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# Influence of Organic and Bio-Fertilizer on Growth and Yield of two Fenugreek Cultivars Grown in Sandy Soil

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**Abstract:** Two field experiments were carried out during 2009/2010 and 2010/2011 winter seasons at the farm of Research and Production Station, National Research Centre, Nubaria District, EL-Behaira Governorate, Egypt, to study response of two fenugreek cultivars to organic and bio-fertilizer on growth and productivity. Fenugreek cultivars significantly differed in growth parameters at 100 days after sowing except (spaceific leaf weight at 100 days after sowing )in both seasons as well as, in yield components and chemical content except (plant height, number of pods/$m^{2,}$ 100 seed weight, biological yield/fed. and harvest index). The addition of organic and bio-fertilizer at a rate of FYM 4$m^3$/fed. +Rhizobium +Yeast resulted the greatest values from growth characters at 100 days after sowing except (total dry weight plants/$m^2$ and spaceific leaf weight). On the other hand, FYM 4$m^3$/fed. + Rhizobium +Yeast treatment produced the great values from yield and yield components except (harvest index). On the other hand, fertilization with FYM 4$m^3$/fed. +Azotobacter +Yeast resulted the highest carbohydrate %, protein % and oil %per seeds compared with other seven treatments under study. The interaction between fenugreek cultivars and organic and bio-fertilizer was significant in all growth characters under study except (spaceific leaf weight)at 100 days after sowing in both seasons, as well as, in yield, yield components and chemical content in seeds under study.

**Key words:** Fenugreek-organic-bio-fertilizer-cultivars.

## INTRODUCTION

Fenugreek (*Trigonella foenum-graceum*) is an annual crop belonging to the legume family. It is commonly found growing in the Mediterranean region of the world. While the seeds and leaves are primarily used as a culinary spice, it is also used to treat a variety of health problems in Egypt, Greece, Italy, and South Asia Acharya *et al*., (2008). Fenugreek seed contains 20% protein, 50% carbohydrate, 5% fat and 25% dietary fibers lipids, cellulose starch, ash, calcium, iron and β-carotene USDA (2001). Also it has been found to contain vitamin C, niacin, potassium, and diosgenin (which are a compound that has properties similar to estrogen). Other active constituents in fenugreek are alkaloids, lysine and L-tryptophan, as well as steroidal saponins therefore it is used to in artificial flavoring and in the production of hormones( Acharya *et al* ., 2007a and b). Green fenugreek is a good source of iron (Fe) as well as other minerals for human beings( Chhibba *et al*., 2000). *Trigonella foenum-graceum L*. is a medicinally important plant possessing anti-diabetic, anti-cancerous, anti-microbial and hypocholesterolaemic properties (Naganand *et. al*., 2010). Crop production can be improved through improving the metabolic activity and nutritional status of crop plants. Increasing fenugreek yield per unit area can be achieved by breeding high yielding varieties. Fenugreek cultivars differed in growth characters and yield and its components( Péter *et al*., 2004, Basu *et al.*, 2008 and 2009, Avoid *et al*., 2009 and Ahmed *et al*., 2010).

The soil of Nubaria District, like the sandy texture soils are characterize very low organic matter, low water holding capacity and high nutrient leaching losses. It is well known that such soil factors are known to limit mobility and availability of soil fertilizers therefore organic and bio-fertilization, as a particular way to supply Marco and micro-nutrients. If applied properly, organic and bio-fertilization can be considered practical to supply nutritional plant requirements. Numerous studies confirmed positive response for the organic and bio-fertilization(Ahmed and Badr, 2009, EL-Kramany *et al*., 2009 and Ahmed *et al*., 2010) working on Chickpea . Thus the objective of this study is investigate growth, yield and its components as well as some chemical constituents of two cultivars of fenugreek as affect by organic and bio-fertilization under reclaimed sandy soil.

## MATERIAL AND METHODS

Two field experiments were carried out at reclaimed sandy soil in the farm of Research and Production station, National Research Centre, El-Nubaria Province, El-Behira Governorate, Egypt, during the two successive winter seasons of 2009/2010 and 2010/2011 to study response of two fenugreek cultivars to organic and bio-fertilization on growth and productivity. Some physical and chemical characters of soil (0-30cm depth) in the experimental site were as follows: Sand 91.76%, Silt 3.33%, clay 6.26%, PH 7.45, Organic matter 0.27%, Ca CO3 1.53%, EC 0.4ds/m, soluble N 7.78 ppm, available P 3.66 ppm and available K 23 ppm soil measured

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as described by Chapman and Pratt, (1978). A number of soil microorganisms, i.e. *Azospirilum lipoferum*, *Azotobacter chroococcum* and yeast (*Candida tropicalis*), isolated and identified by Gomaa (1995), was used as bio-fertilizers either single or in combination to from the various bio-treatments. Each experiment included sixteen treatments which were the combinations between two fenugreek cultivars (i.e. Giza-2 and Giza-3) and eight treatments representing the interaction between two FYM fertilizers, i.e. 2 and 4 m3/fed. and four bio-fertilizer, i.e. Rhizobium, Rhizobium + Azotobacter, Azotobacter + Yeast, and Rhizobium + Yeast.

***The Treatments of this Study were:***
***A- Fenugreek Cultivars:***
1. Giza- 2 cultivar.
2. Giza- 3 cultivar.

***B- Organic and Bio-Fertilization:***
1. FYM 2 $m^3$/fed. + Rhizobium.
2. FYM 2 $m^3$/fed. Rhizobium + Azotobacter.
3. FYM 2 $m^3$/fed. Azotobacter + Yeast.
4. FYM 2 $m^3$/fed. + Rhizobium + Yeast.
5. FYM 4 $m^3$/fed. Rhizobium.
6. FYM 4 $m^3$/fed. Rhizobium + Azotobacter.
7. FYM 4 $m^3$/fed. Azotobacter + Yeast.
8. FYM 4 $m^3$/fed. + Rhizobium + Yeast.

Organic fertilizer (FYM) treatments in the form of the composted rice residues were applied before ridging, chemical composition of the organic fertilizer as follows: dry weight of 1 m3 460 kg, pH 8.8, organic matter 36.56 %, C/N ratio 1: 16.8, N 1.24 %, P 0.58 %, K 1.15 %.The experiments were laid in a split plot design with three replications, where, fenugreek cultivars occupied the main plots and organic and bio-fertilization were allocated at random in sub plots. Each plot consisted of 15 rows (20 cm spacing) of 3.5 meter length i.e.10.5 m2 (1/400 fed). Fenugreek cultivars were planted on 2nd and 1st December in 2009 and 2010 seasons, respectively, with seed rate of 40 kg / fed. The normal agronomic practices of growing fenugreek were practiced till harvest as recommended by Legumes Research Dept. A.R.C., Giza.

***I-Growth Characters:***
One random samples of one square meter from each plot were taken at 100 days after sowing to the laboratory where the following characters were recorded.
1. Plant height (cm)
2. Number of branches/$m^2$.
3. Number of leaves/$m^2$.
4. Total dry weight/$m^2$ (g).
5. LA ($cm^2$) was determined according to Bremner and Taha (1966).
6. LAI: Leaf area per plant ($cm^2$)/land area per plant ($Cm^2$) was determined according to Watson (1952).
7. Specific leaf area (SLA) ($Cm^2$/ $Cm^3$) SLA=leaf area per plant ($Cm^2$)/Air volume per plant ($Cm^3$) was determined according to Abdel-Gawad *et al*., (1980).
8. Specific leaf weight (SLW) (g/$Cm^2$) SLW =leaf dry weight (g)/ leaf area ($Cm^2$) was determined according to Pearce *et al*., (1969).

***II- Yield and Yield Components:***
At harvest, a random sample of one square meter were taken from each plot to determine,
1. Plant height (cm).
2. Number of pods/$m^2$.
3. Weight of pods/ $m^2$ (g).
4. Weight of seeds/ $m^2$ (g).
5. Weight of 100 seeds (g).
6. Seed yield (kg/fed).
7. Straw yield (kg/fed).
8. Biological yield (kg/fed).
9. Harvest index.

In addition, seed, straw and biological yields "Kg/fed" were determined from the whole area of experimental unit and then converted to yield per fed. Harvest index (seed yield (kg/fed) /biological yield (kg/fed) x100).

***III-Chemical Constituents:***

1. Carbohydrate (percentage) was determined according to the method described by Dubois *et al*., (1956).
2. Protein content was calculated by multiplying total nitrogen concentration by 6.25 according to Chapman and Pratt (1978).
3. Oil (percentages) were determined according to the method described by A.O.A.C.(1984).

***Statistical Analysis:***

All data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran (1990). Treatments means were compared by L.S.D test.

## RESULTS AND DISCUSSIONS

***I Growth Characters:***

***1-Cultivar Differences:***

Data recorded in Table (1) shown that three significant differences between two fenugreek cultivars in all growth characters except spacefic leaf weight at 100 days after sowing in both seasons. In addition, it is clear that Giza-3 cultivar significantly outweighed Giza- 2 cultivar in plant height, number of branches /$m^2$, number of leaves /$m^2$ and total dry weight /$m^2$ at 100 days after sowing in both seasons. Where, Giza 2 cultivar significantly surpassed Giza 3 cultivar in leaf area/plant,leaf area index and spaceific leaf area at 100 days after sowing in both seasons.

The differences among fenugreek cultivars in growth parameters may be due to the differences in number of nodules formed in the root of tested cultivars, consequently, the growth of each cultivar may depended mainly on nitrogen fixation Tawfic *et. al.* (1991), also, to the differences in partition and migration of photosynthetic between cultivars Ahmed *et. al.* (1997) and the endogenous hormone content Shalaby and El-Ashry (2000). The results of cultivar differences in growth characters obtained in this study are in agreement with those obtained by EL-Karamany and Bahr (1999), Chhibba *et. al.* (2008), Ahmed and Badr (2009), Ahmed *et. al.* (2010) and Ahmed *et.al.* (2010).

***2-Effect of Organic and Bio-Fertilizer:***

Table (1) revealed that the combination of organic and bio-fertilizer treatments had a significant effect on all studied growth characters except spacefic leaf weight at 100 days after sowing in both seasons. The same table illustrated that fertilization with FYM +Rhizobium +Yeast recorded the highest significant values from plant height, number of branches/$m^2$, leaf area / plant, leaf area index and spaceific leaf area at 100 days after sowing compared with other seven treatments under study in both seasons.

While, 2 $m^3$/fed. organic fertilizer (FYM +Rhizobium +Azotobacter and 2$m^3$/fed. organic fertilizer (FYM)+ Rhizobium gave the highest significant value from total dry weight plants/$m^2$ in the first and second season, respectively.

Results were in accordance with those obtained by Hafiz (2004), Seema *et. al.* (2007), Ahmed and Badr (2009) and Ahmed *et. al.* (2010).

In addition, inoculation of plant with microbes increase dry matter content (Alagawadi and Gaur, 1998). Over 80% of the bacteria isolated from rizosphere can produce IAA (Arshad and Frankenberger, 1998). The increase in plant height of inoculated treatments is due to the stimulatory effects of microbe induced growth regulators i.e., IAA and GA (Robie, 1996). This increase in dry matter production of inoculated plants may be attributed to enhanced nodulation, higher nitrogen fixation rate and general improvement of root development (Erum and Bank, 2008). Inoculation of Rhizobium sp. caused a greater increase in growth and yield (Akhtar and Siddiqui, 2009). Field trials, conducted under green house conditions, revealed that 10% bio-fertilizer co-inoculums supported maximum growth of the plants when the seeds were coated with charcoal (Nagaranda *et.al.*, 2010).

***3-Effect of the Interaction:***

Table (2) observed that the interaction between cultivars organic and bio-fertilizer significantly affected an all growth characters except (spaceific leaf weight) at 100 days after sowing in both seasons. Generally, it could be concluded that the highest value of plant height and number of branches /$m^2$ were collected by Giza 3 cultivar treated with FYM 4$m^3$ /fed. +Rhizobium + Yeast at 100 days after sowing in both seasons meanwhile, Giza 3 cultivar treated with FYM 2$m^2$/fed. +Rhizobium gave the highest significant value of total dry weight plant /$m^2$ at 100 days from sowing in the first and second season, respectively. While Giza 2 cultivar treated with FYM 4$m^3$/fed.+Rhizobium + Yeast gave the highest significant values from number of leaves / $m^2$, leaf area index and spaceific leaf area at 100 days after sowing in both seasons.

***II- Yield and its Components:***

***1- Cultivar Differences:***

Data reported in table (3) observed that fenugreek cultivars significantly differed in weight of pods/$m^2$, seed weight/$m^2$, seed yield/fed. straw yield /fed. and harvest index. Data observed clearly that Giza-2 cultivar significantly outweighed Giza-3 cultivar in weight of pods/$m^2$ in both seasons, seed weight/$m^2$ in the second season and seed yield/fed. in the second season.

Moreover, Giza-3 cultivar significantly exceeded Giza-2 Cultivar in seed weight /$m^2$ in the second season, seed yield/fed. in the first season and straw yield/fed. in both seasons. On the other hand, differences between Giza-2 and Giza-3 cultivars in plant height, pods number /$m^2$, 100 seed weight, biological yield/fed. and harvest index failed to reach the significant level at 0.05 in both seasons

The differences between fenugreek cultivars in the production efficiency may be due to the differences in number of nodules formed on the root of the tested cultivars, consequently, the growth of each cultivar may depend mainly on nitrogen fixation (Tawfic *et.al.*,1991),also, to the differences in partition and migration of photosynthetic between cultivars( Ahmed *et.al.*,1997). It could be concluded that varietals differences between fenugreek cultivars may be due to genetically differences between cultivars.

It is worthy to mention that the results of varietals differences in fenugreek yield and its components were in harmony with the results obtained by chhibba *et. al.* (2000), Basu *et.al.* (2008 and 2009), Davoud *et.al.* (2009) and Ahmed *et al.* (2010).

**Table 1:** Effect of cultivars, Organic and bio-fertilizers on growth characters of fenugreek plants at 100 days after sowing in 2009 -2010 and 2010-2011 seasons.

| Characters | Plant height (cm) | | No. of branches /$m^2$ | | No. of leaves /$m^2$ | | Total dry weight plants gm/$m^2$ | | Leaf area plant $cm^2$ | | leaf area index LAI | | Spaceific leaf area SLA | | spaceific leaf weight (mg $cm^2$) SLW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| Cultivars<br>Giza 2 | 23.1 | 25.6 | 48.7 | 48.8 | 246.6 | 245.3 | 457.3 | 458.6 | 15.2 | 15.1 | 0.164 | 0.164 | 19.2 | 19.2 | 0.053 | 0.052 |
| Giza 3 | 26.9 | 27.1 | 53.6 | 51.4 | 267.9 | 268.4 | 472.5 | 475.3 | 14.5 | 14.7 | 0.158 | 0.159 | 18.4 | 18.6 | 0.060 | 0.061 |
| LSD at 5% level | 0.3 | 0.4 | 0.9 | 1.0 | 0.8 | 0.9 | 1.0 | 1.2 | 0.2 | 0.2 | 0.002 | 0.004 | 0.2 | 0.2 | ns | ns |
| Organic and bio-fertilizers<br>$2m^3$ FYM +R | 23.6 | 23.5 | 48.7 | 48.4 | 238.5 | 227.0 | 477.5 | 482.0 | 14.0 | 13.6 | 0.147 | 0.147 | 17.3 | 17.5 | 0.059 | 0.056 |
| $2m^3$ FYM+ R+ A | 24.9 | 24.3 | 50.0 | 49.7 | 240.0 | 239.5 | 482.0 | 480.0 | 12.8 | 12.8 | 0.139 | 0.139 | 16.2 | 16.2 | 0.063 | 0.063 |
| $2m^3$ FYM + A+ Yeast | 24.8 | 25.1 | 49.5 | 50.0 | 244.0 | 246.5 | 456.0 | 458.0 | 14.9 | 14.9 | 0.162 | 0.162 | 18.9 | 18.8 | 0.054 | 0.054 |
| $2m^3$ FYM+ R+Yeast | 26.4 | 26.1 | 50.0 | 50.0 | 246.0 | 249.0 | 459.5 | 464.0 | 13.9 | 13.9 | 0.151 | 0.151 | 17.5 | 17.8 | 0.057 | 0.057 |
| $4m^3$ FYM + R | 26.8 | 26.9 | 50.8 | 50.7 | 246.5 | 247.5 | 462.5 | 465.0 | 15.0 | 15.0 | 0.163 | 0.163 | 19.5 | 19.0 | 0.053 | 0.052 |
| $4m^3$ FYM+ R+ A | 25.7 | 26.3 | 46.6 | 45.7 | 244.0 | 244.5 | 455.5 | 457.0 | 15.8 | 15.9 | 0.172 | 0.167 | 19.4 | 20.2 | 0.050 | 0.052 |
| $4m^3$ FYM + A+ Yeast | 27.7 | 27.5 | 48.7 | 50.2 | 247.5 | 247.0 | 457.5 | 458.5 | 15.8 | 16.0 | 0.173 | 0.174 | 20.0 | 20.3 | 0.048 | 0.050 |
| $4m^3$ FYM + R+ Yeast | 29.6 | 30.1 | 55.8 | 56.1 | 251.5 | 254.0 | 468.5 | 471.0 | 16.9 | 17.1 | 0.184 | 0.185 | 21.4 | 21.5 | 0.049 | 0.047 |
| LSD at 5% level | 0.8 | 0.9 | 2.0 | 2.0 | 1.2 | 1.3 | 2.1 | 2.2 | 0.4 | 0.5 | 0.004 | 0.007 | 0.5 | 0.5 | ns | ns |

S1= First season S2= Second season R=Rhizobium A= Azotobacter

**Table 2:** Effect of interactions between cultivars, Organic and bio-fertilizers on growth characters of fenugreek plants at 100 days after sowing in 2009 -2010 and 2010 - 2011 seasons.

| Characters | | Plant height (cm) | | No. of branches /$m^2$ | | No. of leaves /$m^2$ | | Total dry weight plants gm/$m^2$ | | Leaf area plant $cm^2$ | | leaf area index LAI | | Spaceific leaf area SLA | | spaceific leaf weight (mg $cm^2$) SLW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| cultivars | Organic and bio-fertilizers | 21.9 | 21.3 | 44.8 | 45.7 | 239.1 | 220.9 | 452.1 | 450.9 | 14.9 | 14.2 | 0.152 | 0.154 | 18.1 | 18.8 | 0.056 | 0.051 |
| Giza 2 | $2m^3$ FYM +R | | | | | | | | | | | | | | | | |
| | $2m^3$ FYM+ R+ A | 23.5 | 23.2 | 45.5 | 45.4 | 243.0 | 243.4 | 453.8 | 453.2 | 13.7 | 13.6 | 0.149 | 0.148 | 17.3 | 17.2 | 0.061 | 0.058 |
| | $2m^3$ FYM + A+ Yeast | 23.5 | 24.0 | 46.0 | 47.0 | 246.3 | 248.3 | 451.4 | 453.2 | 15.3 | 15.3 | 0.166 | 0.166 | 19.5 | 19.3 | 0.052 | 0.052 |
| | $2m^3$ FYM+ R+Yeast | 25.2 | 26.2 | 48.0 | 47.0 | 250.2 | 252.5 | 455.1 | 453.0 | 14.6 | 14.2 | 0.159 | 0.158 | 18.5 | 18.4 | 0.054 | 0.055 |
| | $4m^3$ FYM + R | 27.9 | 28.2 | 53.2 | 52.8 | 244.3 | 245.0 | 468.1 | 471.7 | 14.4 | 14.2 | 0.157 | 0.155 | 18.2 | 17.9 | 0.055 | 0.056 |
| | $4m^3$ FYM+ R+ A | 26.9 | 27.5 | 47.4 | 45.9 | 242.4 | 243.2 | 457.8 | 458.2 | 15.2 | 15.4 | 0.165 | 0.168 | 19.3 | 19.5 | 0.052 | 0.052 |
| | $4m^3$ FYM + A+ Yeast | 26.8 | 26.1 | 51.0 | 52.5 | 252.4 | 250.9 | 455.1 | 456.3 | 16.2 | 16.4 | 0.177 | 0.178 | 20.5 | 20.8 | 0.049 | 0.048 |
| | $4m^3$ FYM + R+ Yeast | 27.9 | 28.4 | 53.5 | 53.7 | 257.2 | 259.1 | 463.7 | 467.8 | 17.2 | 17.3 | 0.188 | 0.188 | 21.8 | 21.8 | 0.045 | 0.046 |
| Giza 3 | $2m^3$ FYM +R | 25.3 | 25.6 | 52.5 | 51.0 | 238.3 | 233.0 | 503.4 | 512.8 | 13.0 | 13.0 | 0.142 | 0.14 | 16.5 | 16.3 | 0.061 | 0.061 |
| | $2m^3$ FYM+ R+ A | 26.2 | 25.3 | 54.5 | 53.9 | 237.4 | 236.2 | 510.1 | 507.4 | 11.9 | 11.9 | 0.129 | 0.129 | 15.1 | 15.1 | 0.066 | 0.067 |
| | $2m^3$ FYM + A+ Yeast | 26.2 | 26.1 | 53.0 | 53.0 | 242.3 | 245.4 | 461.3 | 462.9 | 14.4 | 14.5 | 0.157 | 0.157 | 18.3 | 18.2 | 0.005 | 0.055 |
| | $2m^3$ FYM+ R+Yeast | 27.5 | 28.2 | 52.0 | 53.0 | 242.3 | 246.4 | 463.8 | 470.1 | 13.2 | 13.4 | 0.143 | 0.146 | 16.6 | 17.1 | 0.06 | 0.059 |
| | $4m^3$ FYM + R | 25.7 | 25.6 | 48.5 | 48.5 | 249.1 | 249.0 | 455.5 | 457.7 | 15.5 | 15.8 | 0.168 | 0.172 | 19.6 | 20 | 0.051 | 0.05 |
| | $4m^3$ FYM+ R+ A | 24.5 | 25.2 | 45.8 | 45.4 | 246.3 | 246.2 | 453.4 | 456.1 | 16.4 | 16.4 | 0.178 | 0.18 | 20.9 | 20.8 | 0.048 | 0.048 |
| | $4m^3$ FYM + A+ Yeast | 28.6 | 28.9 | 46.3 | 47.9 | 242.7 | 243.0 | 460.1 | 461.3 | 15.4 | 15.5 | 0.168 | 0.169 | 19.9 | 19.7 | 0.051 | 0.051 |
| | $4m^3$ FYM + R+ Yeast | 31.2 | 31.8 | 58.0 | 58.5 | 246.5 | 248.8 | 474.2 | 474.4 | 16.5 | 16.8 | 0.181 | 0.182 | 21 | 21.2 | 0.048 | 0.047 |
| LSD at 5% level | | 0.9 | 1.0 | 2.1 | 2.3 | 1.3 | 1.5 | 2.3 | 2.2 | 1.1 | 1.2 | 0.054 | 0.07 | 1 | 0.9 | ns | ns |

S1= First season S2= Second season R=Rhizobium A= Azotobacter

### *2-Effect of Organic and Bio-Fertilizer:*

Table (3) show that the combination of organic and bio-fertilizer treatment had a significant effect on plant height, weight of pods/$m^2$, seed weight/$m^2$, seed yield/fed., straw yield /fed., biological yield/fed. and harvest index in both seasons. On the other hand, the effect on number of pods/$m^2$ and 100 seed weights was not significant. Data recorded in the same table observed that the fertilization with 4$m^3$ /fed., organic fertilizer FYM +Rhizobium +Yeast gave the highest significant values from plant height, weight of pods/$m^2$, seed weight/$m^2$, seed yield/fed., straw yield/fed. and biological yield/fed. in both seasons, mean whole, 2m3/fed.organic fertilizer (FYM) +Rhizobium and 2$m^3$/fed., organic fertilizer (FYM) 4$m^3$/fed. +Azotobacter +Yeast gave the highest significant value of harvest index in the first and second season, respectively.

**Table 3:** Effect of cultivars, Organic and bio-fertilizers on yield and yield components of fenugreek plants in 2009 -2010 and 2010 - 2011 seasons.

| Characters | Plant height (cm) | | No. of pods /$m^2$ | | Weight of pods gm/$m^2$ | | Seed weight "gm"/m2 gm/$m^2$ | | 100 seed weight "gm" | | Seed yield "kg"/ fed. | | Straw yield "kg"/ fed. | | Biological yield "kg"/ fed. | | Harvest index | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| Cultivars Giza 2 | 29.1 | 29.2 | 248.1 | 248.6 | 153.9 | 154.4 | 101 | 101.4 | 1.53 | 1.52 | 404.8 | 416.9 | 824.5 | 928.5 | 1330.9 | 1330.3 | 30.5 | 30.3 |
| Giza 3 | 29.3 | 29.1 | 247.3 | 248.3 | 155.8 | 156.1 | 101 | 104 | 1.58 | 1.58 | 415.9 | 403.5 | 927.9 | 934.6 | 1349.5 | 1352.4 | 30.5 | 30.4 |
| LSD at 5% level | ns | ns | ns | ns | 1.4 | 1.3 | ns | 3.04 | ns | ns | 1.1 | 1.4 | 4.3 | 4.7 | 55.28 | 54.31 | ns | ns |
| Organic and bio-fertilizers | 25.2 | 25.2 | 238 | 239.5 | 140 | 139.5 | 95.4 | 94.2 | 1.45 | 1.43 | 381.5 | 376.5 | 814 | 830.5 | 1221.5 | 1215.5 | 31.3 | 30.95 |
| 2$m^3$ FYM +R | | | | | | | | | | | | | | | | | | |
| 2$m^3$ FYM+ R+ A | 26.8 | 27.3 | 242 | 242 | 153 | 153 | 100.3 | 100 | 1.52 | 1.52 | 400.5 | 402 | 917 | 917 | 1322.5 | 1316.5 | 30.3 | 30.5 |
| 2$m^3$ FYM + A+ Yeast | 28.8 | 28.5 | 243 | 243 | 153 | 152.5 | 103.7 | 103.7 | 1.56 | 1.56 | 414.5 | 415 | 917.5 | 917.5 | 1332 | 1332 | 31.1 | 31.1 |
| 2$m^3$ FYM+ R+Yeast | 29.5 | 29.9 | 248.3 | 248 | 156.5 | 159 | 104.9 | 104.9 | 1.58 | 1.59 | 420 | 419.5 | 949 | 953.5 | 1358.5 | 1372 | 30.8 | 28.5 |
| 4$m^3$ FYM + R | 28.4 | 28 | 248 | 248.5 | 155.5 | 156 | 101.5 | 101.5 | 1.54 | 1.54 | 406 | 405.5 | 933.5 | 937 | 1342.5 | 1340 | 28.7 | 28.4 |
| 4$m^3$ FYM+ R+ A | 28.2 | 30.7 | 251.3 | 251 | 157 | 157.5 | 104.5 | 104.5 | 1.59 | 1.58 | 418 | 418.5 | 942 | 951.5 | 1360 | 1364 | 30.7 | 30.6 |
| 4$m^3$ FYM + A+ Yeast | 30.4 | 30.6 | 255.5 | 255.5 | 161 | 161 | 104.5 | 104.5 | 1.58 | 1.58 | 416.5 | 417.5 | 965 | 965 | 1381.5 | 1382.5 | 30.2 | 30.2 |
| 4$m^3$ FYM + R+ Yeast | 32.7 | 33.2 | 260 | 260 | 162.5 | 163.5 | 107.2 | 107 | 1.62 | 1.62 | 425.5 | 427 | 974 | 980.5 | 1401.5 | 1407.5 | 30.1 | 30.4 |
| LSD at 5% level | 0.4 | 0.4 | ns | ns | 3.3 | 3.2 | 7.4 | 7.5 | ns | ns | 5.3 | 5.6 | 8.7 | 8.9 | 106.16 | 105.18 | 0.53 | 0.51 |

S1= First season S2= Second season R=Rhizobium A= Azotobacter

**Table 4:** Effect of interactions between cultivars, Organic and bio-fertilizers on yield and yield components of fenugreek plants in 2009 -2010 and 2010 - 2011 seasons.

| Characters | | Plant height (cm) | | No. of pods /$m^2$ | | Weight of pods gm/$m^2$ | | Seed weight gm/$m^2$ | | 100 seed weight gm | | Seed yield" Kg"/fed. | | Straw yield" Kg"/fed. | | Biological yield " Kg"/fed. | | Harvest index | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| cultivars | Organic and bio-fertilizers | 26.9 | 27.2 | 243 | 244.4 | 134.2 | 133.9 | 88.7 | 87.3 | 1.34 | 1.32 | 355.1 | 404.3 | 805.3 | 806.3 | 1160.3 | 1156.4 | 30.6 | 30.2 |
| Giza 2 | 2$m^3$ FYM +R | | | | | | | | | | | | | | | | | | |
| | 2$m^3$ FYM+ R+ A | 29.1 | 29.3 | 246.2 | 245.48 | 156.1 | 155.4 | 93.5 | 94.1 | 1.42 | 1.42 | 374.5 | 427.4 | 935.2 | 931.4 | 1319.4 | 1306 | 28.4 | 28.8 |
| | 2$m^3$ FYM + A+ Yeast | 26.2 | 26.4 | 241.3 | 241 | 152.3 | 151.2 | 108.2 | 108.8 | 1.6 | 1.61 | 431.5 | 432.5 | 909.4 | 909.2 | 1340.2 | 1341.4 | 32.2 | 32.2 |
| | 2$m^3$ FYM+ R+Yeast | 27.2 | 27.2 | 245.1 | 246 | 154.2 | 157.1 | 113.4 | 112.7 | 1.7 | 1.71 | 454.5 | 452.4 | 940.9 | 942.1 | 1393.1 | 1392.4 | 32.5 | 32.4 |
| | 4$m^3$ FYM + R | 30.5 | 30.8 | 248 | 251.48 | 156.87 | 158.28 | 95.1 | 93.9 | 1.44 | 1.42 | 380.4 | 376.5 | 944.5 | 948.9 | 1323.9 | 1323.5 | 28.7 | 28.4 |
| | 4$m^3$ FYM+ R+ A | 32.2 | 32.4 | 55.41 | 255 | 158.35 | 160.45 | 98.2 | 97.9 | 1.49 | 1.48 | 392 | 392.5 | 950.4 | 971.3 | 1341.9 | 1350.6 | 29.2 | 29 |
| | 4$m^3$ FYM + A+ Yeast | 29.2 | 29.3 | 52.35 | 252.39 | 159.14 | 159.39 | 101.8 | 101.7 | 1.52 | 1.52 | 402 | 402 | 953.3 | 953.2 | 1355 | 1355.5 | 29.8 | 29.7 |
| | 4$m^3$ FYM + R+ Yeast | 30.5 | 30.9 | 255.4 | 256.46 | 161.25 | 161.49 | 111.8 | 112.9 | 1.7 | 1.71 | 450.4 | 450.5 | 964 | 967.4 | 1413.8 | 1417.3 | 31.1 | 31.9 |
| Giza 3 | 2$m^3$ FYM +R | 23.5 | 23.2 | 232.5 | 235.1 | 146.48 | 145.26 | 102.1 | 101.39 | 1.55 | 1.53 | 408.3 | 349.5 | 823.2 | 854.2 | 1283.2 | 1275.5 | 31.9 | 31.7 |
| | 2$m^3$ FYM+ R+ A | 24.5 | 25.2 | 238.2 | 239.39 | 150.2 | 150.99 | 107.3 | 106.48 | 1.62 | 1.62 | 427.3 | 377.2 | 899.5 | 903.4 | 1326.2 | 1327 | 32.2 | 32.7 |
| | 2$m^3$ FYM + A+ Yeast | 31.4 | 30.5 | 246.3 | 245.2 | 154.34 | 154.89 | 99.1 | 99.5 | 1.51 | 1.51 | 398.4 | 398.5 | 926 | 926.5 | 1324.4 | 1324.5 | 30 | 30.1 |
| | 2$m^3$ FYM+ R+Yeast | 31.8 | 32.5 | 248.8 | 250.8 | 159.45 | 161.48 | 96.7 | 97 | 1.46 | 1.47 | 386.5 | 387.4 | 957.5 | 965.4 | 1327 | 1352.4 | 29.1 | 28.6 |
| | 4$m^3$ FYM + R | 26.2 | 25.2 | 244.9 | 246.3 | 154.41 | 154.39 | 108.7 | 109.8 | 1.64 | 1.65 | 432.4 | 435.5 | 923 | 926.4 | 1360.9 | 1356 | 28.7 | 28.4 |
| | 4$m^3$ FYM+ R+ A | 28.2 | 28.9 | 247 | 247.2 | 156.39 | 155.47 | 111.4 | 110.7 | 1.68 | 1.67 | 444.27 | 445.5 | 934.4 | 932.1 | 1378.4 | 1377.4 | 32.2 | 32.3 |
| | 4$m^3$ FYM + A+ Yeast | 31.5 | 31.8 | 259.4 | 259.2 | 162.9 | 163.38 | 108.5 | 108.5 | 1.63 | 1.64 | 431.4 | 433.4 | 977.5 | 977.2 | 1408.4 | 1410.3 | 30.6 | 30.7 |
| | 4$m^3$ FYM + R+ Yeast | 34.9 | 35.5 | 261.9 | 264.4 | 164.2 | 166.2 | 101.5 | 101.5 | 1.53 | 1.53 | 401.2 | 404.3 | 984.5 | 994.4 | 1389.1 | 1398.2 | 29.1 | 29 |
| LSD at 5% level | | 1.8 | 1.9 | 19.4 | 19.3 | 4.5 | 4.5 | 9.3 | 9.8 | 0.77 | 0.77 | 8.4 | 8.5 | 19 | 18.9 | 20 | 19.2 | 0.7 | 0.7 |

S1= First season S2= Second season R=Rhizobium A= Azotobacter

In addition, inoculation of plant with microbes increase dry matter content (Alagawadi and Gaur, 1998).Over 80%of the bacteria isolated from rhizosphere can produce IAA( Arshad and Frankenberger, 1998).This increase in dry matter production of inoculated plants may be attributed to enhanced nodulation, higher nitrogen fixation rate and general improvement of root development( Erum and Bsno,2008). Inoculation of Rhizobium sp. caused a greater increase in growth and yield (Akhtar and Siddiqui,2009).

Generally, our results are in full agreement with those obtained by Hafiz (2004), Jain *et. al.* (2006), EL-Krammany *et. al.* (2009), Ahmed and Badr (2009) and Ahmed *et.al.* (2010).

***3-Effect of the Interaction:***

Table (4) indicated that yield and its components of fenugreek plants significantly affected by the interaction between cultivars organic and bio-fertilizers. Generally, data illustrated show clearly that Giza-3 cultivar treated with FYM $4m^3$/fed. +Rhizobium +Yeast gave the highest significant values from plant height, number of pods/$m^2$, weight of pods/$m^2$ and straw yield/fed. in both seasons. Giza-2 cultivar with FYM $2m^3$/fed. +Rhizobium +Yeast gave the highest values of seed weight/$m^2$, 100 seed yield/fed. and harvest index in both seasons, meanwhile, the same cultivars produced the highest significant biological yield/fed. under treatment with FYM $4m^3$/fed. +Rhizobium +Yeast in both seasons.

***III- Chemical Content:***

***1-Cultivar Differences:***

Data presented in Table (5) indicated that fenugreek cultivars Giza 2 and Giza 3 differed significantly in the carbohydrate, crude protein and oil %. It concluded that Giza 2 cultivar significantly exceeded Giza 3 cultivar in carbohydrate, protein and oil percentages. These results may be due to increase of growth and yield which in turn reflected positively on chemical of fenugreek grains.

***2-Effect of Organic and Bio-Fertilizer:***

Data reported in Table (5) show that the fertilization with 4m3/fed.,organic fertilizer (FYM)+Azotobacter +yeast gave the highest significant values of carbohydrate, protein and oil percentages.

**Table 5:** Effect of cultivars, Organic and bio-fertilizers on chemical content of fenugreek grains.

| Character Treatments | Carbohydrate % | Protein % | Oil % |
|---|---|---|---|
| Cultivars<br>Giza 2 | 42.1 | 22 | 11.61 |
| Giza 3 | 41.8 | 21.7 | 11.52 |
| LSD at 5% level | 0.2 | 0.1 | 0.02 |
| Organic and bio-fertilizers<br>$2m^3$ FYM +R | 39.4 | 19.9 | 10.22 |
| $2m^3$ FYM+ R+ A | 40.1 | 20.3 | 10.49 |
| $2m^3$ FYM + A+ Yeast | 42 | 21.8 | 11.42 |
| $2m^3$ FYM+ R+Yeast | 41.4 | 21.2 | 11.09 |
| $4m^3$ FYM + R | 42.4 | 22.2 | 11.66 |
| $4m^3$FYM+ R+ A | 42.8 | 22.6 | 12.21 |
| $4m^3$ FYM + A+ Yeast | 43.9 | 23.8 | 12.85 |
| $4m^3$ FYM + R+ Yeast | 43.4 | 23.3 | 12.61 |
| LSD at 5% level | 0.3 | 0.2 | 0.05 |

R= Rhizobium A= Azotobacter

***3-Effect of the Interaction:***

Table (6) the interaction between fenugreek cultivars organic and bio fertilizers significantly affect on carbohydrate, crude protein and oil %. It can be concluded that Giza 2 cultivar treated with FYM $4m^3$/fed. +Azotobacter +Yeast gave the highest values of carbohydrate, crude protein and oil percentages.

**Table 6:** Effect of interactions between cultivars, Organic and bio-fertilizers on chemical content of fenugreek grains.

| Characters | Treatments | Carbohydrate % | Protein % | Oil % |
|---|---|---|---|---|
| cultivars | Organic and bio-fertilizers<br>$2m^3$ FYM +R | 39.6 | 20.3 | 10.21 |
| Giza 2 | $2m^3$ FYM+ R+ A | 40.3 | 20.5 | 10.53 |
| | $2m^3$ FYM + A+ Yeast | 42.0 | 21.8 | 11.48 |
| | $2m^3$ FYM+ R+Yeast | 41.6 | 21.2 | 11.41 |
| | $4m^3$ FYM + R | 42.5 | 22.3 | 11.73 |
| | $4m^3$FYM+ R+ A | 42.9 | 22.7 | 12.25 |
| | $4m^3$ FYM + A+ Yeast | 43.9 | 23.9 | 12.92 |
| | $4m^3$ FYM + R+ Yeast | 43.5 | 23.5 | 12.71 |
| Giza 3 | $2m^3$ FYM +R | 39.2 | 19.4 | 10.24 |
| | $2m^3$ FYM+ R+ A | 39.8 | 20.1 | 10.49 |
| | $2m^3$ FYM + A+ Yeast | 41.9 | 21.7 | 11.28 |
| | $2m^3$ FYM+ R+Yeast | 41.2 | 21.2 | 11.19 |
| | $4m^3$ FYM + R | 42.3 | 22 | 11.68 |
| | $4m^3$FYM+ R+ A | 42.6 | 22.5 | 11.75 |
| | $4m^3$ FYM + A+ Yeast | 43.8 | 23.7 | 12.76 |
| | $4m^3$ FYM + R+ Yeast | 43.2 | 23.1 | 12.52 |
| LSD at 5% level | | 0.3 | 0.2 | 0.11 |

R= Rhizobium A= Azotobacter

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