdered cow manure based on test weight and evenly over the plot, which were needed receiving manure was spread to a depth of 30 cm was mixed thoroughly with the soil. Urea fertilizer based on soil test recommendations in accordance with the experimental treatments plan, the distribution of rows for furrow the irrigation was performed immediately. Third Urea Nitrogen fertilizer treatments in each plot at planting and another third leg earthing up plants and the remainder was used in coincide with flowering. Before planting of potato tubers needed for bacterial the inoculum (Azospirillum, Pseudomonas and Azospirillum + Pseudomonas) were soaked in the shade. To prevent mixing of fertilizers, irrigation water, irrigation was performed in each replicate and each plot independently and water and repetitive plot was prevented the outflow. When during the harvest, total yield and harvest index were measured. From the tubers weight of 2 kg per plot a random sample were prepared and nitrate concentrations, protein percentage, starch percentage and dry matter percentage of tubers was determined. Bartlet test was performed before the combined analysis. The results indicate that the variances are congruent. The results of the experiments in using combined analysis and treatment means were evaluated using Duncan's test for a statistically calculations software MSTATC and charts using EXCEL software.

Results And Discussion
Specific gravity of tubers
Combined analysis of variance showed that consumer review (Urea + Manure) × Biofertilizer had no significant effect on tuber specific gravity affects it at the 5% level. According to the results of the comparison, the highest rate of tuber specific gravity (1.103 g cm⁻³) caused interaction by Non fertilizer × Pseudomonas was treated with all treatments except 100% N × (Azospirillum + Pseudomonas) the difference was significant (Table 1 and Figure 1). Bacteria Pseudomonas produce compounds with plant growth regulators and increasing the availability of nutrients for plants to increase photosynthesis and dry matter production of the plant will be. Application of plant growth stimulating bacteria, causing an increase in the amount of grain growth and food elements and this increase is mainly due to the production of plant growth regulators on the growth and root effect by bacteria and increase the absorption of water and nutrients from the soil (Hajilo et al., 2010). Phosphate solubilizing bacteria secrete organic acids and phosphates cause the release of toxic elements in soils are complex and the availability of plant nutrients to increase (Jatur and Reddy, 2007; Rudresh et al., 2005; Mohammadi et al., 2009). This is a consequence of the increase in tuber specific gravity. But the treatment of 100% N × (Azospirillum + Pseudomonas), merging the two bacteria fixing nitrogen in the soil with a sharp 100% N consumption of large amounts of nitrogen (328 kg.N.ha⁻¹) in the plant and cause toxicity plant and tuber specific gravity is reduced.
Tuber yield

The potato yield has resulted the number of tubers and average weight of the tuber (Lemaga and Caesar, 1990). Most of yield is tubers (73.08 t.ha⁻¹) owned by the interaction of treatment (66% N + 33% manure) × Pseudomonas and lowest tuber yield (41.79 ton.ha⁻¹) owned by the interaction of 100% manure × (Azospirillium + Pseudomonas) that were significantly different from each other (Table 1 and Figure 2). The reason is that this treatment is equivalent to 216.5 kg.N.ha⁻¹ and 7941 kg of manure per hectare with bacteria Pseudomonas consumed the vegetative growth and tuber production and appears to be relatively modest in the case of chemical fertilizers, manure and biological increased tuber yield is observed. Having the properties of nitrogen-fixing bacteria Pseudomonas and phosphorus solvers develop aviation sector and with major changes in plant physiology increased the yield and quality of the plants. It could colonize the plant rhizosphere microorganisms and their populations are rapidly and the production of secondary metabolites such as antibiotics and hydrogen cyanide phytopathogen growth and enhance plant growth is inhibited (Leben et al., 1987; Kloepper, 1983). Biofertilizers improves soil structure and activity of beneficial microorganisms, leading to desirable plants and water available macro and micro nutrients that the plant is increased (Darzi et al., 2006). Increased plant growth, phosphorus solvent-treated bacteria such as Pseudomonas, the ability of the bacteria transform inorganic phosphorus in the form of inaccessible form available to the plant. Siderophore production which makes iron available to pathogens of plants should be removed and disposed and the ability of bacteria to produce enzymes that make hormones regulate plant growth is related causes (Akhtar and Siddiqui, 2009). Used alone or in combination with fertilizers Bacillus maximum potato yield caused (Ekin et al., 2009). Combined use of biofertilizers, chemical and organic alternatives to chemical fertilizers can improve establish a balance between the elements in soil and rhizosphere conditions such as low pH and reducing the effects caused by stress (Leben, 1987) increased potato tuber yield and protein yield the potato (Mohammady-Aria et al., 2010). Organic materials containing low concentrations of various nutrients are released slowly decay in the short term to increase yield and its components is not. Provide a combination of nutrients using organic fertilizers, chemical fertilizers reduce and offset food shortages, maintain soil fertility and crop production has stabilized. Because of the increased yield due to the Integrated Systems Research match between the nitrogen available to the plant needs to know (Mooleki et al., 2004). Another reason for the increased yield of the integrated system can be made to preserve nutrients and prevent leaching of soil nitrogen in the soil improving the structure of the increased activity of manure can be of the biological (Ranells and Wagger, 1997; Ebelhar et al., 1984). In fact, this increased yield can be used to modified soil physical and chemical properties, reduce the specific gravity and increase the water maintenance capacity of the soil as influenced by integrated nutrition system. The result with the results (Paul and Beauchamp, 1993) is corresponded. This increases yield by providing food cycle and increase the availability of their ability to absorb is achieved by bacteria (Roesty et al., 2006).

Biological yield

In this respect, the comparison showed that the highest biomass yield (112.8 t.ha⁻¹) of treatment 33% N + 66% manure × non bacteria of a significant difference with most treatments, especially treatments 100% manure × Azospirillium (Table 1 and Figure 3). The combined application of organic and chemical fertilizers hasten mineralization process and release organic nitrogen and inorganic nitrogen supply during the growth period increases (Beauchamp, 1986). Adding organic matter to the soil, the organic process of the nitrogen mineralization occurs. Adding organic chemicals simultaneously, while providing nitrogen to organic nitrogen by chemically degrading bacteria in soil organic matter, reduced waste nitrogen (leaching or evaporate) and the mineralization process, nitrogen again gradually absorbed into the plant's availability during the period of plant growth will become due. In this regard, it is important to fit both organic and inorganic forms. With greater nutrient uptake by plants increases plant growth and biochemical activity of the tuber and biological yield in the plant is increased. This indicates that under conditions of reduced nitrogen fertilizer, manure can increase in consumption has been largely replaced chemical fertilizers to boost yield and biomass.

Harvest index

Harvest index quantity of plant biomass that is assigned to the turbe represents, therefore, an indicator of the plant's ability to allocate resources between vegetative and reproductive structures (Carruthers et al., 2000). Possibly because the biological yield harvest index is split tuber yield. Therefore, changes in these parameters will have a major impact on harvest index. According to the results of the comparison, the highest levels of the trait (69.79%) achieved 100% manure × Azospirillium interaction was significant difference with 100% N × Pseudomonas interactions between the lowest harvest index (48.94%) had the highest (Table 1 and Figure 4). Adding organic fertilizer in addition to providing nutrients and improving soil physical properties and provide favorable conditions for root development (Mohammadi et al., 2007). The organic fertilizers such as manure and compost improves soil physical properties and soil bulk density is reduced environment for root growth and development will be provided (Hati et al., 2006).
Table 1. Mean comparisons of some qualitative and quantitative traits of potatoes affected by urea fertilizer, animal manure and bio-fertilizer in the combined analysis of two years of the experiment.

<table>
<thead>
<tr>
<th>Biofertilizers</th>
<th>Specific gravity of tubers (g cm⁻³)</th>
<th>Tuber nitrate (mg kg⁻¹)</th>
<th>Starch (%)</th>
<th>Protein (%)</th>
<th>Tuber dry matter (%)</th>
<th>Protein yield (kg ha⁻¹)</th>
<th>Tuber yield (ton ha⁻¹)</th>
<th>Biological yield (ton ha⁻¹)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non used bacteria</td>
<td>1.074 ab</td>
<td>86.47 b</td>
<td>16.53 ab</td>
<td>4.897 ab</td>
<td>24.03 ab</td>
<td>612.5 bc</td>
<td>55.02 abc</td>
<td>81.9 abc</td>
<td>67.04 a</td>
</tr>
<tr>
<td>Non Azospirillum</td>
<td>1.069 ab</td>
<td>42.82 b</td>
<td>15.88 ab</td>
<td>5.857 ab</td>
<td>21.88 b</td>
<td>747.4 abc</td>
<td>58.52 abc</td>
<td>89.01 abc</td>
<td>66.75 a</td>
</tr>
<tr>
<td>Non used fertilizer</td>
<td>1.080 ab</td>
<td>30.78 b</td>
<td>16.77 ab</td>
<td>4.325 b</td>
<td>22.20 b</td>
<td>683.5 bc</td>
<td>66.75 abc</td>
<td>105.0 ab</td>
<td>64.25 a</td>
</tr>
<tr>
<td>Non Azospirillum</td>
<td>1.084 ab</td>
<td>45.92 b</td>
<td>15.06 b</td>
<td>4.945 ab</td>
<td>20.44 b</td>
<td>668.3 bc</td>
<td>59.87 abc</td>
<td>98.71 abc</td>
<td>60.65 a</td>
</tr>
<tr>
<td>100% N Pseudomonas</td>
<td>1.081 ab</td>
<td>32.87 b</td>
<td>14.27 b</td>
<td>4.537 b</td>
<td>21.85 b</td>
<td>519.2 bc</td>
<td>45.17 bc</td>
<td>93.44 abc</td>
<td>48.94 b</td>
</tr>
<tr>
<td>Azospirillum + Pseudomonas</td>
<td>1.022 b</td>
<td>43.88 b</td>
<td>15.66 ab</td>
<td>4.395 b</td>
<td>22.71 ab</td>
<td>546.5 bc</td>
<td>54.87 abc</td>
<td>85.46 abc</td>
<td>65.97 a</td>
</tr>
<tr>
<td>66% N Non used bacteria</td>
<td>1.083 ab</td>
<td>32.80 b</td>
<td>15.74 ab</td>
<td>4.628 b</td>
<td>23.09 ab</td>
<td>683.3 bc</td>
<td>59.07 abc</td>
<td>92.17 abc</td>
<td>65.19 a</td>
</tr>
<tr>
<td>33% Azospirillum</td>
<td>1.071 ab</td>
<td>29.02 b</td>
<td>15.85 ab</td>
<td>4.763 b</td>
<td>21.66 b</td>
<td>720.9 abc</td>
<td>62.28 abc</td>
<td>93.35 abc</td>
<td>67.89 a</td>
</tr>
<tr>
<td>+ Pseudomonas</td>
<td>1.096 a</td>
<td>46.65 b</td>
<td>17.88 ab</td>
<td>5.432 ab</td>
<td>24.21 ab</td>
<td>1096. a</td>
<td>73.08 a</td>
<td>110.8 a</td>
<td>66.53 a</td>
</tr>
<tr>
<td>manure Azospirillum + Pseudomonas</td>
<td>1.076 ab</td>
<td>33.80 b</td>
<td>17.15 ab</td>
<td>4.935 ab</td>
<td>22.90 ab</td>
<td>617.4 bc</td>
<td>61.00 abc</td>
<td>88.00 abc</td>
<td>62.15 a</td>
</tr>
<tr>
<td>33% N Non used bacteria</td>
<td>1.082 ab</td>
<td>39.20 b</td>
<td>15.56 ab</td>
<td>5.235 ab</td>
<td>22.52 ab</td>
<td>887.1 abc</td>
<td>71.04 abc</td>
<td>112.8 a</td>
<td>63.67 a</td>
</tr>
<tr>
<td>+ Azospirillum</td>
<td>1.065 ab</td>
<td>42.42 b</td>
<td>15.65 ab</td>
<td>4.698 b</td>
<td>22.96 ab</td>
<td>566.1 bc</td>
<td>52.08 abc</td>
<td>80.84 abc</td>
<td>65.69 a</td>
</tr>
<tr>
<td>66% Pseudomonas</td>
<td>1.087 a</td>
<td>41.40 b</td>
<td>14.80 b</td>
<td>5.830 ab</td>
<td>21.56 b</td>
<td>749.5 abc</td>
<td>60.05 abc</td>
<td>92.10 abc</td>
<td>66.36 a</td>
</tr>
<tr>
<td>manure Azospirillum + Pseudomonas</td>
<td>1.076 a</td>
<td>150.4 a</td>
<td>19.08 a</td>
<td>4.905 ab</td>
<td>26.67 a</td>
<td>767.8 abc</td>
<td>60.03 abc</td>
<td>90.41 abc</td>
<td>67.41 a</td>
</tr>
<tr>
<td>100% Non used bacteria</td>
<td>1.09 ab</td>
<td>38.35 b</td>
<td>15.56 ab</td>
<td>8.173 a</td>
<td>23.63 ab</td>
<td>535.0 bc</td>
<td>49.11 abc</td>
<td>73.95 bc</td>
<td>65.04 a</td>
</tr>
<tr>
<td>Azospirillum</td>
<td>1.083 ab</td>
<td>22.43 b</td>
<td>16.97 ab</td>
<td>4.948 ab</td>
<td>24.19 ab</td>
<td>469.7 c</td>
<td>44.89 bc</td>
<td>66.85 c</td>
<td>69.79 a</td>
</tr>
<tr>
<td>33% N + 66% Manure Pseudomonas</td>
<td>1.100 a</td>
<td>39.65 b</td>
<td>17.31 ab</td>
<td>4.262 b</td>
<td>23.71 ab</td>
<td>522.3 bc</td>
<td>51.42 abc</td>
<td>77.68 abc</td>
<td>66.71 a</td>
</tr>
<tr>
<td>Manure Azospirillum + Pseudomonas</td>
<td>1.072 ab</td>
<td>91.17 ab</td>
<td>14.32 b</td>
<td>7.035 ab</td>
<td>21.23 b</td>
<td>572.0 bc</td>
<td>41.79 c</td>
<td>70.40 bc</td>
<td>60.35 a</td>
</tr>
</tbody>
</table>

Mean followed by similar letters in each column are not significantly different.

Figure 1. Mean comparison of interaction (Urea + Manure) x Biofertilizer on tuber specific gravity.
Figure 2. Mean comparison of interaction (Urea + Manure) × Biofertilizer on tuber yield.

Figure 3. Mean comparison of interaction (Urea + Manure) × Biofertilizer on biological yield.
Figure 4. Mean comparison of interaction (Urea + Manure) × Biofertilizer on harvest index.

Figure 5. Mean comparison of interaction (Urea + Manure) × Biofertilizer on tuber nitrate.
Figure 6. Mean comparison of interaction (Urea + Manure) × Biofertilizer of tuber starch.

Figure 7. Mean comparison of interaction (Urea + Manure) × Biofertilizer on tuber protein.
Figure 8. Mean comparison of interaction (Urea + Manure) × Biofertilizer on tuber dry matter.

Figure 9. Mean comparison of interaction (Urea + Manure) × Biofertilizer on tuber protein yield.
Tubers nitrate

Most nitrate (150.4 mg.kg\(^{-1}\)) belonging to the interaction of treatment (33% N + 66% manure) × (Azospirillum + Pseudomonas) and lowest (62.7 mg.kg\(^{-1}\)) from the interaction of 100% Manure × Azospirillum that had a significant difference with each other (Table 1 and Figure 5). This is due to the treatment (33% N + 66% manure) × (Azospirillum + Pseudomonas) plants during their growing season, nitrogen gets a lot of different sources that have opportunity to possibly convert them all proteins and other materials are not. However, nitrate levels much lower than the permissible (250 to 300 mg.kg\(^{-1}\)) is limit. To explain this, it can be stated that the use of different sources of fertilizers, animal and plant life along with nitrogen and phosphorus needs, providing micronutrients for plants is and nitrogen into proteins and other materials well done and reduces the accumulation of harmful nitrates in potato tubers. Reported in de de (2003) permissible and acceptable levels of nitrates in potato tubers is 300 mg.kg\(^{-1}\) of dry matter in Germany but acceptable nitrate is based on fresh weight of 200 mg.kg\(^{-1}\) (Santamrya, 2006). In relation to the interaction of 100% manure × Azospirillum on nitrate can be said that the effect of biofertilizers in combination with various nutritional nitrogen on nitrate potatoes, because saving fertilizer nitrogen is probably due to the indisputable biofertilizers on nitrogen fixation and other beneficial soil organisms are (Parmar et al., 1998). One important role of nitrogen in plant proteins are involved in production. As was seen in a negative synergistic effect amounts to 100% manure utilization of along with Azospirillum bacteria feed on nitrate taste. It seems that the presence of bacterial nitrogen fixation in medium containing manure improves the activity of bacteria and other microorganisms are and cause the solubility of minerals, especially nitrogen and subsequently provides plant available nitrogen increases and the large increase in the baseline nitrate concentration nitrogen in the plant is so it can convert nitrogen to protein and other ingredients and to prevent accumulation of nitrate in plants.

Starch percentage

The highest percentage of starch (19.08%) belonged to the interaction of 33% N + 66% manure × (Azospirillum + Pseudomonas) which was not significantly different (15.66%) and the interaction of treatment 100% N × Pseudomonas (Table 1 and Figure 6). Has been observed in up to 40% phosphorus with starch potatoes there of phosphorus from phytate (inositol phosphate form) to starch are involved in the regulation of tuber growth (Khdjbry and Islam Zhadeh, 2001). As well as organic fertilizer and bio-chemical composition, improves growing conditions and increased photosynthesis and increases asimelason and increase storage of starch in tubers. Appears to increase the percentage of starch in the treatment, providing sufficient nitrogen by biological factors besides urea and manure and save it as starch, because starch to produce enough plant material is first increasing it the amount of nitrogen that plants (Goma and Magda, 2007). The nitrogen-fixing bacteria Azospirillum and Pseudomonas, having properties and dissolved phosphorus increased the yield and quality of the crop is produced. Therefore the system uses a combination of 33% N + 66% manure × (Azospirillum + Pseudomonas) not only starch yield can be boosted but can significantly reduce the nitrogen chemical fertilizers. In fact, the increase in the starch can be modified physical and chemical properties of soil, reducing the density and water holding capacity of the soil, as influenced by integrated nutrition system.

Protein percentage

Direct relationship between the amount of protein in plant nitrogen. Protein quality of tubers for seed potatoes is important so that the farming of potato tubers increases the protein content of food may increase the quality of potato tubers. According to the results of a mean comparison table of the highest tuber proteins (8.17%) resulting from the interaction of 100% manure × non use of bacteria (Table 1 and Figure 7). It can be stated that the addition of 100% manure to the soil by improving soil physical conditions and vital processes, In addition to creating a favorable environment for root growth and provide nutrients needed for plant growth and subsequently increase the production of more protein is to. Probably by preventing the use of 100% manure nitrogen waste nitrogen is managed more nitrogen in the plant and therefore 100% manure of the protein content of the treated is higher than other treatments. Kheir et al., (1991) reported that increased nitrogen consumption of sunflower seed protein. Adding organic fertilizer in addition to providing nutrients and improving soil physical properties and provide favorable conditions for root development (Mohammadi et al., 2007).

Tuber dry matter percentage

Tuber dry matter content in different varieties of potato tubers is an important factor in determining the quality. Comparison of means showed that the interactions (33% N + 66% manure) × (Azospirillum + Pseudomonas) the highest rate of tuber dry matter had (26.67%) and the significant interaction of treatment with 100% N × Azospirillum (20.44%) at 5% level indicated (Table 1 and Figure 8). Should bear in mind that dry matter at a special rate is not constant but is influenced by various factors such as soil, water, air, and minerals will change. Python (1990) reported that the consumption of bio-fertilizers and bio-nitrogen to mineral nitrogen to improve the quality of potatoes. Azospirillum and Pseudomonas bacteria having the properties of nitrogen fixation and phosphorus solvers develop aviation sector is growing corn and dramatic increase in yield and quality. Results Hassanzadeh et al., (2008) showed that the effect of phosphorus fertilizer on grain yield barley were significant. So
using a fusion system (33% N + 66% manure) × (Azospirillum + Pseudomonas), it is not only the tuber dry matter percentage increased significantly, but can also reduce nitrogen chemical fertilizers.

**Protein yield**

Yield protein is equal to the protein percentage × tuber dry weight. According to the results of the comparison, the highest amount of protein yield in tuber (1096.00 kg.ha⁻¹), the resulting interaction (66% N + 33% manure) × Pseudomonas was a significant interaction of treatment with 100% manure × Azospirillum lowest protein yield of tubers (469.70 kg.ha⁻¹) had the highest (Table 1 and Figure 9). Combined use of biofertilizers, chemical and organic alternatives to chemical fertilizers can improve the balance between the elements in soil and rhizosphere conditions such as low pH and reducing the effects of stress (Leben et al., 1987) increased potato tuber yield and protein yield the potato (Mohammady-Aria et al., 2010). Bacteria Pseudomonas produce compounds with plant growth regulators and increasing the availability of nutrients for plants to increase photosynthesis and dry matter production of the plant will be. Synergistic effects of interactions between bacteria and manure on another factor for the increase in plant biomass and increased protein yield of potatoes. Phosphate solubilizing bacteria secrete organic acids and phosphates cause the release of toxic elements in soils are complex and the availability of plant nutrients to increase (Jultur and Reddy, 2007; Rudresh et al., 2005; Mohammadi et al., 2009).

**Conclusions**

The results of this study show that the Nitrogen application based on soil test can not only produce high quality tuber yield deleterious accumulation of excess nitrate to prevent tubers. In the use of bacteria Azospirillum, Pseudomonas and Azospirillum + Pseudomonas combines the best results bacterium Pseudomonas in relation to the specific gravity of tubers, mean tuber weight per plant and shoot dry weight at physiological maturity showed. This would indicate that the bacteria have the ability to dissolve phosphorus to reduce the consumption of chemical fertilizer and increase yield and protect the environment and it can be concluded that the use of this bacteria is not only economical, but also the level of environmental pollution resulting from the indiscriminate use of fertilizers as well as avoids. In this respect, the nitrogen can be done with bacteria Pseudomonas from the harmful accumulation of excess nitrates in potato tubers also prevented. According to the results achieved more positive impact of Pseudomonas bacteria on the qualitative and quantitative indicators have potatoes and it can be recommended for use in potato cultivation. As a general conclusion it can be said that sustainable agricultural systems with sufficient input integrated nutrition plant implementation of by employing urea, manure and bio-fertilizers as a ecological approach can be used as a sustainable agricultural systems to reduce the use of chemical fertilizers and increase the productivity and sustainability of crop production inputs achieved.

**Acknowledgments**

The authors wish to thank the Islamic Azad University for supporting projects. This research was supported by Islamic Azad University, Takestan Branch, Takestan, Iran.

**References**


Malakouti MJ. 1996. Sustainable agriculture and enhanced performance optimization of fertilizer use, publication, dissemination of agricultural education. Karaj, Iran.