Effects Of Biofertilizers on Yield and Yield Components of Chickpea (*Cicer arietinum* L.) under Different Irrigation Levels

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**Abstract:** To evaluate the effects of nitrogenous and phosphorous biofertilizers on yield and yield components of chickpea under different irrigation levels a research was conducted in a split- split plot experiment with three replications based on completely randomized block design at Research Field of Islamic Azad University Tabriz Branch in the spring of 2009. Irrigation levels (normal and deficit irrigation) were considered as a main factor and cultivars (ILC482 and Pirouz) and also fertilizers levels (control, nitragin, biosuper and nitragin + biosuper) as sub and sub-sub factors respectively. The results showed that application of biofertilizers moderated water deficit stress, but its effect was lower as compared to complete irrigation. The effect of nitragen+biosuper application was higher than their separate applications. Cultivars ILC482 and Pirouz produced 73/33 gr/m² and 47/98 gr/m² respectively.

**Key words:** Biofertilizers, Biosuper, Chickpea, Deficit irrigation, Nitragen.

**INTRODUCTION**

Chickpea is one of the suitable plants grown broadly in most of the arid regions and dry farming areas in developing countries. It is also an important source of protein to feed the people (Abdul-Jaleel *et al*., 2007). This crop plant tolerates drought stress especially in marginal lands (Krishnamurthy *et al*., 2003). Chickpea has an active root system and releases organic matters regularly to the soil; these compounds promote growth and microbial population of the soil and as a result increase soil productivity (Kader, 2002). Biofertilizers are some non-symbiotic and symbiotic microbes like *Azospirillum*, *Bacillus polymyxa*, *Pseudomonas striata* and *Azotobacter*, in the soil (Saxena, 1993) that stimulate plant growth and contribute to the improvement of ecosystem. They also play an active role in biologic control of plant pathogens, (Tilk *et al*., 2005). *Azotobacter* and *Azospirillum* also release giberlln, biotin and auxin. These substances are effective in promotion of plant growth as biofertilizers (Vessey, 2003). *Azotobacter*, for example, produces antifungal compounds and increases speed of seed germination and seeding establishment (Tilk *et al*., 2005). It also enhances root growth, water and nutrients uptake and facilitate atmospheric nitrogen fixation (Saxena, 1993 and Sinclair *et al* 1998). *Bacillus polymixa* and some species of *Pseudomonas* dissolve rock phosphates and convert them to solubilized forms. They, thus, stimulate plant growth synthesis of hormones and increase phosphorous intake and nitrogen fixation (Serraj and Sinclair, 1998, El Zemranya *et al*., 2002, Kaur *et al*., 2006, Kizilkaya, 2008). Parson and Kirichman (2003) studied the effects of chemical nitrogen fertilizer and biofertilizer applications on agricultural soil and they concluded that organic matters added to the soil may delay organic nitrogen mineralization. Water and nitrogen availability to plant influence their potential growth and yield (Rajala *et al*., 2009). Drought stress reduces plant growth and yield though reduced leaf surface area and rate of photosynthesis. Extent of photosynthetic reduction depends on stress levels and stage of growth at which plants are exposed (Krishnamurthy *et al*., 2003).

It is thus decided to evaluate the effects of biofertilizers on chickpea yield and yield components under different levels of irrigation.

**MATERIALS AND METHODS**

To investigate the effects of nitragin and biosuper, as biofertilizers, on two cultivars of chickpea under the normal irrigation and deficit irrigation, a research was carried out at Research Field of Islamic Azad University, Tabriz Branch 15 kilometers east of Tabriz, Iran, during growing season of 2008-2009 summary of experimental yields has been depicted in (Table 1). This study was performed in a split- split plot experiment with three replications , two irrigation levels, two cultivars and four levels of biofertilizer arranged in a randomizes complete block design. Normal and deficit irrigations were asseinged to main plots, cultivars (ILC482 and Pirouz) to sub plots and biofertilizers (nitragin, biosuper, nitragin+biosuper and control) to sub-sub plots. Plots were 3m × 2m with four planting rows 50cm a part. The distance between plots and blocks were considered to
be one meter. Based on the results of soil test only 4 kg/ha of urea was added into soil as starter fertilizer (Table 2). Seeds were inoculated with one liter of nitragin (involving different concentrations of Azotobacter and Azospirillum) and 2 liters of biosuper (consisting of Azotobacter, Azospirillum, soil pathogenic agents’ inhibitor, Basillus subtilis and Pseudomonas fluorescens). Plots were irrigated regularly every week until plants were at flowering stage and it was stopped in drought stress plots when plants 10 percent of the were in bloom. After pod formation, ten competitive plants were selected randomly from two middle rows and traits like plant height, number of pods per plant, pods per main and lateral branches, seed number per plant, pods weight per plant and seed yield were measured. Statistical analysis and comparison of means were performed by software SAS and Dankens multiple range test at 5% level of probability.

RESULTS AND DISCUSSION

Analysis of variance of data showed that there was a significant difference between cultivars concerning plant height (p<.01), pods weight in per plant and seed yield (p<.05). Interaction between cultivars × plant height × irrigation levels were also significant (p<.05). Different levels of fertilizer treatments showed significant difference for plant height (p<.05), number of pods in per plant, number of pods per main branch, number of seed per plant, pods weight per plant and seed yield (p<.01). Interaction of fertilizer treatments × cultivars × irrigation levels for traits like number of pods in second branch, number of seed per plant and pods weight per plant were significant (p<.05) (Table 2).

Plant height:
Mean comparisons of cultivars showed that normal irrigation increased the plant height. Deficite irrigation, on the other hand, decreased ILC482 and Piruz cultivar by 6/26% and 71% respectively (figure 1). Lodeiro et al (2000) observed that chickpeas grown under atmospheric nitrogen fixation were more drought tolerant than plants grown under inorganic nitrogen. Treatment of nitragin and biosuper increased plant height by about 7/7 % (figure 2). It has been reported that inoculation chickpea of with both Pseudomonas fluorescense and Rhizobium enhances stem height, root length and dry weight (Dileep Kumar et al., 2001). Mekki and Amel (2005) also claimed that application of biofertilizer increases plant height and dry weight of soybean.

Number of pods per plant:
Number of pods per plant was found to be about 17/43 when nitragin and biosuper biofertilizers were used. This about 42% higher as compared with control group (Figure 3). Number of pods was significantly correlated with pod and seed weights per plant and seed yield (Table 3). In study of the effects of organic and biologic fertilizers on soybean growth and quality of seed, Mekki and Amel (2005) showed that the number of pods per plant was increased by applying biofertilizer. In an investigation on peanut, by the aim of replacement of chemical manure with organic manure, El Kramany et al (2007) also obtained the highest number of pods per plant when they treated it with 25% chemical manure and 75% biologic+organic fertilizer.

Number of pods in main branch:
The results showed that average number of pods in the main branch (5/77) was higher in normal irrigation than deficit irrigation (4/7) (Figure 4). Lower number of pods in the main branch due to drought stress can be attributed to protein decomposition and its sion to peptides and amino acids. Translocation of carbon and nitrogen into shoots, is also retarded under drought stress (Lodeiro and et al., 2000). Application of nitrogen+biosuper fertilizer increased number of pods in the main branch by 29/15% as compared with not using them. Separate application of these two fertilizers had similar effect on this trait (Figure 5). Bacteria, living within the root zone promote plant growth, its reproductively and nutrient uptake by releasing auxins and gibberellins (Kader, 2002).

Number of pods in lateral branch:
Mean comparisons of the different fertilizer treatments indicated that cultivars reacted differently to fertilizer under normal irrigation. Biosuper increased average number of pods in lateral branches in ILC482 cultivar. Nitratin biofertilizer was effective under water deficit stress (Figure 6). Pirouz cultivar did not respond to fertilizer application. The number of pods in lateral branch under normal irrigation increased without using fertilizer. Biofertilizers did not promote these traits. Biosuper biofertilizer under deficit irrigation, on the other hand, increased number of pods in second branch. Combined (nitragen+biosuper) application of biofertilizers was very effective under deficit irrigation (Figure 6). El Zemranya et al (2006) showed that nitrogen fixing microorganisms, like Azospirillum produce phytohormons that cause morphological and physiological changes in root, root cell multiplication and its lengthening and thus enable plants to absorb water and nutrients effectively.
Number of seed per plant:
The comparison of the treatments effects on number of seed per plant under different irrigation levels showed that application of nitragin+biosuper fertilizer increased seed number per plant by about 48/20% in ILC482 cultivar by 18/98% seed under normal irrigation. The increase in seed number was only 9% for ILC482 cultivar under deficit irrigation. However, single application of nitragin and biosuper did not have considerable effect on number of seed per plant (Figure 7). In Pirouz cultivar, application of nitragin+biosuper fertilizer increased seed number by 15/07% under deficit irrigation as compared with 17/83% under normal irrigation. Thus, there was not significant increase in seed number (Figure 7). It has reported that drought as an abiotic stress reduces photosynthesis and limits growth and seed yield (Bao et al., 2009 and Levi et al., 2009). Biofertilizers containing Azospirillum bacteria increase plant growth, lateral and capillary roots and as a result water and nutrient intake and nitrogen fixation (Mollaa et al., 2001).

Pod weight per plant:
Application of nitragin+biosuper increased pod weight by about 62/76% in ILC482 cultivar. On the other hand, pod weight increase under water deficit stress, was only 10/13% (Figure 8). Zaady et al., (1993) reported that biofertilizer containing Azospirillum increases plants, above ground dry weight, because it expands root growth and its surface area. Application of biosuper + nitragin fertilizers showed an increase of 43/04% in dry weight of Pirouz under complete irrigation. However single application of biosuper and nitragin did not increase pod weight significantly as compared to control and also highly with each other. Combined application of nitragin and biosuper highly influenced pod weight per plant under water deficit stress (Figure 8). Meshram and Shende (1993) suggested that Azospirillum increases root surface area and thus promotes intake of nitrogen, phosphorous, potassium, other nutrients, and water and consequently above ground weight of plants.

Seed yield:
Mean comparisons showed that ILC482 cultivar and Pirouz prodused 73/33 gr/m^2 and 47/98 gr/m^2 respectively (Figure 9). It was also revealed that application of nitragin+biosuper fertilizer produced 32% more grain yield than control. Results also indicated that there was not significant yield difference between nitragin and biosuper applications. However, combined application of these low fertilizers increased yield (Figure 10). Bacteria had beneficial effect on plant growth and seed yield, because they fix atmospheric nitrogen and release auxins to the root zone to enhance growth (Rees et al., 2009). Addition of biofertilizer promotes bacterial response to nitrogen fixation and soil fertility. Higher rates of atmospheric nitrogen fixation promotes growth and yield (El-Desuki et al., 2010). Yields of ILC482 and Pirouz cultivar highly correlated with plant height (r=0.932), number of pods in main branch (r=0.548), number of seed per plant (r=0.601) and pods weight per plant (r=0.960).
In conclusion it can be seed that application of biofertilizers, specially nitragin+biosuper, influenced yield and components of yield in chickpea cultivars under drought condition and thus, application of biofertilizer moderated the adverse effect drought stress.

**Table 1:** Summery of experimental field condition

<table>
<thead>
<tr>
<th>Soil textural class</th>
<th>%Clay</th>
<th>%Silt</th>
<th>%Sand</th>
<th>K ppm</th>
<th>p (ppm)</th>
<th>T.N (%)</th>
<th>O.C (%)</th>
<th>%TNV</th>
<th>EC(mS/cm)</th>
<th>pH</th>
<th>deep (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy loam</td>
<td>7</td>
<td>13</td>
<td>80</td>
<td>380</td>
<td>75/2</td>
<td>0/134</td>
<td>1/56</td>
<td>12</td>
<td>1/21</td>
<td>8/11</td>
<td>0-30</td>
</tr>
</tbody>
</table>

**Table 2:** Analysis of variance for the traits under study

<table>
<thead>
<tr>
<th>Mean squares</th>
<th>F.D</th>
<th>Plant height cm</th>
<th>Number of pods per plant</th>
<th>Number of pods in main branch</th>
<th>Number of pods in lateral branch</th>
<th>Number of pods per plant</th>
<th>Pod weight per plant</th>
<th>yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>replication</td>
<td>2</td>
<td>52.814</td>
<td>320.276</td>
<td>4.521</td>
<td>1.005</td>
<td>382.270</td>
<td>23.875</td>
<td>5517.322</td>
</tr>
<tr>
<td>irrigation</td>
<td>1</td>
<td>15.357</td>
<td>184.671</td>
<td>13.653*</td>
<td>0.888</td>
<td>109.626</td>
<td>17.115</td>
<td>3086.305</td>
</tr>
<tr>
<td>Error A</td>
<td>2</td>
<td>10.934</td>
<td>46.830</td>
<td>0.361</td>
<td>0.473</td>
<td>36.465</td>
<td>5.073</td>
<td>1488.520</td>
</tr>
<tr>
<td>cultivar</td>
<td>1</td>
<td>175.759 **</td>
<td>4.845</td>
<td>0.067</td>
<td>0.004</td>
<td>0.261</td>
<td>25.820**</td>
<td>7713.625*</td>
</tr>
<tr>
<td>× irrigation cultivar</td>
<td>1</td>
<td>10.407*</td>
<td>47.104</td>
<td>0.021</td>
<td>0.404</td>
<td>53.004</td>
<td>7.647</td>
<td>780.587</td>
</tr>
<tr>
<td>Error B</td>
<td>4</td>
<td>0.944</td>
<td>20.512</td>
<td>0.592</td>
<td>0.080</td>
<td>24.233</td>
<td>2.389</td>
<td>682.562</td>
</tr>
<tr>
<td>fertilizer</td>
<td>3</td>
<td>6.423*</td>
<td>57.474**</td>
<td>3.526**</td>
<td>0.019</td>
<td>30.145**</td>
<td>4.540**</td>
<td>559.825**</td>
</tr>
<tr>
<td>irrigation fertilizer ×</td>
<td>3</td>
<td>0.652</td>
<td>4.437</td>
<td>0.297</td>
<td>0.030</td>
<td>3.172</td>
<td>0.343</td>
<td>19.517</td>
</tr>
<tr>
<td>fertilizer cultivar ×</td>
<td>3</td>
<td>0.333</td>
<td>6.372</td>
<td>0.290</td>
<td>0.222*</td>
<td>5.967</td>
<td>0.506</td>
<td>99.516</td>
</tr>
<tr>
<td>Variable</td>
<td>Coefficient</td>
<td>Error</td>
<td>p-values</td>
<td>Percentage</td>
<td>Significance</td>
<td></td>
<td></td>
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<td>---------------------------</td>
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<tr>
<td>Fertilizer × irrigation</td>
<td>1.150</td>
<td>3.642</td>
<td>0.045</td>
<td>0.236*</td>
<td>28.856*</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Cultivar</td>
<td>7.673*</td>
<td>0.783*</td>
<td>0.073</td>
<td>0.276</td>
<td>39.573</td>
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</tbody>
</table>

Significant difference in p=1% and p=5%

Fig. 1: Effects of different irrigation levels on plant height
a: irrigation; a1: normal irrigation, a2: deficit irrigation,b: chickpea cultivar: b1: ILC482, b2: Pirouz

Fig. 2: Effects of biofertilizers on plant height
a1: control, a2: nitragin, a3: biosuper, a4: nitragin+biosuper

Fig. 3: Effects of biofertilizers on number of pods per plant
a1: control, a2: nitragin, a3: biosuper, a4: nitragin+biosuper

Fig. 4: Effects of irrigation levels on number of pods in main branch
Fig. 5: Effects of biofertilizers on number of pods per plant
a1: control, a2: nitragin, a3: biosuper, a4: nitragin+biosuper

Fig. 6: Interaction effect of fertilizer * irrigation * cultivars on number of pods in lateral branch
a1: normal irrigation, a2: deficit irrigation, b1: ILC482, b2: Pirouz, c1: control, c2: nitragin, c3: biosuper, c4: nitragin+biosuper

Fig. 7: Interaction effect of fertilizer * irrigation * cultivars on number of pods per plant
a1: normal irrigation, a2: deficit irrigation, b1: ILC482, b2: Pirouz, c1: control, c2: nitragin, c3: biosuper, c4: nitragin+biosuper

Fig. 8: Interaction effect of fertilizer * irrigation * cultivars on pod weight per plant
a1: normal irrigation, a2: deficit irrigation, b1: ILC482, b2: Pirouz, c1: control, c2: nitragin, c3: biosuper, c4: nitragin+biosuper
Fig. 9: Mean comparison of different chickpea cultivars

![Graph showing mean comparison of chickpea cultivars.]

Fig. 10: Effect of biofertilizers on seed yield of chickpea cultivars

a1: control, a2: nitragin, a3: biosuper, a4: nitragin+biosuper

Table 3: Coefficient correlation in study traits

<table>
<thead>
<tr>
<th>Plant height cm</th>
<th>Number of pods per plant</th>
<th>Number of pods in main branch</th>
<th>Number of pods in lateral branch h</th>
<th>Number of seeds per plant</th>
<th>Pod weight per plant</th>
<th>yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/513*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/354</td>
<td>0/863**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/321</td>
<td>0/601*</td>
<td>0/525*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/408</td>
<td>0/963**</td>
<td>0/849**</td>
<td>0/618*</td>
<td>1</td>
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<td>0/867**</td>
<td>0/844**</td>
<td>0/661**</td>
<td>0/574*</td>
<td>0/774**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0/932**</td>
<td>0/704**</td>
<td>0/548*</td>
<td>0/496</td>
<td>0/601*</td>
<td>0/960**</td>
<td>1</td>
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REFERENCES


