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Study of the Effects of Number of Irrigation Intervals and Different Levels of Compost on Biological Fixation on Nitrogen in two Cultivars of lentil (*Lens culinaris* Medik.)

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ABSTRACT: *In order to study the effects of number of irrigation intervals and different levels of compost on biological fixation on nitrogen in two varieties of lentila trial was carried out in a field located in Badder Abad village, Saqez. The experimental design was factorial arranged in RCB with three factors and three replications. The first factor contained two varieties of lentil (Bilesavar and Kimia) and the second factor contained three levels of irrigation (no-irrigation, one irrigation interval, two irrigation intervals) and two levels ofcompost (control and 20 t/ha). Results showed that in terms of %N and %protein of the shoot and the number of nodes of the root there were significant differences. Among the irrigation levels there were significant differences in terms of %N and %protein and number of nodes of the root and finally the effect of compost on all of the studied traits was significant. In the present study the Kimia variety had more %protein and number of nodes than the Bilesavarvariety. Among the irrigation levels the treatment of three irrigation intervals had more %N and %protein of root and number of nodes than the rest of the irrigation intervals. Finally, the application of compost significantly increased %N and %protein of root and number of nodes compared with the check.*

Key words: *Irrigation, Compost, Nitrogen, Lentil*

INTRODUCTION

Lentil (*Lens culinaris* Medik.) is one of the most important cold-season legumes being often dry farmed in Iran.

This plant with a protein content of nearly 28% is the major legume in developing countries and is considered complementary to the cereals and a suitable source of protein and amino acids in people's diet in the aforementioned countries.

Lentil, due to the ability to fix nitrogen, increases soil fertility and in rotation with certain field crops such as wheat and barley it will improve and stabilize crop yield (Parsa 2008).

However, lentil is often dry-farmed in marginal field and in soils with low fertility which in this state, due to low and irregular rainfall, its yield is unstable and poor (Bagheri, 2001).

Complementary irrigation at critical stage of plant requirements (flowering stage) is an effective method of preventing yield fluctuation and achieving a stable production of lentil in arid and semi-arid areas (Parsa, 2008).

In this method, the effects of drought on plant lessen and rather a suitable moisture, especially at sensitive growth stages, is provided and consequently the yield is improved (Oweis and Hachum, 2006).

Also, irrigation in areas where temperature during plant growth and development is above the optimal degree will favorably reduce soil temperature and plant canopy and is useful for node-making, N fixation and finally the plant yield(Bagheri et all, 1997).

The findings of Oweis *et al*. (2004) confirm that grain yield and lentil biomass increase with increasing irrigation intervals.

Application of two complementary irrigation intervals (before flowering and at grain filling) increased the lentil yield by 20% relative to dry-farming on the average (Hamdi *et al*., 1992).

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Therefore, irrigation at reproductive stage which not only increases the velocity of plant growth at grain filling and elongates the lifetime of plant's green tissues during that stage, but also improves growth rate and grain size of grain legumes and finally results in higher crop yield. Studies on rhizobium of alfalfa (Athar and Johnson, 1996) and bean (Mylona*et al.*, 1995) have indicated that with increasing drought the number of nodes, plant dry weight and shoot nitrogen content reduce.

Singleton *et al*. (1984) have announced that node-making in alfalfa and soybean reduces affected by drought which this is probably due to demolition of plasmodesmata which connect the nodes with the plant cells.

This will lead to superficial withering of nodes and demolition of intercellular space or cortical of tissues.

Thus, it can be concluded that drought stress could reduce nitrogen fixation rate, nodes respiration, plant dry weight and crop yield (Keck *et al*., 1984).

In many sustainable agriculture systems the organic fertilizers and compost are used for improving soil fertility and also controlling and preventing plant pests and diseases (Abdul-jaleel *et al*., 2007).

Compost and organic fertilizers can, in addition to their nutritional role, have direct anti-disease effects; stimulate competitive micro-organisms; increase the number of N-fixing nodes and also cause the plants to resist disease (Barker and Bryson, 2006).

Compost has favorable effects on the physicochemical characteristics of the soil such as pH, nutrient absorption capacity and increasing the exchange of macro and micro nutrients and also increases plant growth and yield. Also, since the nutrients existing in compost are released slowly and become available to the plant, hence cause the environment less pollution (Hector Santos, 2011).

Eriksen *et al*. (1999) studied the effects of compost on the soil characteristics in corn cultivation and reported the increase in soil organic materials as a result of application of municipal solid waste compost.

Singer *et al*. (2004) reported that the application of compost increase pH, organic carbon and soil potassium content and also improves soil physical characteristics such as apparent specific gravity (volume weight), water holding capacity and soil structure.

Mahboubi and khamami (2006) in a study on the effects of nitrogen fertilizer and compost reported that the effects of compost on the growth indices of Azolla were significant and announced that compost accelerates nitrogen absorption in the plant.

Marjoui (2003) studied the effects of city compost on sugar beet yield in a four-year trial and reported that the wheat and sugar beet yields especially in the second year in treatments which contained compost increased significantly. Also, the concentration of nutrients such as nitrogen, phosphorus, potassium, iron, zinc and copper increases significantly in compost-treated soils.

Finally, the aim of the present study was to evaluate the effects of irrigation intervals and different levels of compost on the biological fixation of nitrogen in two varieties of lentil: Bilesavarand Kimia.

MATERIALS AND METHODS

The trial was conducted on a farm located in Bader Abad village, Saqez (latitude 36°12'N, longitude 46°21'E) at an altitude of 1607m in 2011.

The experimental design was factorial arranged in RCB with three factors and three replications. The first factor contained two varieties of lentil (Bilesavar and Kimia) and the second factor contained four levels of irrigation (no-irrigation, one irrigation interval, two irrigation intervals and three irrigation intervals) and two levels of compost (control and 20 t/ha).

Before planting soil samples were taken from the experiment field (Table 1). Also, the composed used in the experiment was analyzed to determine the percentage of its nutrients.

After the preparation of the land the seeds were planted on March 25, 2013.

The seeds of each variety were planted by hand in four 6m-long rows 25cm apart.

During the growth season the field was wed with small hoes. The replications were 1m apart and the two side rows of each replication were considered as marginal ones.

Before planting and according to the planting plan as much as 20t/ha of compost was added to each plot and mixed with the soil.

The first irrigation was done immediately after planting, the second at stem extension stage and the last at flowering. The stress treatment was not irrigated.

100

percent nitrogen= [(Amount of acid consumed in the titration * 0.0014)/ weight sample]*100

The most important traits evaluated in the present study were %root nitrogen content, %stem nitrogen and protein content and number of nodes. The

%nitrogen content of root and stem were calculated by Kjeldahl method and using the following equation:

Percentage of nitrogen= [(acid amount consumed in titration×0.0014)/weight of sample]×100

To calculate protein content of root and stem the nitrogen content of the sample was multiplied by 6.25.

According to the statistical model of the experimental design, data were analyzed using the program SAS9.2. Mean comparisons of each trait were made by Duncan test at p≤0.05.

Table 1
Soil test analysis data (from a depth of 30cm)

K (mg\kg)	(mg\kg) P	Soil tissue type	Sand%	Silt%	Clay%	T.N.V%	OC%	Sp%	pH	Ec*10-3
631	19.4	Silty-Clay-Loamy	7	57	36	6.4	1.22	51	7.51	0.54

RESULTS AND DISCUSSION

Percentage of Root N content

According to ANOVA table there is significant difference (p≤0.01) among irrigation levels, compost levels, variety × irrigation and irrigation × compostregarding the effect on the trait of %root N.

Mean comparison of the effects of different irrigation levels on %root N showed that the two irrigation intervals treatment with an average of 1.87% not only had the highest %root N but also increased its content by 10 and 16% more than the treatments of no-irrigation and one irrigation interval, respectively.

When the environmental conditions become favorable the roots get a chance to grow and develop. The increase in cells size can influence the %root N in two ways: 1) with increasing the root volume the uptake of macro and micro-nutrients from the soil increases, and 2) the symbiotic micro-organisms are provided with a greater surface for their activity to produce nodes and fix nitrogen.

Athar and Johnson (1996) and Mylano*et al*. (1995) observed the effects of irrigation on the nitrogen content of alfalfa and bean roots being consistent with the findings of the present study.

In the present study the application of compost increased the root nitrogen content by 9.4% compared with the check.

Apparently, the application of compost by increasing soil organic matterand improving structure and physical condition of the soilhas provided a favorable condition for the growth of plants and active micro-organisms.

Shata*et al*. (2007) reported that in the presence of compost the uptake of nitrogen from the soil increases.

By analyzing the interaction of variety and irrigation levels it was revealed that both varieties had the highest root nitrogen content at two irrigation intervals treatment, but the variety Kimia had the lowest %N content at no-irrigation treatment and the varietyBilesavarat one irrigation interval treatment (Table 3).

Among the combined levels of irrigation and compost from the point of view of effects on the %root nitrogen, with increasing the irrigation intervals and using compost the %root N increased so that two-interval irrigation with the application of compost had the highest %root N and the zero-level (check) of both treatment had the lowest %root N (Table 5).

So, it can be concluded that with improving water and environmental conditions for the growth of lentil plants the %root N increases without application of chemical fertilizers.

Percentage of Root Protein

The analysis of variance concerning the %root protein trait showed that the main effects of irrigation and compost levels (p≤0.01) and interactions of (variety×irrigation) and (irrigation levels×compost) at p≤0.05 were significantly different (Table 2).

Among the irrigation levels the treatment of three-interval irrigation had the highest %protein content with an average of 11.71.

It is worth mentioning that in the present study from the point of view of %stem protein content there was no significant difference among one-interval irrigation and no irrigation treatments.

In this study the application of compost increased the %root protein content by %9 compared with the check (Table 4).

Table 2
Means Square of the studied traits

		MS				
SOV	*df*	*%Root N*	*%Root Protein*	*%Shoot N*	*%Shoot Protein*	*No. of Root Nodes*
Replication	2	0.02	1.08	0.04	1.63	0.13
Cultivar	1	0.07^{ns}	2.95^{ns}	1.47^{**}	27.55^{**}	5.7^{**}
Irrigation Interval	3	0.22^{**}	8.75^{*}	0.15^{ns}	5.86^{ns}	7.21^{**}
Compost	1	0.26^{**}	10.21^{*}	0.48^{*}	18.95^{*}	10.55^{**}
Cultivar×Irrigation	3	0.20^{**}	7.98^{*}	1.34^{**}	24.22^{**}	1.81^{**}
Cultivar×Compost	1	0.01^{ns}	0.40^{ns}	0.37^{*}	49.38^{*}	0.37^{ns}
Irrigation Interval×Compost	3	0.11**	6.46^{*}	0.09^{ns}	3.59^{ns}	2.13^{**}
Cultivar×Irrigation×Compost	3	0.01^{ns}	0.47^{ns}	0.24^{*}	9.4^{*}	0.40^{ns}
Error	14	0.03	1.17	0.06	2.64	0.18
CV%	-	%10.08	10.08	%9.52	%9.52	%13.21

ns: non-significant * and **: significantly different at $p \leq 0.05$ and 0.01, respectively

Table 3
Means Comparison of Mixed Levels of Cultivar and Priming Concerning Effect on the Studied Traits

Cultivar	*Irrigation Intervals*	*%Root N*	*%Root Protein*	*%Shoot N*	*%Shoot Protein*	*No. of Root Nodes*
Kimia	No Irrigation	1.42c	14.54cd	2.33cd	8.85c	13.13c
	One-interval Irrigation	1.72ab	14.17d	2.27d	10.73ab	13.04c
Bileswar	No Irrigation	1.81ab	16.48bc	2.94ab	11.30ab	11.58d
	One-interval Irrigation	1.63b	18.38ab	3.22a	10.20b	12.85c

Regarding the effects of irrigation levels on the two studied varieties it was seen that with increasing irrigation intervals the %root protein content of Bilesavarincreased while in Kimia concerning %protein content the one-interval irrigation and no irrigation (check) treatments were not significantly different.

According to the means comparison of the combined levels of irrigation and compost the highest and the lowest %root protein content were seen in two-interval irrigation×compost and one-interval irrigation×no compost, respectively(Table 5).

Usually when the environmental conditions are favorable the plant can grow and develop well that in this case proteins play a very noticeable role.

Proteins are present in plants either as enzymes or as part of the cell’s structure.

Organic materials such as composts, because of having micro elements and gradually releasing the rest of the elements necessary for the synthesis of proteins, could play an important role in increasing protein synthesis in plant tissues.

Percentage of Shoot Nitrogen

According to the ANOVA table the effects of variety, compost, variety × irrigation and variety × compostwere significantly different regarding %shoot nitrogen.

In this study the varietyBilesavarwith an average of 2.93% had more nitrogen than Kimia with an average of 2.53% (Table 2).

Various varietieswith regard to their different genetic structure may be different in absorbing and transferring nitrogen.

Also in this study, the application of compost positively influenced %shoot nitrogen so that the 8% compost increased the shoot nitrogen compared with the check (Table 3).

It can be said that compost by making nitrogen gradually available to the plant and increasing enzymes and soil microbes' activity results in availability increase in plant nitrogen.

Machiqua *et al*. (2008) in an experiment showed that the application of organic fertilizer leads to an increase in nitrogen fixation in the roots of red clover.

Concerning the effects of irrigation levels on %shoot protein content the variety Kimia had the highest %protein at two-interval irrigation, but the protein content in Bilesavarresponded negatively to the increase in irrigation interval so that the highest %shoot protein content was seen at one-interval irrigation and also in the check.

Except for the interaction of Bileswar×compost which had the highest %shoot protein there was no significant difference in the interaction of Kimia×compost (Table 4).

Nitrogen is made available to the plants either by molecular fixation or the application of organic and chemical fertilizers and is consumed I different processes including protein synthesis.

Nitrogen has a major role in chlorophyll structure and is also the most important element for the synthesis of proteins and its increase to a certain extent, under favorable conditions, causes increase in protein synthesis (Malakouti and Sepehr, 2004).

Percentage of Shoot Protein

The analysis of variance of data showed that in terms of %shoot protein content there was significant difference among the main effects of variety and compost level and the interactions of variety × irrigation and variety×compost.

Among the varietiesstudied Bilesavarwith an average protein of 18.33% was superior to Kimia with anaverage protein of 16.34%.

Also, the application of compost increased the percentage of shoot protein content by 8.2% compared with no-compost treatment.

Means comparison of the interaction of variety and irrigation interval showed that the two varietiesresponded differently to the increase in irrigation interval so thatin case of Kimia with increasing irrigation interval the %shoot protein increased but in Bilesavarthe increase in irrigation interval did not cause increase in %shoot protein compared with the check.

The study of the effects of compost on the shoot protein content revealed that although the application of compost increases the %shoot protein but in case of Bilesavar this increase was not statistically significant.

Number of Root Nodes

According to the ANOVA (Table 2) the main effects of variety, irrigation intervals and compost levels ($p \leq 0.01$) and the interactions of variety×irriation and irrigation interval×compost were statistically significant in terms of influencing the number of root nodes.

Among the two studied varieties Kimia with an average of 13.80 nodes/root exceededBilesavar with an average of 12.71 nodes/root.

Means comparison of effects of irrigation intervals on the number of root nodes showed that with increasing irrigation intervals the number of root nodes increases so that the three –interval irrigation increased the number of root nodes by 14.5% and 10.5% compared with the check and two-interval irrigation, respectively.

Athar and Johnson (1996) in their study on Alfalfa and Mylona *et al*. (1995) reported that irrigation has a positive effect on the increase in the number of nodes per root.

Singleton *et al*. (1984) found that node-making in alfalfa and soybean decreases under drought stress conditions.

In this study the use of compost had a positive effect on the increase in the number of root nodesso that the application of compost with an average of 14.32nodes/root was superior to the check with an average of 12.2 nodes/root.

According to the means comparison of the interaction of variety and irrigation intervals (Table 3) although Kimia at one-interval irrigation did

Table 4
Means Comparison of Mixed Levels of Cultivar and Compost Concerning Effect on the Studied Traits

Cultivar	*Compost*	*%Root N*	*%Root Protein*	*%Shoot N*	*%Shoot Protein*	*No. of Root Nodes*
Kimia	Check	1.57a	15.71a	2.51b	9.83b	12.84a
	20t/ha	1.78a	15.90a	2.54b	11.10a	14.76a
Bileswar	Check	1.70a	16.98a	2.72b	10.61ab	11.55a
	20t/ha	1.83a	19.69a	3.15a	11.46a	13.87a

Table 5
Means Comparison of Mixed Levels of Priming and Compost Concerning Effect on the Studied Traits

Cultivar	*Compost*	*%Root N*	*%Root Protein*	*%Shoot N*	*%Shoot Protein*	*No. of Root Nodes*
No Irrigation	Check	1.49c	17.18ac	2.75a	9.32a	11.78d
	10t/ha	1.73b	17.51ab	2.80a	10.83a	12.94c
One-interval Irrigation	Check	1.61bc	15.52c	2.48a	10.08a	11.71d
	10t/ha	1.73b	17.03ac	2.73a	10.84a	14.18b
Two-interval Irrigation	Check	1.80ab	16.33bc	2.61a	11.25a	13.10b
	10t/ha	1.95a	18.85a	2.03a	12.18a	15.83a

The values with common letters do not have significant difference ($p \leq 0.05$).

not increase the number of root nodes compared with the check, but in Kimia with increasing the irrigation intervals the number of nodes per root increased.

Finally, the means comparison of The combination ofirrigation intervals and compost levels showed that at three irrigation intervals the application of compost increased the number of root nodes so that the two-interval irrigation combined with compostproduced the highest (with an average of 15.83) and the treatment of no-irrigation and no-compost produced the lowest (with an average of 11.78) number of nodes/root (Table 5).

CONCLUSION

In the present study among the different irrigation intervals the three-interval irrigation had the highest %root N, %root protein and number of nodes compared with the rest of irrigation intervals. Finally, the application of compost significantly increased %root N, %root protein, %shoot N and the number of root nodes.Therefore, it can be concluded that complementary irrigation and the application of organic materials could increase the rate of nitrogen fixation in lentil without using chemical fertilizers which have destructive environmental effects.

REFERENCES

Aliasgarzadeh, N. (1997), Microbiology and biochemistry of soil.Tabriz University publication.

Athar, M. and D. A. Johnson. (1996), Influence of drought on competition between selected Rhizobium meliloti strains and naturalized soil rhizobia in alfalfa. Plant Soil 184: 231-241.

Bagheri A., Goldani M. and Hassanzadeh M. (1997), Lentil Agronomy and Breeding.Jihad Daneshgahi Publications of Mashhad. Mashhad 248pp.

Bagheri A., Nezami A. and Soltani M. (2001), Breeding of cold-season legumes for tolerance to cold.Organization for Agricultural Research, Education and Extension. 445pp.

Barker, A.V., and G.M. Bryson. (2006), Comparisons of compost with low or high nutrient status for growth of plants in containers. Communic. *Soil. Sci. plant Anal.* 37: 1303-1319.

Hamdi A., Erskine W., and Gates P. (1992), Adaptation of lentil seed yield to varying moisture supply. *Crop Science*, 32: 987–990.

Keck, T. J., P. Wagent., W. F. Campbell and R. E. Knighton. (1984), Effect of water and salt stress on growth and acetylene reduction in alfalfa. *Soil. Sci. Soc. Am. J.* 48: 1310-1315.

Machickova, T., and C. Saetang. (2008), Correlation and path coefficient analysis on seed yield in sunflower. *Suranaree Journal Science and Technology.* 15(3):243-248.

Mahboub Khamami A. (2006), The effects of nitrogen fertilizer and compost on the growth index of Azallia. *Plant and Seed Journal.* 22: 129-140.

Malakouti, M. J., and Sepehr. (2004), Optimize nourishment for oil seeds (effective step to attained oil independence in country). Khaniran press, Tehran.464 p. (in Persian).

Mylona, P., K. Pawlowski and T. Bisseling. (1995), Symbiotic nitrogen fixation. Plant Cell 7:869-885.

Omar, S. A. (1998), The role of rock-phosphate solubilizing fungi and vesicular-arbuscular-mycorrhiza (VAM) in growth of wheat plants fertilized with rock phosphate. *World Journal Microbiol and Biotechnol,* 14, 2.

Oweis T., and Hachum A. (2006), Water harvesting and supplemental irrigation for improved water productivity of dry farming systems in West Asia and North Africa. Agricultural Water Management, 80: 57-73.

Oweis T., Hachum A., and Pala M. (2004), Lentil production under supplemental irrigation in a Mediterranean environment. *Agricultural Water Management,* 68: 251-265.

Parsa M. and Bagheri A. (2008), The Legumes.Jihad Daneshgahi Publications of Mashhad. Mashhad. 580pp.

Shata, S. M., A. Mahmoud., and S. Siam. (2007), Improving calcareous soil productivity by integrated effect of intercropping and fertilizer. *Reacerch Journal of Agriculture and Biological Sciences* 3(6): 733-739.

Singelton, P. W. and B. B. Bohlool. (1984), Effect of salinity on nodule formation by soybean. *Plant Physiol.* 74:72-76.

Singh, K. B. and M. C. Saxena. (1993), Breeding for Stress Tolerance in Cool-Season Food Legumes. The Hague, The Netherlands: MartinusNijhoff/Junk.