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# The effect of irrigation and nitrogenous and phosphorous biofertilizers on yield and yield component on chickpea (*Cicerarietinum* L.) ILC482 line

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**Key words:** Biofertilizers, Biosuper, Chickpea,Deficit *I*rrigation, Nitragen.

## 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 plot experiment with three replicationsbased on completelyrandomized 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 also fertilizers levels (control, nitragin, biosuper and nitragin + biosuper) sub factors respectively. Control treatment of biofertilizer showed fewer enhancements. Comparison of biofertilzer treatments showed that nitrogen + biosuper biofertilizer increased more number of pods with one seed per plant by 19/28, number of pods with two seed by 15/28, seed weight per plant by 4/47 g/$m^2$, pod weight per plant by 5/93 g/$m^2$and yield by 89/39g/$m^2$. There is no significant difference among nitragen ,biosuper and control treatments.Comparison of the different irrigation levels effect on number of pods with two seed per plant showed that complete irrigation produced more number of pods with two seed per plant by 24/1.and 100 seed weight by 30/76 g nitragen and biosuper produced significant yield relative to other treatments.

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## Introduction

Grain legumes are a major source of proteins in human and animal nutrition and they play a key role in crop rotation in most parts of the world (Ben Romdhan et al., 2009). Chickpea is indeterminate, diploid (2n=16), self-pollinated. Kabuli chickpea (*Cicerarietinum L.)* is a quantitative long day plant and is one of the most widely cultivated cool season food legumes. It is best adapted to spring–early summer seasons of the mediterean and cool winter temperatures in the semi-arid tropics. The world average seed yield of 796 kg/ha results in a shortfall between production and demand in most countries. Micro organisms are an essential and large component of the living biomass of the soil (Naiman, *et al*., 2009). Many different genera of plant growth promoting *Rhizobacteria* such as *Azospirillum, Azotobacter, Bacillus* have been used as biofertilizer for economically important crops (Rokhzadi and Toashih, 2011). Generally, legume dominant stands show better response tobiofertilizer application because theyobtain their nitrogen andphosphorus requirements via symbiotic pathways (Erkovan *et al.* 2010). *Bacillus megaterium var. phosphaticum*,a phosphorus solubilizing bacteria, release acid into therhizosphere to enhance nutrient uptake (Vazquez *et al.* 2003). This process might reduce pH levels ofsoils and might alter competition conditions within naturalcommunities (Erkovan *et al.* 2010). The bacteria used as phosphorus and nitrogenus biofertilizers could contribute to increasing the availability of phosphates and nitrogen immobilized in soil and could enhance plant growth by increasing the efficiency of other nutrients (Erkovan *et al*., 2010). Indeed, studies on the application of nitrogen fixingand phosphorus solubilizing bacteria were shown to increaseyields cicer (Elkoca *et al.* 2008).The recorded increase in wheat grain yield by co-inoculation of the plant with bio-fertilizers could be due to the increase in the number of grains per plant and due to increased weight of grains per plant (Askary, *et al*., 2009). Water deficiency and drought directly affect persistence andsurvival of biofertilizer in the soil, nodule activity and function and also limits nodulation through its effectson root-hair colonization and usage fertilizer by plant (BemRamadhan *et al.* 2009). Increasing crop tolerance to water deficit would be the most economical approach to enhance productivity and reduce agricultural utilization of fresh water resources (Gao *et al*., 2008). Leport *et al*., (2006) showed that early water stress affects on dry matter production, biomass and seed yield in chickpea.Even under stress condition, *Azospirillun* inoculation increased the grain yield and mineral nutrition in plant under stress (Creus, *et al*., 2004).

It is thus decided to evaluate effects of biofertilizers on chickpea yield and its components under different levels of water stress.

## Materials and methods

To investigate the effects of nitragen and biosuper, as biofertilizerson one 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 yield has been depicted in (Table 1). This study was conducted in a split plot experiment with three replications, two irrigation levels, four levels of biofertilizer arranged in a randomized complete block design. Normal and deficit irrigations were assigned to the main plots, and biofertilizers (nitragen, biosuper, nitrogen + biosuper and control) to sub plots. Plots were 3m × 2m with four planting rows with 50cm in each part. The distance between plots and blocks were considered to be one meter. Based on the results of the soil test only 4 kg/ha of urea was added into the soil as starter fertilizer (Table 1). 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, *Basillussubtilis* and *Pseudomonas fluorescens*). Plots were irrigated regularly every week until plants were at flowering stage and it stopped in drought stress plots when plants were in 10 percent of the bloom.

After pod formation, ten competitive plants were selected randomly from two middle rows and traits like pod number with one and two, seed number per plant, pods weight per plant, seed weight per plant, 100 seed weight and seed yield were measured. Statistical analysis and comparison of means were performed by software SAS and LSD multiple range test at 5% level of probability.

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

| Soil textural class | % Clay | % Silt | % Sand | K ppm | P (ppm) | T.N (%) | O.C (%) | % TNV | EC (mS/cm) | pH | Deep (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy loam | 7 | 13 | 80 | 380 | 75/2 | 0/134 | 1/56 | 12 | 1/21 | 8/21 | 30-0 |

**Results and discussion**

Analysis of variance of data showed that there was a significant differencein irrigation on number of pods eith two seeds (p<%5). Fertilizers treatments shows significant difference according to plant height, number of pods in main branch, number of pods with two seeds, seed weight per plant, pod weight per plant and yield (p<%1) and number of pods in lateral branch, number of pods with one seed (p<%5). Interaction of fertilizer treatment × irrigation levels for traits like number of seed per plant and 100 seed weight (p<%5) (Table 2).

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

| | | Mean squares | | | | | |
|---|---|---|---|---|---|---|---|
| variable | F.D | Number of pod with one seed | Number of pod with two seed | seed weight per plant | Pod weight per plant | 100 seed weight | yield |
| replication | 3 | 173.18 | 0.18 | 9.52 | 17.14 | 48.14 | 3755.90 |
| irrigation | 1 | 60.96 | 3.52* | 4.62 | 7.21 | 35.62 | 1591.37 |
| Error A | 2 | 96.68 | 0.17 | 6.42 | 10.66 | 13.53 | 2830.89 |
| fertilizer | 3 | 31.48* | 0.88* | 2.07** | 4.85** | 23.93** | 533.63** |
| irrigation×fertilizer | 3 | 5.18 | 0.31 | 0.584 | 0.81 | 12.39* | 59.48 |
| error | 12 | 6.38 | 0.13 | 0.30 | 0.58 | 3.22 | 84.31 |
| Variable coefficient% | | 21 | 22.21 | 15.27 | 16.35 | 6.71 | 11.89 |

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

*Number of pods with one seed*

Mean comparison of the different fertilizers showed that there is a positive interaction between nitrogen and biosuper. This biofertilizer increased number of pods with one seed per plant and treatment nitrogen + biosuper produced more number of pods with one seed per plant by 19/28. There is no significant difference among other treatments. Single application of biofertilizer did not affect on number of pods with one seed per plant, while there is no significant difference among these treatments and control (Figure 1). The recorded increase in wheat grain yield by co-inoculation of plant with biofertilizers could be due to the increased in the number of grains per plant and due to increased weight of grains per plant (Askary, *et al.*, 2009).In, general microorganism can play a very significant role inmaking available phosphorous to plants. Bacterial organicacids after which free phosphate may sometimes beliberated by hydrolysis can dissolve organic phosphate.

It is essential to bring about some microbial transformations of both inorganic and organic-compounds in soil to make available of this element toplant (Mekki and Amel, 2005).

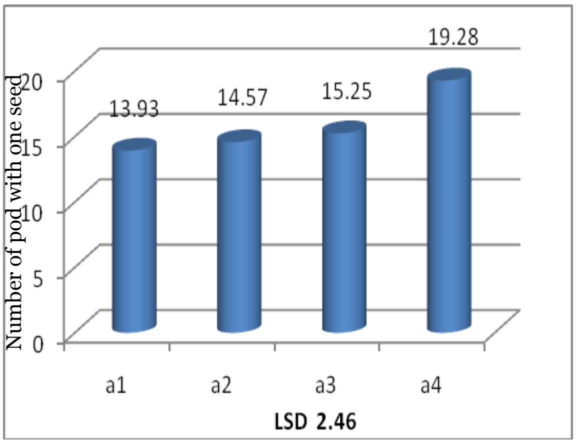

**Fig. 1**. Effects of biofertilizers on number of pod with one seed a1: control, a2: nitragen, a3: biosuper, a4: nitrogen + biosuper.

*Number of pods with two seed*

Mean comparison of the different irrigation levels effect on number of pods with two seed per plant showed that complete irrigation produced more number of pods with two seed per plant by 24/1 relative to water deficit by 14/9 number of pods with two seed per plant .So it is indicated 38/17% reduction in number of pods with two seed per plant. An increase in the number of lateral roots and root hairs cause addition of root surface available for nutrients and water uptake. Higher water and nutrient uptake by inoculated roots caused an improved water status of plant, which in turn could be the main factor enhancing plant growth (Askary, *et al.,* 2009).Mean comparison of the different fertilizers showed that there is a positive interaction between nitragen and biosuper. Thisbiofertilizer increased number of pods with two seed per plant and treatment nitrogen + biosuper produced more number of pods with two seed per plant by 15/28. There is no significant difference among other treatments. Single application of biofertilizer did not affect on number of pods with one seed per plant, while there is no significant difference among these treatments and control (Figure 2). Number of pods and number of seed per plant and grain yield increased with applied *Azotobacter* + *Azospirillum* + *Pseudomonas* + *Mesorhizobium* (Rokhzadi, *et al.*, 2008).

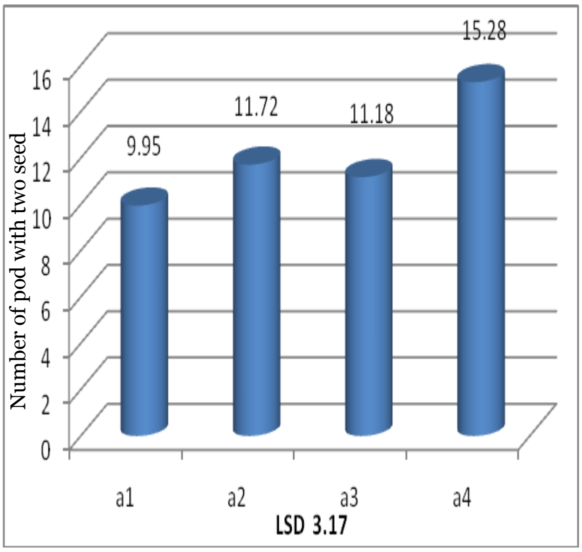


**Fig. 2**. Effects of biofertilizers on number of pod with two seed a1: control, a2: nitragen, a3: biosuper, a4: nitrogen + biosuper.

**Table 3**.Coefficient correlation in study traits.

| yield | 100 seed weight | Pod weight per plan | seed weight per plan | Number of pod with two seed | Number of pod with one seed | |
|---|---|---|---|---|---|---|
| | | | | | 1 | Number of pod with one seed |
| | | | | 1 | .910 | Number of pod with two seed |
| | | | 1 | .956* | .990* | seed weight per plan |
| | | 1 | .999** | .963* | .988* | Pod weight per plan |
| | 1 | .975* | .967* | .924 | .976* | 100 seed weight |
| 1 | .987* | .981* | .980* | .900 | .997** | yield |

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

*Seed weight per plant*

Mean comparison of different fertilizers treatments showed that application of nitragin + biosuper increased seed weight by average of 4/47 g/m$^2$. Other treatments produced the same seed weight. There is no significant difference among treatments (Figure 3). Application of biosuper + nitragen fertilizers enhanced seed weight per plant significantly. Because of inoculation with seed, *Azospirillum* increases root surface area and thus promotes intake of nitrogen, phosphorus, potassium, other nutrients,

water in above ground organs and plant dry weight. Number of pods per plant and pod weight at harvest was recorded significantly maximum at combined inoculation of (*Rhizobium* + *Azospirillum* + *Pseudomonas*) in field pea (Mishra *et al.*, 2010). The general physiological status of the plants as indicated by the dry weight always exhibited positive response to use biofertilizer addition (Mekki and Amel, 2005). According to Table 2 there is a significant and positive correlation among number of seed per plant, plant weight, number of pods in main branch,

number of pods with one seed, number of pods with two seed and 100 seed weight per plant in reliability of one percent and there is a significant correlation with seed weight per plant, pod weight per plant and yield and number of pods per plant, number of seed per plant and pod weight per plant in reliability of five percent.

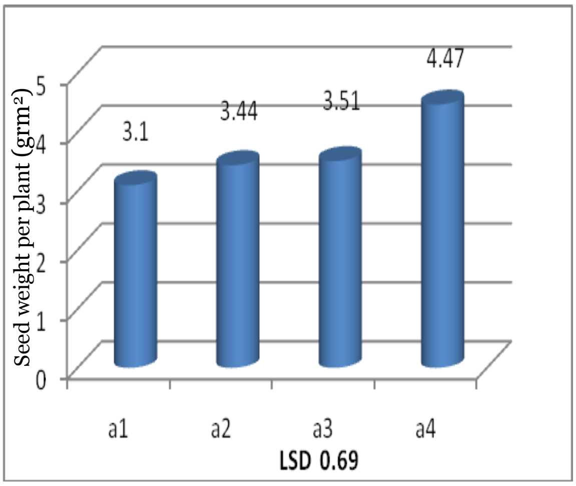


**Fig. 3**. Effects of biofertilizers on seed weight per plant a1: control, a2: nitragen, a3: biosuper, a4: nitragen+biosuper.

*Pod weight per plant*

Mean comparison of different fertilizers treatments showed that application of nitragin + biosuper increased pod weight by average of 5/93 g/m². Other treatments produced the same pod weight. There is no significant difference among treatments (Figure 4). Application of biosuper + nitragen fertilizers enhanced pod weight per plant significantly. Because of inoculation with seed,*Azospirillum* increases root surface area and thus promotes intake of nitrogen, phosphorus, potassium, other nutrients, water in above ground organs and plant dry weight. Number of pods per plant and pod weight at harvest was recorded significantly maximum at combined inoculation of (*Rhizobium* + *Azospirillum* + *Pseudomonas*) in field pea (Mishra *et al.,* 2010). The general physiological status of the plants as indicated by the dry weight always exhibited positive response to use bio-fertilizer addition. (Mekki and Amel, 2005).

*Hundred seed weight*

Mean comparison of different fertilizers treatments under different level of irrigation showed that application of nitragen by 29/04g and nitrogen + biosuper by 30/76g increased hundred seed weight. There was no significant difference between nitragen and biosuper. Control treatment produced less hundred seed weight by 23/59g under complete irrigation. Application of 27/84g nitrogen + biosuper increased hundred seed weight under water deficit. 24/06g biosuper produced less hundred seed weight indicating negative reaction of the biofertilizerunder water stress. Since under water stress, the ideal condition is reduced for activity of bacteria, so it leads to negative effect on plant (Figure 5). Such an effect result in higher 100 seed weight and higher grain yield grap in the tropics from dry season or low irrigation crops compared to wet or complete irrigation crops because of higher irradianc (Yang *et al.*, 2008). Ibeawuchi and Onweremalu (2007) in an experiment showed that, at frist of all the highest 1000 seed weight was in integrated fertilizer treatments. Improved plant growth by A. brasilense has been attributed both to production of plant hormones, especially growth promoters and by supplying combined nitrogen (Pedraza *et al.,* 2007).

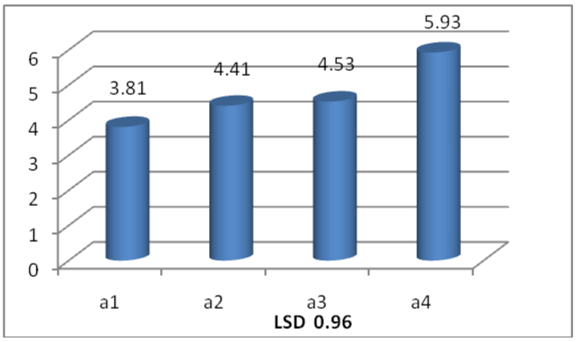


**Fig. 4.** Effects of biofertilizers on pod weight per plant a1: control, a2: nitragen, a3: biosuper, a4: nitragen+biosuper.

**Yield:** Mean comparisons of different fertilizers treatments showed that application of nitragin +

biosuper by 89/39 g/m² produced more yield. Application of single bio-fertilizer did not affect on yield positively. There was no significant difference among nitragin,
biosuper and control treatments(Figure 6).Bacteria have beneficial effect on plant growth and yield, and because they fix atmospheric nitrogen and release auxins to the root zone to enhance growth (Rees et al., 2009). Ali *et al.* (2008) who reported that seed inoculated plants. Exhibited significantly greater yield and component yield in garden pea. Co-inoculation of wheat seeds with Azotobacter and Azospiriilum had positive significant effects on the grain yields about average 53/8% higher compared to non inoculation plant (Askary, *et al.*, 2009). Addition of biofertilizer promotes bacteria response to nitrogen fixation and soil fertility. High atmospheric nitrogen fixation increases growth and yield (El-Desuki *et al.*, 2010).

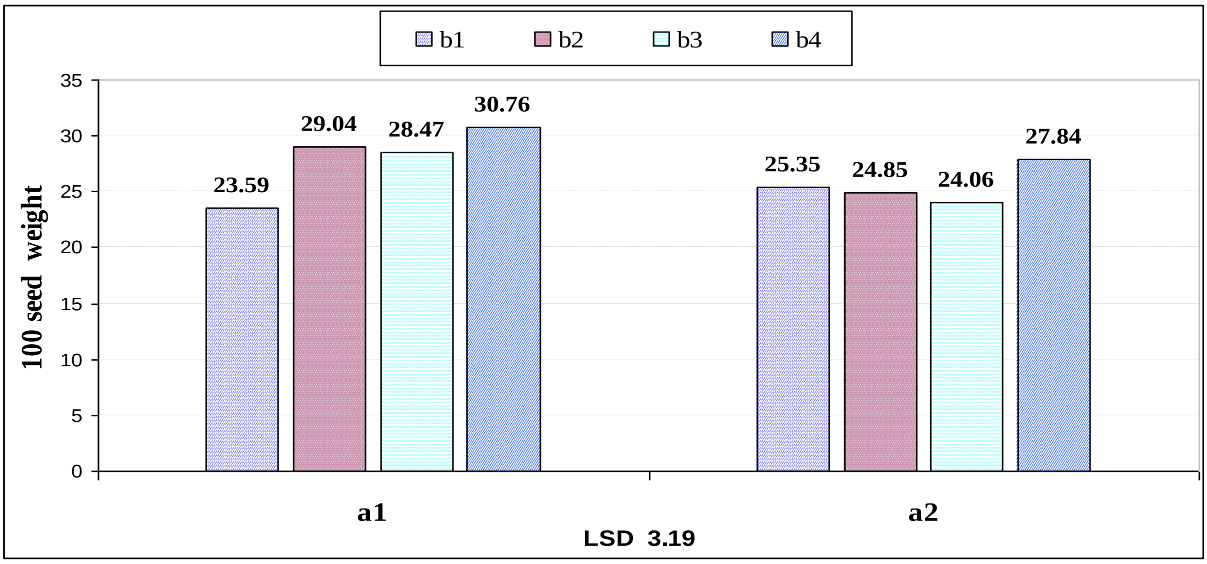


**Fig. 5.** Interaction effect of fertilizer * irrigation on 100 seed weight a1: normal irrigation, a2: deficit irrigation, b1: control, b2: nitragen, b3: biosuper, b4: nitragen+biosuper.

According to Table 3 there is a significant and positive correlation among yield, plant weight, seed weight per plant, pod weight per plant, 100 seed weight per plant in number of seed per plant in reliability of five percent and there is a significant and positive correlation among number of pods per plant, number of pods in main branch and number of pods with one seed in reliability of one percent.

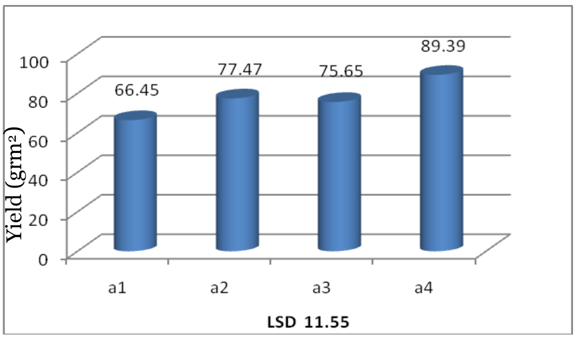


**Fig. 6.** Effects of biofertilizers on yield a1: control, a2: nitragen, a3: biosuper, a4: nitragen+biosuper

**Conclusion**

The results show that application of biofertilzer adjusts water deficit in general. Under complete irrigation, number of pods with two seed was increased 38/73 % by 24/1relative to water deficit by 14/9 number of pods with two seed. Application of bio-fertilzers enhances number of pods in lateral branch. Using nitrogen + biosuper increases plant weight, seed weight per plant, pod weight per plant , number of seed per plant ,number of pods per plant , number of pods in main branch and number of pods with one seed and yield. There is no significant difference among nitragen, biosuper and control treatments statistically. Application of nitrogen + biosuper increases seed weight per plant, 100 seed weight and yield under complete irrigation.

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