Journal of Biodiversity and Ecological Sciences
(JBES©)
Vol.3, Issue3
ISSN: 2008-9287
Summer 2013 JBES

*Original Article*

# Effects of Bio-stimulators on fenugreek (TRIGONELLA FOENUM-GRACUM L.) under drought stress for decrease chemical fertilizers application

M. Mohammdi*[1]
H. Omidi[2]
A. Mehrafarin[3]
H. A. Naghdi Badi[3]

[1]*MSc Student, Department of agronomy and plant breeding, Agricultural College, University of Shahed, Tehran, Iran*
[2]*Department of Agronomy and Plant Breeding, Faculty of Agriculture, Shahed university, Tehran*
[3]*Department of Cultivation and Development, Institute of Medicinal Plants, ACECR, Karaj, Iran;*

***Corresponding Author:**
*Mohammadi_ae@yahoo.com*

## ABSTRACT

To investigate the effects of drought stress and chemical fertilizer and bio-stimulators on yield and some quantitative characteristics of Trigonella foenum-gracum, a factorial experiment was conducted on the basis of completely randomized blocks design with three replicates in Department of Cultivation and Development, Institute of Medicinal Plants, ACECR in Karaj, Iran in 2011. Treatment included drought stress with levels of non stress (40%FC), average stress (55%FC) and Severe stress (70%FC) and fertilizer with levels control (A), aminolforte (B), Fosnutren (C), kadostim (D), humiforte(E), humiforte+50% (NPK)(F), humiforte+100% (NPK)(G). Results showed that effect of fertilizer ×drought stress was significant ($P \leq 0.01$) on parameters of chlorophyl, plant height , petiole length, Root fresh weight, Root dry weight, total seeds fresh weight, total seeds dry weight, seeds thousand weight, the number of seeds per pod. So that was the most chlorophyll, petiole length, number of seeds per pod related to the combination treatment Fosnutren with non stress and most plant height, root dry weight, root fresh weight, seed dry weight related to the combination treatment humiforte+100% (NPK) with severe stress and most seeds fresh weight related to the combination treatment humiforte+100% (NPK) with average stress and most seeds thousand weight related to the combination treatment kadostim with severe stress .

**KEYWORDS:** Fenugreek; Biostimulators; Drought stress; Chemical fertilizer.

## INTRODUCTION

Plants are always exposed to different stresses in natural and agricultural conditions and water deficiency is the most restricting factor for crop yield in most regions[12]that the drought effect depends on growth stage of the plant and period of drought [16]. Wide agricultural operations needs to extensive application of chemical fertilizers that are too expensive and cause environmental pollution. So recently sustainable agriculture has attracted so much attention to itself [3][9][11][13][17]. At the moment bio-fertilizers are considered as substitution for chemical fertilizers to increase soil fertility in sustainable agriculture [22]. On the other hand researches showed that bio-sources (Organic) like organic fertilizer mixed with chemical fertilizers leads to soil fertility and increase in crop production.

Because this system will afford the most of plant nutritional needs and increases efficiency of nutrients absorption [2][4][14]. In fact among factors that effect on efficiency of chemical fertilizers and nutrient absorption are the application time of fertilizer and biologic fertilizers application [7]. Application of bio-stimulators as biological products compatible with environment and in joint with new agriculture can cause increase in quality and quantity growth of plants and decrease in effects of environmental stresses [15]. In recent year the main subject of research activities in the most world research centers is focused on different applications of amino acids as Bio-Synthesized Free Amino Acid (SFAA) and oligo peptides with low molecular weight [6][15]. Foliar application is a method to decrease consumption of chemical fertilizers and their environmental threats especially nowadays the policy of decreasing herbicides application and improve of fertilizer consumption is considered [10]. In traditional treatments a lot of applications are mentioned for fenugreek. This plant is used for digestion and increasing metabolism and strengthening the body. This plant is one of the most important medicinal plants due to synthesis of medicinal alkaloids, Steroid compounds, sapogenines and strong therapeutic effect [8].

The aim of this study is to evaluate the effects of bio-stimulators in yield and some quantitative

specifications of Trigonella foenum gracum L. and with acquaintance of bio-stimulators and biological products can act to decrease consumption of chemical fertilizers, costs and maintenance of environment and sustainable agriculture.

## MATERIALS AND METHODS

This experiment is conducted to evaluate the effect of water stress and bio-stimulators and chemical fertilizers on yield and some of quantitative specifications of Fenugreek in research field ( with geographical latitude of 36˚ 35′ N. and geographical longitude of 50˚56′E. and height of 1426 from sea level) of Karaj Jahad Daneshgahi Research Center on the basis of completely randomized blocks design and as a factorial experiment in 63 unit and 3 replicates in 2011. Each experimental unit is a treatment and with 2 m2. Measured parameters were Chlorophyll, plant height, petiole length, root fresh weight, root dry weight, seed fresh weight, seed dry weight, seeds thousand weight and the number of seeds per pod. Dilution rate for each of bio-stimulators was 1 L.ha-1 in 500 L water separately. Foliar application was conducted three times in stem growth, flower initiation and flourishing .

Data from this experiment were analyzed with SPSS software and for mean comparisons Duncan Test was used.

## RESULTS

Results showed that effect of fertilizer ×drought stress was significant (P≤0.01) on parameters of chlorophyl, plant height , petiole length, root fresh weight, root dry weight, total seeds fresh weight, total seeds dry weight, seeds thousand weight, the number of seeds per pod. So that was the most chlorophyll, petiole length, number of seeds per pod related to the combination treatment Fosnutren with non stress and most plant height, root dry weight, seed fresh weight, seed dry weight related to the combination treatment humiforte+100% (NPK) with severe stress and most root fresh weight related to the combination treatment humiforte+100% (NPK) with non stress and most seeds thousand weight related to the combination treatment kadostim with severe stress. If it should be specified for the best bio-stimulator in the highest yield, in the parameters of chlorophyll, plant height, root fresh weight, root dry weight, seed fresh weight, petiole length and number of seeds per pod the best bio-stimulator is fosnutren with non stress and in parameters of seed dry weight, Aminolforte in non stress and in seeds thousand weight kadostim in severe stress were selected.

**Table 1.** variance analysis for interaction effects of Bio-stimulators and stress on quantitative arameters.

| | | Mean squares | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S.O.V | df | chlorophyl | plant height | Petiole length | Root fresh weight | Root dry weight | total seeds fresh weight | total seeds dry weight | seeds thousand weight | the number of seeds per pod |
| drought | 2 | 1739.284** | 24.301 ns | 44.118** | 0.018** | 0.002** | 0.804** | 0.092** | 11.756** | 1366.419** |
| biostimulators | 6 | 539.774** | 84.478** | 4.402** | 0.010** | 0.002** | 0.616** | 0.047** | 47.290** | 389.934** |
| treatment×concentration | 12 | 273.503** | 47.192** | 12.958** | 0.004** | 0.001** | 0.116** | 0.026** | 62.325** | 292.735** |
| error | 40 | 56.394 | 8.186 | 0.940 | 0.001 | 0.000047 | 0.009 | 0.003 | 1.833 | 14.650 |

*,**, ns shows significant in 5%, 1%, and insignificant ,respectively

**Table 2.** Mean comparisons for interaction effects of Bio-stimulators and stress on quantitative parameters.

| Irrigation | concentration | chlorophyl | plant height | petiole length | Root fresh weight | Root dry weight | seeds fresh weight | seeds dry weight | seeds thousand weight | the number of seeds per pod |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | 50.433$^{defg}$ | 16.277$^{efg}$ | 10.368$^{bc}$ | 0.107$^{bcde}$ | 0.051$^{jkl}$ | 0.511$^{ghi}$ | 0.162$^{fghi}$ | 9.981$^{bcd}$ | 19.333$^{ij}$ |
| | A | 61.833$^{bcd}$ | 23.266$^{bc}$ | 11.255$^{b}$ | 0.14$^{abcd}$ | 0.082$^{bcd}$ | 1.093$^{b}$ | 0.358$^{b}$ | 10.028$^{bcd}$ | 36.111$^{bcd}$ |
| | F | 77.166$^{a}$ | 24.855$^{b}$ | 13.864$^{a}$ | 0.175$^{ab}$ | 0.093$^{b}$ | 1.183$^{ab}$ | 0.306$^{bcd}$ | 6.992$^{fg}$ | 44.889$^{a}$ |
| Irrigation2 | H | 58.766$^{bcd}$ | 19.555$^{bcdef}$ | 8.911$^{cde}$ | 0.151$^{abc}$ | 0.064$^{fghi}$ | 0.859$^{c}$ | 0.286$^{bcd}$ | 8.917$^{bcdef}$ | 33.222$^{de}$ |
| | K | 65.033$^{abc}$ | 23.366$^{bc}$ | 9.341$^{cd}$ | 0.136$^{abcd}$ | 0.081$^{bcde}$ | 1.117$^{b}$ | 0.334$^{bc}$ | 8.647$^{bcdef}$ | 41.778$^{abc}$ |
| | H+50% | 56.433$^{bcde}$ | 21.133$^{bcde}$ | 8.047$^{defghi}$ | 0.126$^{bcde}$ | 0.059$^{ghij}$ | 0.814$^{ed}$ | 0.281$^{bcde}$ | 9.802$^{bcd}$ | 29.778$^{def}$ |
| | H+100% | 49.533$^{defg}$ | 23.522$^{bc}$ | 8.232$^{defg}$ | 0.202$^{a}$ | 0.08$^{cde}$ | 1.089$^{b}$ | 0.359$^{b}$ | 10.653$^{bc}$ | 35.0$^{cd}$ |
| | C | 25.766$^{i}$ | 12.778$^{g}$ | 5.257$^{k}$ | 0.004$^{f}$ | 0.026$^{n}$ | 0.081$^{h}$ | 0.031$^{j}$ | 7.154$^{efg}$ | 4.556$^{l}$ |
| | A | 41.199$^{fgh}$ | 22.855$^{bcd}$ | 9.01$^{cd}$ | 0.16$^{abc}$ | 0.088$^{bc}$ | 0.654$^{defg}$ | 0.244$^{cdefg}$ | 11.277$^{b}$ | 22.778$^{fghi}$ |
| | F | 31.033 | 18.333$^{cdef}$ | 6.163$^{jk}$ | 0.068$^{e}$ | 0.056$^{hij}$ | 0.591$^{efgh}$ | 0.173$^{efghi}$ | 8.667$^{bcdef}$ | 21.333$^{ghi}$ |
| Irrigation4 | H | 54.4$^{bcdef}$ | 23.677$^{bc}$ | 8.108$^{defgh}$ | 0.159$^{abc}$ | 0.07$^{efg}$ | 0.767$^{cde}$ | 0.253$^{bcdef}$ | 10.133$^{bcd}$ | 27.222$^{efg}$ |
| | K | 56.266$^{bcde}$ | 23.444$^{bc}$ | 7.798$^{defghij}$ | 0.093$^{cde}$ | 0.053$^{ijk}$ | 0.760$^{cde}$ | 0.22$^{defgh}$ | 8.462$^{cdef}$ | 26.778$^{efgh}$ |
| | H+50% | 42.433$^{efgh}$ | 8.688$^{cdef}$ | 8.377$^{def}$ | 0.079$^{de}$ | 0.041$^{klm}$ | 0.443$^{hi}$ | 0.148$^{fghi}$ | 5.034$^{g}$ | 19.889$^{hij}$ |
| | H+100% | 40.933$^{fgh}$ | 18.689$^{cdef}$ | 6.475$^{ghijk}$ | 0.068$^{e}$ | 0.036$^{mn}$ | 1.055$^{b}$ | 0.097$^{ij}$ | 9.667$^{bcde}$ | 10.556$^{kl}$ |
| | C | 34.733$^{hi}$ | 17.166$^{efg}$ | 6.225$^{ijk}$ | 0.060$^{ef}$ | 0.043$^{klm}$ | 0.228$^{ih}$ | 0.099$^{ij}$ | 7.59$^{def}$ | 12.444$^{k}$ |
| | A | 50.666$^{cdefg}$ | 17.555$^{defg}$ | 6.715$^{fghijk}$ | 0.109$^{bcde}$ | 0.069$^{efgh}$ | 0.352$^{ij}$ | 0.139$^{fghi}$ | 10.146$^{bcd}$ | 4.111$^{l}$ |
| | F | 49.833$^{defg}$ | 16.177$^{efg}$ | 6.678$^{fghijk}$ | 0.064$^{ef}$ | 0.039$^{lm}$ | 0.351$^{ij}$ | 0.131$^{hij}$ | 10.342$^{bc}$ | 13.777$^{jk}$ |
| Irrigation6 | H | 61.733$^{bcd}$ | 19.211$^{cdef}$ | 9.545$^{cd}$ | 0.148$^{abc}$ | 0.083$^{bcd}$ | 0.573$^{fgh}$ | 0.21$^{defgh}$ | 9.844$^{bcd}$ | 21.556$^{ghi}$ |
| | K | 57.933$^{bcd}$ | 21.322$^{bcde}$ | 7.108$^{efghij}$ | 0.123$^{bcde}$ | 0.076$^{cdef}$ | 0.694$^{cdef}$ | 0.299$^{bcd}$ | 24.216$^{a}$ | 25.0$^{fghi}$ |
| | H+50% | 38.733$^{ghi}$ | 15.347$^{fg}$ | 6.288$^{hijk}$ | 0.124$^{bcde}$ | 0.074$^{def}$ | 0.723$^{cdef}$ | 0.333$^{bc}$ | 8.696$^{bcdef}$ | 35.778$^{cd}$ |
| | H+100% | 68.8$^{ab}$ | 32.677$^{a}$ | 11.491$^{b}$ | 0.173$^{ab}$ | 0.108$^{a}$ | 1.317$^{a}$ | 0.517$^{a}$ | 0.012$^{h}$ | 42.667$^{ab}$ |

## DISCUSSION

Alkire et al (1993) with study of the effect of complete irrigation, slight irrigation and without irrigation on peppermint( Mentha Piperita) resulted that water stress decreases internodes length, plant height and leaf dry weight, stem dry weight and root dry weight. With decrease in irrigation water, application of integrated nutritional system had better result. Application of compound chemical fertilizers and bio-stimulators in comparison with only organic fertilizer had the most effect on plant height, root fresh weight, root dry weight, seeds fresh weight and seeds dry weight. Studies showed that bio sources (organic) like organic fertilizer mixed with chemical fertilizer can lead to soil fertility and increase in crop production. Because this system can afford nutritional needs of plant and efficiency of nutrients absorption with plant [2][4][14]. To explain the cause of high yield in chemical fertilizer 100% in comparison with 50% under drought stress, it is resulted that due to decrease of transpiration, nitrogen absorption is decreased and so mass flow in soil and roots decreases. Therefore increase in humiforte+ 100% in comparison with humiforte + 50% is related to increase of nutrients availability in chemical fertilizers .In research on (Picea abies L.) growth and development rate of root and aerial parts of the plant was improved with application of bio-stimulators humifrte, kadostim, fosnutren and aminolforte [18]. In other reports yield of pistachio, rice, Soy bean, maize, olive, potato, cotton, citrus, canola increased with application of biological products like humifrte, kadostim, fosnutren and aminolforte in accordance with these results [15]. Entezari et al(2008) showed that foliar application of amino acids in slight irrigation increased number of seeds in cluster to 18%. In this research with application of prolin and other amino acids with availability of sufficient carbohydrate, seed thousand weight increased that results of Walton et al (2002) were similar to these results. Proline and other amino acids act as nitrogen and carbon source for the plant. This additional source increases thousand seed weight and seed yield. Bio-stimulators are the biological factors with low concentration that can improve main biochemical processes in plants and soil and finally cause
growth and development in plants [6]. Probably amino acids used in formulations of these bio-stimulators improve quality and quantity yield in short time especially in stress conditions with activating of reproductive hormones, carbohydrate synthesis, increase of absorption and transport of elements and increase of protein in plants [15][6][19].In stress conditions synthesis of amino acids is stopped and application of amino acids as fertilizer affords the need of plant and the plant can use its energy to more growth and increase the yield and quality of products. Amino acids accelerate the process of stem, leaf and root growth and formation system. Also they improve quality and quantity of the crops with increase in chlorophyll content and photosynthetic activity in plant. One of amino acids in bio-stimulators is hydroxyl proline [15] that ovary and pollen cells are rich in glycolised proteins that are rich in hydroxyl proline and they have vast duties from formation to interaction between pollen cells and ovary [21]. In other research with application of glutamic acid (from amino acids in bio-stimulators) on Codiaeum variegatum significant effect on growth parameters of root, stem and leaves fresh weights. There are Many reports in regard to positive effect of Glysine Betain (other amino acid) on growth and yield of crops in drought stress that can point out to Tobacco, wheat, barely, soy bean, and bean. For example in bean, treated plants with Glysine Betain showed lower decrease in water potential under stress condition and untreated plants showed the wilting signs rapidly [23]. In this research, effects with observation to negative effects of drought stress on different parameters, application of bio-stimulators has accelerated synthesis processes and additional carbon is used for growth and in drought stress the plant had its growth and stress has lower effect on it .

## CONCLUSION

With these results obtained from bio-stimulators application, it is concluded that with decrease in cost of crop production, environmental pollution from chemical fertilizers can become lower and it can maintain or increase soil fertility.

## REFERENCES

Alkire, B.H., Simon, J.E., Palevitch, D., and Putievsky, E., 1993. "Water management for Midwestern peppermint (Mentha piperita L.) growing in highly organic soel. Indiana", USA. *Acta Horticulture*. 344: 544-556.

Bauer, A., and Black, A. L.. 1994. "Quantification of the effect of soil organic matter content on soil productivity". *Soil Sci*. Soc. of Amer. 58: 185-193.

Bostick, W.M.N., Bado, V.B., Bationo, A., Solar, C.T., Hoogenboom, G., and

Jones, J.W. 2007. "Soil carbon dynamics and crop residue yields of cropping systems

in the Northern Guinea Savanna of Burkina Faso". *Soil Tillage Research*,

93(7): 138–151.

Eghbal, B., Binford, J. F., Baltenspreger, D. D., and Anderson, F. D., 1995. "Maize temporal yield variability under long term manure and fertilizer application". Fractal analysis. *Soil Sci*. 59: 1360-1364.

Entezari, S., khalatbari, M., Nasri, M.,and Zakeri mohammad ababdi, A. 2008. "The effect of foliar amino acid on low irrigation wheat farming in the plain of Varamin". *Journal of Plant and Ecosystem*. 4:64-76.

Gawronaka, H., 2008. "Biostimulators in modern agriculture (general aspects)". Arysta LifeScience. Published by the editorial House Wies Jutra, Limited. Warsaw. 7(25): 89.

Gilick, B.E., Penrose, D., and Wenbo, M. 2001 ."Bacterial promotion of plant growth".*Biotechnology Advances*. 19: 135-138.

Hasanzadeh E., Reza zadeh Sh., Shamsa S.F., Dolat Abadi R., Zarin ghalam j., (2010). A review on phytochemistry and Therapeutic propertiesof Fenugreek. Journal of Medicinal Plants. 34:1-18.

Haynes, R.J., and Naidu, R. 1998. "Influence of lime, fertilizer and manure applications on soil organic mattercontent and soil physical conditions": a review. Nutr. Cycl. *Agroecosys*. 51: 123–137.

Kumar, A., and Singh, R.P. 1995. "Technology growing rapeseed and mustard". *Indian–Farming*. 39: 6-8.

Lopez-perez, A., Casanova, E., Chacon, L.A., Pazand, P.M., and Guerrero, J.R., 1990. "Residual effect of three phosphate rocks from Tachina (Venezuela) in agreenhouse experiment with maize (Zea mays L.) as indicator plant". Revista- Cientifica- UNET 4 (1–2): 29–48.

Munns, R., 2002. "Comparative physiology of salt and water stress". *Plant, Cell and Environment*. 25: 239-250.

Orhan, E., Esitken, A., Ercisli, S., Turan, M., and Sahin F. 2006. "Effects of plant growth promoting rhizobacteria (PGPR) on yield, growth and nutrient contents in organically growing raspberry". *Scientia Horticulturae*. 111: 38–43.

Parmar, D. K., Sharma, T. R., 1998. "Integrated nutrient supply system for DPPG8, vegetable pea *(Pisum sativum* Var aravense*)* in dry temperate zone of Himachal Pradesh". Indian J. *Agric. Sci*. 68: 247-253.

Research and development unit of Inagropars. 2010. Inagropars production (Agro-Biological industries Co.) No. 21, Golestan 2, Pasdaran Ave. Tehran 16669 Iran. 16 pp. http://www.inagropars.com/Catalogue.pdf.

Saini, H.S., and Wesygate, M.E., 2001. "Reproduction development in grain crop during drought". *Advances in Agronomy*. 68: 60-95.

Sarkar, S., Singh, S.R., andSingh R.P., 2003. "The effect of organic and inorganic fertilizers on soil physicalcondition and the productivity of a rice– lentil cropping sequence in India". *Journal of Agricultural Science*. 140: 419–425.

Slawik, M., 2005. "Production of Norway spruce (*Picea abies* [L.] Karst.) seedlings on substrate mixes using growth stimulants". *Journal of Forest Science*. 51(1): 15 – 23.

Thomas, J., Mandal, A.K.A., Raj Kumar, R., and Chordia, A., 2009. "Role of biologically active amino acid formulations on quality and crop productivity of Tea (*Camellia* sp.)". *Int. J. Agric. Res.* 4: 228 – 236.

Walton, G.N.,2002. "Medham, "M.Robertson and , T.potter. Phenology, Physiology and Agronomy". *Astralian Journel of Agricltural Research*. 59: 1425-39.

Wu, H., Graaf, B.de., Mariani, C., and Cheung, A.Y., 2001. "Hydroxyproline-rich glycoproteins in plant reproductive tissues:structure,functions and regulation reproductive tissues:structure,functions and regulation".- CMLS, Cell. Mol. Life Sci. 58 1418-1429.

Wu, S.C., Coa, Z.H., Li, Z.G., Cheung, K.C., and Wong, M.H., 2005. "Effects of biofertilizer containing N-fixer, P and K solubilizers and fungion maize growth". Geoderma. 125: 155-166.

Xing, W., and Rajashekar, C.B., 1999. "Alleviation of water stress in beans by exogenous glycine betaine". *Plant Science*. 148(2): 185-192.