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EFFECT OF MYCORRHIZA FUNGI (VAM), ATONIK AND SOIL MEDIA ON GROWTH AND CHEMICAL COMPOSITION OF CAROB SEEDLINGS (*Ceratonia siliqua L.*)

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ABSTRACT

This study was carried out to investigate the response of carob seedlings to growing media, Biostimulants (Atonik) and Mycorrhiza fungi (VAM). So, this study included 2 parts. Generally, growing the carob seedlings in a mixture of sand+ clay+ perlite+ peatmoss or sand+ clay+ peatmoss resulted in the tallest seedlings with the greatest number of leaves. Whereas the mixture of sand+ clay+ vermiculite decreased the plant height of carob seedling. Most of the growing mixtures had a favorable effect on increasing the stem diameter of the carob seedlings as compared with seedlings grown in sand+ clay. The fresh and dry weights of leaves and stems were the heaviest in the mixtures of sand+ clay+ vermiculite+ peatmoss, sand+ clay+ perlite+ peatmoss or sand+ clay+ peatmoss. The mixtures of sand+ clay+ perlite, sand+ clay+ peatmoss or sand+ clay+ perlite+ peatmoss markedly increased the root length, whereas the mixture of sand+ clay+ vermiculite+ peatmoss decreased it. The mixture of sand+ clay+ vermiculite was the most effective medium in increasing the contents of (chlorophyll–a–b and caroteniods). Using sand+ clay+ peatmoss mixture increased the accumulation of nitrogen in the leaves. Adding vermiculite to sand+ clay mixture had a favorable effect on increasing the N content in the stems and roots of the carob seedlings. Regarding the effect of Atonik and Mycorrhiza on carob seedlings. It was found that adding Mycorrhiza to soil was the most effective on increasing the vegetative growth (plant height, stem diameter, root length, fresh and dry weight of leaves, stems and roots, and chemical constituents (chlorophyll-a-b, carotene, total carbohydrates content N, P and K percentage in all parts of carob seedlings. comparing with the application of Atonik treatment and the control plants.

Key words: Mycorrhiza, chlorophyll, peatmoss, vermiculite, perlite.

INTRODUCTION

The carob tree is an important component of the Mediterranean vegetation and its cultivation in marginal and prevailing calcareous soils of the Mediterranean region is important environmentally and economically.The Carob genus, *Ceratonia*, belongs to the *Fabaceae* (Legume) family. The carob tree grows as a sclerophyllous evergreen shrub or tree up to 10 m high, with a broad semispherical crown and a thick trunk with brown rough bark and sturdy branches. Leaves are 10-20 cm long, the leaves are sclerophyllous and have a very thick single-layered upper epidermis, the cells of which contain phenolic compounds in the large vacuoles, and stomata are present only in the lower epidermis and arranged in clusters (Mitrakos 1988). The production of nursery seedlings, including carob seedlings, involves a number of cultural inputs. Among these, perhaps the most important is the type of growing medium used. Due to the relatively shallow depth and limited volume of a container, growing media must be amended to provide the appropriate physical and chemical properties necessary for plant growth. Selecting the appropriate growing media to use is an important step in producing a good quality carob plant. It is well known that a good medium is made up of components that provide optimum aeration, drainage and moisture holding characteristics. These are usually made up from combinations of peat moss, perlite, vermiculite, sand or similar materials. The primary role of a medium is to provide support and moisture while the plant is developing. These requirements are quite different from plant to another, which may have to sustain a mature or growing plant over a long period of time. Generally speaking, the media used for plant production in the greenhouse will vary depending on the production approach being used. Each media has its specific properties, and resulting advantages and disadvantages. The most important symbiotic microorganisms for crop production are *Rhizobium* and mycorrhizal fungi. The former is a kind of bacteria, and forms a symbiotic relationship with leguminous plants. The latter is a kind of fungi, and forms a symbiotic relationship with most of the plants. In particular, VAM fungi infect almost all the plants. The VAM fungi penetrate the living cells of plants without harming them, and form the typical organs, such as vesicles and carbuncles, in the root. Besides, the hyphens range for into the bulk soil. By doing so, the fungi link plant and soil, transporting mineral nutrients, especially P, to plant and carbon compounds to the soil and its biota. VAM fungi-infected plants have high potential of resistance to soil environmental stresses. According to a fossil record, VAM fungi were infecting in the roots of *Aglaophyton major*, an Early Devonian land plant, at least 400 million years ago Remy *et al*. (1994).

The Early Devonian has been known to be the period when plants invaded the land, and it will be of great interest to imagine how the plants invaded the land where there was a severe situation for them with the help of VAM fungi. The known functions of VAM fungi on plants are that 1) the absorption of minerals, especially P, is promoted, 2) growth is stimulated, 3) high quality of fruits is produced every year, 4) resistance to environmental stresses is enhanced, and 5) resistance to soil disease is enhanced. At present, most countries have some projects about sustainable agriculture. I believe that VAM fungi can play a major role in the quest for sustained plant productivity in all segments of agriculture. Soil degradation involved disturbance of the balance by cultivation, monoculture, excessive inputs of agrochemicals and fertilizers, removal of organic matter from the soil by crop removal and accelerated decomposition without replacement, and erosion. To maintain economic levels of productivity, farmers have been forced to increase inputs. Our goal is to reduce chemical inputs for environmental and health reasons.

Thus, I am convinced that VAM fungi need to be reestablished to a high level of effectiveness to offset the reduced inputs. On the utilization of VAM fungi, the present study was done to study the effects of growing media and as well as some natural products (Atonik and Mycorrhiza) in order to increase its quantity and quality to provide growers with information useful. about media and nutrition program of these seedlings.

MATERIALS AND METHODS

This study was carried out at the Experimental Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during two successive years; 2008 and 2009. This study included 2 parts:

Part I: Effect of growing media on growth and chemical constituents of carob seedlings: The aim of this experiment was to investigate the effects of some growing media on growth and chemical composition of carob seedlings. Uniforms seedlings of carob. were planted in 30-cm diameter plastic pots filled with one of the following growing media at (1: 1: 1 V/ V/ V)

1- Sand + clay.
2- “”””””””+ “” + perlite.
3- “”””””””+ “” + peatmoss.
4- “”””””””+ “” + vermiculite.
5- “”””””””+ “” + peatmoss+ perlite.
6- “”””””””+ “” + peatmoss+ vermiculite.

The seedlings were fertilized with NPK (1: 1: 1) at 2.5 g/ pot at 21 days intervals using ammonium nitrate 33%N, potassium sulphate 45% K_2O, calcium super phosphate 16% P_2O_5.

Part II: Effect of Atonik and Mycorrhiza fungi on growth and chemical constituents of carob seedlings:

a. Effect of Atonik: The aim of this experiment was to investigate the effects of Atonik and Mycorrhiza fungi on growth and chemical constituents of carob seedlings, On the 1, th of December, 2008, uniform seedlings of carob were planted in 30-cm diameter plastic pots, filled with a mixture of sand: clay (1: 1 V/V).

After 21 days from transplanting the seedlings were sprayed at three months intervals with an aqueous solution of Atonik at 50 cm/ L Bsit- vied was used as a wetting agent at 0.5 cm/ L. All the seedlings were fertilized with N P K (1: 1: 1) at 2.5 g/ pot, every 21 days, the irrigation was done as the seedlings required.

b. Effect of Mycorrhiza fungi (VAM):

Root infection counts determination:

Root infection counts were determined as described by Philips and Hayman (1970) as follows:

a- Whole root pieces either fresh or fixed in F.A.A (5:5:90 formalin: acetic acid: 70% ethyl alcohol) were placed in 10% KOH and heated for 30 min. at 80-90 ^{0}C in a water bath.

b- Roots were rinsed twice by distilled water before placing in glass beaker with diluted HCL for 5 min.

c- Trypan blue stain was prepared by dissolving 600 mg Trypan blue in 200 ml lactic acid then 400 ml of glycerol were added and the volume was made up to one liter by deionized water.

d- Roots were covered by 0.06% Trypan blue stain and left in water bath for 5-10 min at 80-90 ^{0}C.

e- Root pieces were placed on slide with few drops of lactic acid for microscopic examination. Ten pieces were represented for each replicate. Photographs were taken to show hypha and vesicles of VAM are showed in Figure.1.

Statistical analysis:

Data recorded were analyzed according to Sendecor and Cochran (1980). Treatment means were compared by using LSD at 5% level of probability**.**

Figure 1. Hypha and vesicles of VAM

RESULTS AND DISCUSSION

1. Effect of growing media on carob seedlings.

a. On vegetative growth:

1. Plant height: The responses of seedling height of the carob seedlings to the different growing media are shown in Table(1).The obtained data, indicated that, growing the seedlings in a medium consisting of the mixture from sand+ clay+ perlite+ peatmoss followed by sand+ clay+ peatmoss resulted in the tallest seedlings (37 and 33 cm) respectively. In this respect, Mohamed (1994) on tuberose plant, obtained the tallest plants from using a mixture of loamy+ sand+ peatmoss at ratio of (1: 1: 1 V/ V/ V).

2. Stem diameter: The responses of stem diameter of carob seedling to the different growing media are shown in Table (1). The data showed significant differences, between the stem thicknesses in the different growing media, where growing seedlings in a mixture of sand+ clay+ vermiculite+ peatmoss, significantly increased stem diameter of seedlings to 0.57 cm, while stem diameter of seedlings grown in sand+ clay was 0.37 cm. It could be concluded that using a growing medium containing vermiculite together with peatmoss had a remarkable effect on increasing stem growth of carob seedling. These findings are in accordance with those reported by Lackey and Alm (1982) on *Pinus resinosa* and *Picea glauca.* and Abuo Dahab (1996) on *Brassaia arboricola* , they reported that growing mixture containing vermiculite markedly increased the stem diameter.

3. Number of leaves: Data in Table (1), revealed that the carob seedling formed the maximum number of leaves (70.33) when they were grown in the mixture of sand+ clay+ peatmoss, followed by the mixtures of sand+ clay+ vermiculite+

peatmoss (63.00) and sand+ clay+ perlite, sand+ clay+ perlite+ peatmoss (56.67), while number of leaves of seedlings grown in sand+ clay was (24.67). In this respect, El-Khateeb *et al.* (2006) on two cultivars of *Ficus alii*, found that, the mixtures of clay+ peatmoss+ perlite as well as clay+ peatmoss+ vermiculite produced the highest number of leaves.

4. Root length: As shown in Table(1)growing carob plants in the mixtures of sand+ clay+ perlite, sand+ clay+ peatmoss and sand+ clay+ perlite+ peatmoss, encouraged the root growth of carob seedling , and significantly affected the length of roots. In this respect, Singh *et al*. (2002) on *Maranta bicolor* obtained the longest roots, with soil+ coco peatmoss mixture (1:1v/v). Also, Karakir *et al.* (1994) on fig cv. Sari lop obtained the best root growth in medium of sand+ perlite.

Table1. Effect of growing media on plant height (cm), stem diameter (cm), number of leaves and root length (cm) of carob seedlings.

Growing Media		**Plant height**	**Stem diameter**	**Number of leaves**	**Root length**
Sand+ clay	**---**	21.17	0.37	24.67	33.67
	Perlite	25.33	0.48	56.67	49.33
	Peatmoss	33.00	0.47	70.33	42.67
	Vermiculite	22.00	0.48	33.00	36.83
	perlite+ peatmoss	37.00	0.47	56.67	38.33
	vermiculite+ peatmoss	28.00	0.57	63.00	27.17
LSD at 5 %		**2.29**	**0.08**	**2.94**	**2.21**

5. Fresh and dry weights of leaves stems and roots:

Regarding the effect of growing media on fresh and dry weights of leaves of carob plant, the data in Table (2) showed that fresh and dry weights of carob's leaves & stems were greatly affected by composition of growing media. Significant effects had been obtained as a result of these media. The highest values of fresh weights of leaves (23.32, 19.45 ,18.40 and 14.14 g) were obtained from growing the plants in the mixtures of media consisting of sand+ clay+ vermiculite+ peatmoss, sand+ clay+ perlite and sand+ clay+ peatmoss, sand+ clay+ perlite, respectively. So it can be mentioned that using peatmoss and vermiculite together in growing media, had a favorable effect on increasing the fresh weight of leaves. These results are in harmony with El-Khateeb *et al.* (2006)

Growing media	**Weights of**

		Leaves		Stems		Roots	
		Fresh	**Dry**	**Fresh**	**Dry**	**Fresh**	**Dry**
San+ clay+	**--------**	08.09	3.57	4.02	1.79	10.54	3.87
	Perlite	14.14	7.83	4.20	2.16	22.17	8.88
	Peatmoss	18.40	8.62	7.80	3.77	14.72	6.45
	Vermiculite	08.23	3.85	3.48	1.76	18.49	8.01
	perlite+ peatmoss	19.45	9.73	7.41	3.52	21.17	7.11
	vermiculite+ peatmoss	23.32	9.84	6.80	2.65	21.34	8.16
LSD at 5 %		**0.50**	**0.11**	**0.06**	**0.06**	**0.14**	**0.11**

Table 2. Effect of growing media on fresh and dry weights (g.), of leaves, stem and roots for carob seedling.

on *Ficus alii*, found that, clay+ peatmoss+ vermiculite, and produced the heaviest fresh and dry weights. It was clear that using the mixtures of sand+ clay+ peatmoss had a favorable effect on increasing the fresh and dry weights of stems, in this respect. Abou Dahab (1996) on *Brassaia arboricola*, stated that the addition of clay or vermiculite to the mixture of peatmoss+ sand gave the heaviest dry weight of stems .Also, fresh weights of roots were greatly increased when plants were grown in sand+ clay+ perlite (22.17 g), sand+ clay+ vermiculite+ peatmoss (21.34 g) and sand+ clay+ perlite+ peatmoss (21.17 g) as compared with other growing media .In this respect. El-Khateeb *et al.* (2006) on two cultivars of *Ficus alii*, found that the fresh weight of roots increased with using the mixtures of clay+ sand+ perlite and clay+ sand+ peatmoss.

b. Effect on chemical constituents.

1. Pigments content: Data in Table (3) showed the effect of growing media on the contents of chlorophyll -a,-b and carotenoids in the leaves of carob plant. The results indicated that, the mixtures of sand+ clay+ vermiculite showed the highest content of chlorophyll-a (1.26 mg/ g F.W) in the leaves. Whereas, the lowest content of chlorophyll-a (0.80 mg/ g F.W) in the leaves of carob was recorded when plants were grown in sand+ clay+ perlite+ peatmoss. The highest value of chlorophyll-b (0.40 mg/ g F.W) and carotenes (0.76 mg/ g F.W) in the leaves of carob was recorded with the mixture of sand+ clay+ vermiculite. Generally the mixtures of sand+ clay+ vermiculite , was the most effective media in increasing the contents of chlorophyll–a, chlorophyll–b and caroteniods in this regard .Abou Dahab (1996) on *Brassaia arboricola*, reported that using a mixture of

Table 3. Effect of growing media on the contents of chlorophyll-a, b, caroteniods mg/ g F.W in the leaves and total carbohydrates.% D.W in the different parts of carob seedlings. (*Ceratonia siliqua* L.).

Growing media		Pigment content			Total carbohydrates		
		Chl-a	Chl-b	Carotene	Leaves	Stems	Roots
Sand+ clay	------	١.٠٧	٠.٢٦	٠.٥٥	١٥.٣١	٢١.١٧	٢٦.٤٣
	Perlite	٠.٩٤	٠.٢٤	٠.٥١	١٧.٣٦	١٨.٩٠	٢٦.٩٨
	Peatmoss	١.٠٣	٠.٣٨	٠.٤٣	٠٨.٨٨	٢١.٥٢	٢٧.٧٣
	Vermiculite	١.٢٦	٠.٤٠	٠.٧٦	١٧.٣٨	٢٧.١٠	٣٠.٠٣
	Perlite+ peatmoss	٠.٨٠	٠.٢٣	٠.٥٢	١٠.٦٦	١٩.٥٢	٢٧.٢٠
	Vermiculite +peatmoss	٠.٩٩	٠.٢٧	٠.٥٩	١٤.٧٤	٢٧.٢٣	١٤.٥٤

vermiculite+ clay+ sand gave the highest chlorophyll a+ b content.. El-Khateeb *et al.* (2006) on *Ficus alii,* found that using clay+ sand+ vermiculite medium showed the highest content of chlorophyll-a. Whereas, Saleh (2000) on *Ficus benjamina* cv. "Starlight" indicated that using sand+ peatmoss+ clay as a growing mixture decreased the content of caroteniods in the leaves.

2. Total carbohydrates content (% DW): Data in Table 3 showed the effect of growing media on the contents of carbohydrates in the different parts of carob plant the results indicated that. the highest value of the carbohydrates content in the leaves of (17.38 g) carob plants was recorded with the mixtures of sand+ clay+ vermiculite, The stem content of carbohydrates reached to the highest value when plants were grown in sand+ clay+ vermiculite+ peatmoss or sand+ clay+ vermiculite. The highest value of carbohydrates in the roots of carob was recorded with the mixture of sand+ clay+ vermiculite. In this connection, El-Khateeb *et al* (2006) on *Ficus alii,* found that the mixtures of clay+ peat+ perlite, and clay+ sand+ vermiculite, increased the content of carbohydrates in the leaves, whereas the highest content of carbohydrates in the roots was obtained on media containing vermiculite.

3. N ,P and K contents: The response of N,P and K contents in the leaves, stems and roots of the carob plants to the different growing media are presented in Table 4. The results show that, using sand+ clay+ peatmoss and sand+ clay+ perlite+ peatmoss, increased the N% .whereas, sand+ clay+ vermiculite and sand+ clay+ perlite, showed the lowest content of nitrogen in the leaves The highest content of N stems and roots were recorded when plants were grown in sand+ clay+ vermiculite. Similar findings were reported by Mohamed (1994) on

Table 4. Effect of growing media on the percent of nitrogen, phosphorus and potassium (% D.W) in the different parts of carob seedlings. (*Ceratonia siliqua* L.).

Growing media		Leaves	Stems	Roots
			Nitrogen	
Sand+ clay+	**--------**	**1.35**	**1.27**	**1.16**
	Perlite	**1.16**	**1.22**	**1.43**
	Peatmoss	**1.70**	**1.08**	**1.08**
	Vermiculite	**1.08**	**1.70**	**1.54**
	perlite+ peatmoss	**1.54**	**1.08**	**1.22**
	vermiculite+ peatmoss	**1.40**	**1.24**	**1.16**
			Phosphorus	
Sand+ clay+	**--------**	**0.136**	**0.090**	**0.100**
	Perlite	**0.125**	**0.148**	**0.144**
	Peatmoss	**0.131**	**0.136**	**0.261**
	Vermiculite	**0.102**	**0.140**	**0.182**
	Perlite+ peatmoss	**0.148**	**0.125**	**0.148**
	Vermiculite+ peatmoss	**0.136**	**0.140**	**0.170**
			Potassium	
Sand+ clay+	**--------**	**0.93**	**0.83**	**0.78**
	Perlite	**0.80**	**0.75**	**0.50**
	Peatmoss	**1.08**	**1.48**	**1.18**
	Vermiculite	**1.40**	**0.93**	**1.65**
	Perlite+ peatmoss	**1.03**	**1.13**	**0.73**
	Vermiculite+ peatmoss	**1.13**	**1.50**	**0.98**

tuberose plant, found that plants grown in a mixture of loam+ sand+ vermiculite (1:1:1 v/v/v) showed more considerable increase in N content. On the other hand, El-Khateeb *et al.* (2006) on *Ficus alii*, found that clay+ sand+ perlite medium showed the highest content of nitrogen in the leaves and stems. It is clear that growing the plants in a mixture of, sand+ clay+ perlite+ peatmoss increased P content in the leaves to the highest values (0.148 % D.W). Whereas, the mixtures of sand+ clay+ perlite and sand+ clay+ vermiculite markedly increased the P content in the stems. On the other side, the highest phosphorus content the roots were recorded in plants grown in sand+ clay+ peatmoss (0.261 %D.W). In this regard, Paradiso and Pascale (2008)mentioned that gerbera plants contained a significant higher P in leaf tissues with the addition of the organic medium to perlite. Growing the plants in a mixtures of sand+ clay+ vermiculite, sand+ clay+ vermiculite+ peatmoss, increased K content in the leaves of the carob as compared with other media... The highest K content in the roots was recorded in plants grown in sand+ clay+ vermiculite. Similar results were reported by El-Khateeb *et al.* (2006) on *Ficus alii*,

2. Effect of Atonik and Mycorrhiza fungi (VAM) on carob seedlings (*Ceratonia siliqua* L.)

a. On vegetative growth.

1. Plant height: The responses of seedling height of the carob plant to the application of Atonik and mycorrhiza are shown in Table (5).The obtained data indicated that there were significant differences, in all treatments, between the seedlings height of the carob plant. Mycorrhiza treatment increased the plant height from 30.83 to 60.67 cm, also supplying the carob plant with Atonik at the 50 cm/ plant increased the plant height from 30.83 to 41 cm. It can be concluded that using mycorrhiza was the most effective on increasing the height of carob plant, these results are in harmony with those mentioned by Bhoopander *et al* .(2003) on *Hordeum vulgar* L. and Asghari *et al*. (2005) on *Atriplex nunmnularia*. they found that, seedlings height increased significantly with inoculation with different strains of mycorrhiza fungi.

2. Stem diameter: In Table 5 showed significant differences, between the stem thicknesses in the different treatments, Mycorrhiza treatment increased the stem diameter of plant from 0.48 to 0.67 cm also supplying the carob plant with Atonik at the 50 cm/ plant increased the stem diameter of plant from 0.48 to 0.52 cm, these results also in line with Rammdan *et al*. (2002) on Cowpea and Maize. Koreish *et al*. (2004) on wheat, and Rabie and Humiany (2004) on Cowpea, demonstrated that, inoculation with mycorrhiza fungi increased seedling stem diameter.

٣. Number of leaves: As shown in Table 5, the data indicated that all treatments of Atonik and Mycorrhiza significantly increased the formation of leaves, compared with the control. Mycorrhiza inoculation remarkably increased seedlings leaves number its (112.3) compared with the control (66.67), while supplying the carob plant with Atonik at the 50 cm /plant increased the number of leaves from 66.67 to 79.67 cm. It can be concluded that using Mycorrhiza was the most effective on increasing number of leaves of carob plant; these results are in harmony with those obtained by Bhoopander *et al*. (2003) on *Acacia auriculiformis*.

4. Root length: As shown in Table 5, the data indicated that all treatments of Atonik and mycorrhiza fungi (VAM) significantly increased the root length of carob plant compared with the control, root length of the control was 30.75 cm

Table 5. Effect of Atonik and Mycorrhiza fungi (VAM) on plant height (cm), stem diameter (cm), number of leaves and root length (cm) of carob plant.

Treatments	Plant height	Stem diameter	Number of leaves	Root length
Control	30.83	0.48	66.67	٣٠.٧٥
Atonik 50 cm/ plant	41.00	0.52	79.67	٤٣.٧٥
Mycorrhiza (25 g/ 1kg soil)	60.67	0.67	112.3	62.50
LSD 5 %	**1.97**	**0.02**	**5.29**	**٢.٤١**

while of mycorrhiza fungi treatment was 62.50 cm and Atonik treatment was 43.75 cm, it can be concluded that using (VAM) treatment at(25 g/ 1 kg soil) was the most effective on increasing root length of carob plant compared with Atonik treatment and control, these results are in accordance with those revealed by Mohammad *et al*. (2003) on Barely (*Hordeum vulgar* L.) and Asghari *et al*. (2005) on *Atriplex nunmnularia*.

5. Fresh and dry weights: Concerning the response of fresh and dry weights of leaves, stems and roots of carob plant, to the treatments of Atonik and mycorrhiza (Table: P 6), the data showed significant differences, between the fresh and dry weights of leaves, stems and roots of carob plant. Mycorrhiza treatment increased fresh and dry weights of leaves, stems and roots of carob plant. Also treating the carob plant with Atonik increased fresh and dry weight of leaves, stems of carob plant, whereas supplying the plants with Atonik treatment decreased the fresh weights of roots of carob plant which reached 10.85 gm comparing with control. It can be concluded that using mycorrhiza treatment was the most effective on increasing fresh weight of leaves of carob plant compared with Atonik treatment and control. These results are in agreement with those demonstrated by Bahoopander *et al*. (2003) on *Acacia auriculiformis*, and Asghari *et al*. (2005) on *Atriplex nunmnularia*,

Table 6. Effect of Atonik and Mycorrhiza fungi (VAM) on fresh and dry weights (g.) of leaves, stem and roots for carob seedlings (*Ceratonia siliqua* L.).

Treatments	Weight of					
	Leaves		Stems		Roots	
	Fresh	Dry	Fresh	Dry	Fresh	Dry
Control	12.17	4.49	6.94	2.63	١٤.٩٤	٥.٤٢
Atonik 50 cm/ plant	16.27	6.62	9.05	3.30	١٠.٨٥	٤.٦٦
Mycorrhiza (25 g/ 1 kg soil)	27.22	10.47	17.04	٦.٥٠	١٦.٠٦	٥.٩٩
LSD 5%	**1.28**	**0.44**	**0.67**	**0.54**	٠.١٥	٠.٤٤

b. Effect on chemical constituents

1. Pigments content: Data in Table 7 showed the effect of Atonik and Mycorrhiza fungi (VAM) on the contents of chlorophyll -a,-b and carotenoids in the leaves of carob plant. It is clear from data that the highest content of chlorophyll-a-b and carotene in the leaves. was recorded when the roots of plants inoculated with mycorrhiza comparing with control, Whereas, the lowest content of chlorophyll-a and carotene in the leaves of carob was recorded when plants were supplying with Atonik comparing with control (1.38 mg/ g F.W), it can be concluded that using Mycorrhiza (VAM) was the most effective on increased contents of chlorophyll -a,-b and carotenoids in the leaves of carob plant. These results are agreement with Giri and Mukerji (2004) on *Sesbania aegyptica* and *Sesbania grandiflora*.

2. Total carbohydrates (% DW):

Data in Table 7 showed the effect of Atonik and mycorrhiza fungi (VAM) on the contents of carbohydrates in the different parts of carob plant. It is clear from data, that soil inoculation with mycorrhiza at (25 g/ 1 kg soil) increased contents of total carbohydrate in different plants parts, comparing with the control. Also, treating the seedlings with Atonik (50 cm/ plant) increased contents of total carbohydrate in different plants parts, comparing with the control. it can be concluded that using mycorrhiza (VAM) at (25 g/ 1 kg soil) was the most effective on increased contents of total carbohydrate in different plants parts. In this regard, Abou – Husein *et al.* (2002a), (2002b), on potato reported that, the application of bio-fertilizers (*Bacillus megaterium*) increased the percentage of N, P, K, Mg, Ca and total carbohydrates in leaves.

Treatments	Chlorophyll content	Total carbohydrates

	Chl-a	Chl-b	Carotene	Leaves	Stems	Roots
Treatment		Leaves		Stems		Roots
Control	١.٣٨	٠.٢٧	٠.٦٥	٧.٤٢	١٢.٩٨	١٢.١٠
Atonik (50 cm/ plant)	1.32	0.33	0.61	8.30	14.82	12.93
Mycorrhiza (25 g/ 1kg soil)	1.46	0.36	٠.٧٣	٩.٢٧	15.25	13.46

Table 7. Effect Atonik and Mycorrhiza fungi (VAM) on the contents of chlorophyll-a, b, carotenoids mg/ g F.W in the leaves and total carbohydrates.% D.W in the different parts of carob seedlings (*Ceratonia siliqua* L.).

3. N ,P and K percent:

The response of N, P and K percent in the leaves, stems and roots of the carob plants to the different treatments of Atonik and mycorrhiza fungi (VAM) are presented in Table 8. The results show that, treating the plants with mycorrhiza fungi increased the percent of N, P and K in the different plants parts comparing with the control. Also, the application of Atonik increased the content of N, P and K in the different plants parts comparing with the control. It can be concluded that using mycorrhiza (VAM) was the most effective on increased contents of N, P and K in the leaves, stems and roots of the carob plant, these result are similar to those mentioned by Koreish *et al.* (2004) on faba bean and wheat plant treated with (VAM) demonstrated that, treatment increased N and P uptake compared with untreated plants, and Kumar and Sukumar (2001) indicated that, bio-fertilizer treatment (Bacillus sp.) significantly increased P contents of mulberry seedlings, Wu *et al.* (2005) on maize.

Conclusively,

Table 8. Effect of Atonik and Mycorrhiza fungi(VAM) on the contents of nitrogen, phosphorus and potassium (%D.W) in the different parts of carob seedlings (*Ceratonia siliqua L.)*.

	Nitrogen		
Control	1.30	1.35	1.22
Atonik (50 cm / plant)	1.43	1.67	1.35
Mycorrhiza (25 g/ 1 kg soil)	1.54	1.78	1.51
	Phosphorus		
Control	0.127	0.114	0.136
Atonik (50 cm/ plant)	0.148	0.119	0.148
Mycorrhiza (25 g/ 1 kg soil)	0.159	0.131	0.153
	Potassium		
Control	0.92	0.70	0.69
Atonik (50 cm/ plant)	0.93	0.90	0.80
Mycorrhiza (25 g/ 1kg soil)	1.15	1.03	1.10

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تأثير فطور الميكوريزا، الاتونيك ونوع التربة على النمو والتركيب الكيماوي لشتلات الخروب

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أجريت هذه الدراسة لمعرفة مدى استجابة شتلات الخروب لأوساط الزراعة ومنشطات النمو مثل الاتونيك وكذلك فطر الميكوريزا وقد اشتملت هذه الدراسة على جزأين: وعموما أظهرت النتائج أن استخدام مخلوط بيئات (الرمل والطين والبيرليت والبيتموس) أو (الرمل والطين والبيتموس) أدى إلى اكبر زيادة في طول النباتات وعدد الأوراق، بينما زراعة النباتات في مخلوط (الرمل والطين والفيرموكيوليت) نقص طول النباتات. معظم المخاليط المستخدمة اثرت بشكل ايجابي على زيادة سمك السيقان لشتلات الخروب مقارنة مع الشتلات النامية في مخلوط من(الرمل والطين). أدى استخدام مخلوط (الرمل والطين والفيرموكيوليت والبيتموس) و(الرمل والطين والبيرليت والبيتموس) أو (الرمل والطين والبيتموس) إلى زيادة في الأوزان الطازجة والجافة للأوراق والسوق.ان استخدام مخاليط بيئات (الرمل والطين والبيرليت) و(الرمل والطين والبيتموس) أو (الرمل والطين والبيرليت والبيتموس) أدت إلى زيادة كبيرة في طول الجذور بينما مخلوط (الرمل والطين والفيرموكيوليت والبيتموس)أدى إلى إنقاصها. واستخدام مخلوط (الرمل والطين والفيرموكيوليت) كان له التأثير الأكبر في زيادة محتوى الكلوروفيل والكاروتين. وأوضحت النتائج أن استخدام مخلوط (الرمل والطين والبيتموس) أدى إلى زيادة نسبة النتروجين في الأوراق بينما إضافة الفيرموكيوليت إلى مخلوط (الرمل والطين) كان أكثر فاعلية في زيادة نسبة النتروجين في السوق والجذور لشتلات الخروب.

بخصوص تأثير كل من الاتونيك وفطر الميكوريزا على النمو والتركيب الكيماوي لشتلات الخروب وجد أن استخدام فطر الميكوريزا كان أكثر فاعلية في زيادة النمو الخضري (طول النبات وقطر الساق وطول الجذور وعدد الأوراق والأوزان الطازجة والجافة لجميع أجزاء النبات) والتركيب الكيمائي (كلوروفيل وكربوهيدرات والعناصر الكبرى NPK في جميع أجزء النبات) مقارنة مع الشتلات المعاملة بالاتونيك ومع الشتلات الغير معاملة.