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Full Length Research Paper

Effect of some climatic factors on endomycorrhizal symbiotic association in a perennial species (case of *Juncus*) and an annual species (case of *Vicia faba* L.*)* developed in south west of Algeria

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Endomycorrhizal symbiotic association plays an important role in the plant life. Except some families such as Cruciferae, Cyperaceae, Juncaceae and Chenopodiaceae, this association is present in all taxons of plant kingdom. During a prospecting on mycorrhizal symbiotic association, carried out with some species which developed in an arid area in south of Algeria (case of Mecheria - Wilaya of Naâma), *Juncus maritimus* revealed the presence of the endomyorrhizae with vesicles and intercellular hypae. This perennial species was considered as a very rare plant not forming endomycorrhizae. To confirm this result, we carried out a second prospecting with three species of *Juncus* which were developed in the west of Algeria *J. maritimus* (Mecheria Wilaya of Naâma); *Juncus effesus* (Hammam Bouhdjar wilaya of Ain Temouchent); *Juncus* sp (Mactaâ, wilaya of Oran). On the other hand, the study of endomycorrhizae of an annual plant (*Vicia faba* L.) which developed in Mecheria wilaya of Naama was effectuated. The preliminary result revealed the presence of the endomycorrhizae with the J*uncus* which developed in Mecheria (arid zone) and Mactaâ and their absence in Hammam Bouhjar. The presence of endomycorrhizae in *Vicia* faba L. was revealed only during the winter season. The study of the climatic factors had been discussed.

Key words: Endomycorrhizae, vesicle, *Juncus* maritimus, *Vicia faba* L., climate, arid zone.

INTRODUCTION

To survive under difficult and marginal climatic conditions, the plants modify their morphology and physiology to adapt to the environment where they live (Williams and Aldon, 1976). Among the adaptation of biological factors, we notice the mycorrhizae symbiotic association. In deed, the mycorrhization provides a high protection to the plants against the environment stress (Sylvia and Williams, 1992) in particular dryness (Subramanian et al., 1995); the cold (Charest et al., 1993; Paradis et al., 1995) the high salinity (Davis and Young, 1985) and pollution (Leyval et al., 1994; Shetty et al., 1995).

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Globally, the mycorrhized plants had seen improved their growth and health and acquire against the unfavourable environmental conditions for their survival (Dalpé, 1996).

According to Malloch et al. (1980), the vesicular arbuscular endomycorrhizal association represents 95% of phanerogams. In a literature review of mycotrophic species, Trappe (1987) mentioned that from 49,900 Monocotyledoneae described, only 1,487 (3%) had been analyzed; of this total, 21% did not reveal the association and 49% formed mycorrhiza of the arbuscular type. Among the Liliopsida, the order Typhales was the most examined (35%); in the other of the subclass Commelinidae, the percentage of examined species varied from 1% in Juncales to 6% in Cyperales.

The endomycorrhizae are much more widespread and are met in trees, shrubs and herbaceous plants (Donmergues and Mangenot, 1970). However, according

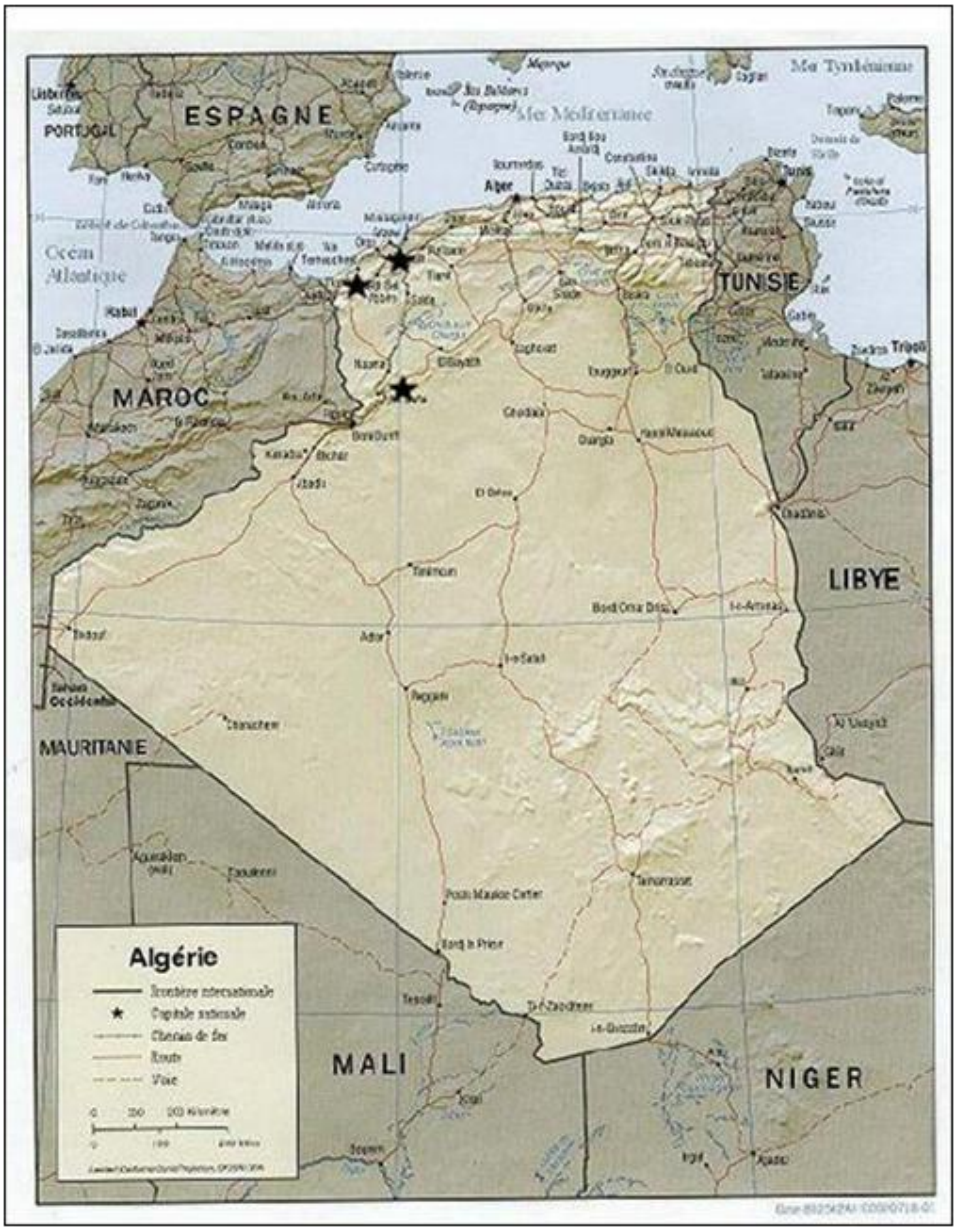

Figure 1: Geographical position of the endomycorrhizae prospecting stations

to these two authors, some taxons appear never to form the mycorrhizae symbiotic association as: Equisetaceae, Polygonaceae, Cruciferae, Centropenales (except Cactaceae), Cyperaceae and Juncaceae. During a prospecting on the mycorrhizal association in the south western of Algeria case of Mecheria (from 400 km to south of Oran, an arid zone); the microscopic observation in the cortex of perennial plants as *J. maritimus* (Juncaceae) and *Scipus holoshenus* (Cyperaceae) revealed the presence of the hyphae and ovals and spherics vesicles specific to the Endomycorrhizae symbiotic association (E.V) this root's colonization is especially high during the dry season (spring and summer) (Chafi and Fortas, 2000).

To confirm these results, a second prospecting was carried out and we choose three stations in the west of Algeria where some species of *Juncus* are developed. Theses three stations are: Mactaa (in Wilaya d'Oran), Hammam Bouhdjar (in Wilaya d'Ain Temouchent), Mecheria (in Wilaya de Naâma) (Figure 1).

On the other hand, the study of endomycorrhizae in an annual plant, case of *Vicia faba* L. which developed in Mecheria was carried out.

So, a comparative climatic study of the stations was effectuated, the description of the endomycorrhizae was carried out and the colonization was estimated. In our study we are going to describe some climatic parameters of three zones where *Juncus* developed.

Table 1. Geographical position of the three stations of development of *Juncus* sp.

Station	Longitude	Latitude	Altitude (meter)
Oran	0'39 W	35°41	11
Hammam Bouhdjar	0'38 W	35°23	150
Mecheria	0'16 N	33°33	1167

MATERIALS AND METHODS

The town Oran was chosen for the station of Mactaa, while Ain Temouchent for the station of Hammam Bouhadiar (Figure 1) because there are no meteorological offices in our stations.

Bioclimatic study of the stations

The meteorological statements concerning the maximum, the minimum and average air temperatures, precipitations; and evaporation were provided by the National Office of Meteorology (ONM) of Oran. The study of these climatic parameters was carried out during for the year of the mycorrhizae prospecting.

Q_2: the Emberger pluviometric quotient was calculated to determine the kind of climatic reigning in three stations.
It is calculated by the following formula:

Q_2: 1000 P/ (M+m) (M – m)

Where P= the sum of annual precipitation in (mm); (M-m) = the thermal amplitude; (M+m) = the average temperatures (The temperatures are used in Kelvin).

More (Q_2) is weak, more the dryness is high and conversely the values of Q_2 are high for fresh and wet climate.

The determination of the species of *Juncus*

The three species belonging to the genus of *Juncus* which are collected in three regions cited were determined in botanic laboratory of Institute National of Agronomy (INA) (El-Harrach – Algiers) and in botanic laboratory of Es-Senia Oran. Moreover, Quezel and Santa (1962) and Ozenda (1973) were also the reference of this determination.

The study of endomycorrhizae of *Juncus*

The technic used to study and to describe the endomycorrhizae of *Juncus* and *Vicia faba* L. was that of Kormanick et al. (1980).

The roots of *Juncus* species and *Vicia faba* L. were stained by acid fuschine 0.1% in lactoglycerol. The microscopic observation was effectuated and the estimate of colonization percentage in *Juncus* species during May and June of the same prospecting year was carried out, according to Berteau et al. (1980).

RESULTS

The study of some climatic parameters of prospecting stations

Table 1 shows the geographical position of the regions which developed the three species of *Juncus.* The results of some climatic parameters of the *Juncu sp* development in the three stations are illustrated in the Table 2

The results obtained in Table 2 shows the visualization of the climate of three regions where *Juncus* develop. It contains the monthly variations of the air temperatures during the year of the prospecting. January is the coldest month for the two stations Oran (Maacta) and Mecheria with a minimal temperature of 2.2 and 0.5°C respectively. On the other hand the minimum of temperature calculated in Ain Témouchent (Hammam Bouhjar) is at February with 4.2°C. In addition, the maximum of the air temperature is situated in summer with 34.22°C at Ain Temouchent 31.4°C at Oran and 36.36°C at Mecheria. The maximum temperatures accentuate the water deficit of the environment by increasing evaporation lasting the dry season. Let us recall that our prospecting was started in May and June of the same year. Precipitations are more or less important during the period of the winter 91 mm (Ain Temouchent); 66 mm (Oran) and 39 mm (Mecheria) and drop in summer 4.3 mm at (Ain Temouchent), 0.4 at (Oran) and 2.9 at (Mecheria). On the other hand, the reverse occurs for evaporations, they are important in summer 94.8 mm (Ain Temouchent); 174 mm (Oran) and 318 mm (Mecheria). We notice that evaporation with Mecheria is almost triple compared to (Ain Temouchent). The Emberger quotient Q_2 in Mecheria reaches 21.12; in Oran Q_2= 28.70 and in Ain Temouchent Q_2= 58.23. According to Emberger (1962) the climate stage in Mecheria and Oran is arid, and in Ain Temouchent is semi arid.

The determination of the species of *Juncus*

We could determine two species:

1. J. maritimus in Mecheria – Wilaya of Nâama (Figure 3a).
2. Juncus effesus in Hammam Bouhdjar – Wilaya of Ain Temouchent.
3. Juncus sp in Mactaâ – Wilaya of Oran (Figure 4).

Table 3 and the Figure 2 show the relationship between the seasons (May spring) and (June summer) and the percentage of endomycorrhizae colonization.

The season and the bioclimatic position have more influence on this symbiotic association than the genetically factor (species). Indeed, the average of the colonization percentage was low in May at the three

Table 2. Climatic parameters of three stations of *Juncu sp* development.

T°C Minima												
Stations/ Month	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**August**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Oran	2.2	5.2	7.8	10	13.3	16.5	19.3	20.9	15	13.4	11.4	6.6
Ain Temouchent	5.6	4.2	9.04	8.6	11.55	16.29	19.29	20.86	16.27	12.85	10.7	7.13
Mecheria	0.5	1.67	5.31	6.80	11.76	15	21.54	20.99	14.64	10.52	6.63	2.55
T°C Maxima												
Stations / Month												
Oran	16.7	16.8	19.7	21.7	23.8	26.8	29	31.4	27.4	23.1	18.4	17
Ain Temouchent	19.16	16.29	20.2	21.58	24.04	27.88	32.97	34.22	27.07	22.68	17.81	16.73
Mecheria	11.93	11.18	15.61	9.13	24.35	30	36.36	34.61	27.61	22.5	13.9	12.57
T°C Average												
Stations / Month												
Oran	3.5	11	13.80	15.9	18.6	21.7	24.2	26.2	21.2	18.3	14.6	11.8
Ain Temouchent	12.4	10.25	14.64	15.14	17.79	22.11	26	27.55	21.69	17.65	14.29	11.78
Mecheria	5.85	6.43	10.64	12.97	18.01	23	28.95	27.8	11.93	16.5	10.27	7.56
Precipitation (mm)												
Stations / Month												
Oran	0.8	66	40	36.9	18	04	01	02	10	49	7.4	08
Ain Temouchent	0.6	91.1	49.9	53.3	25.2	4.3	2.4	3.3	13.4	71.6	105.1	91
Mecheria	0.3	39	42	16	30	2.9	07	01	09	08	47	16
Evaporation (mm)												
Stations / Month												
Oran (Mactaa)	72	70	119	142	151	174	151	174	167	112	60.0	57.7
Ain Temouchent	80	66.7	85.8	36.9	100	94.8	116.7	134.6	107.7	66.3	40.3	34.5
Mecheria	99	95	144	199	318	400	494	471	292	274	93	144

species *of Juncus*. It was 2.22% in the case of *Juncus effesus*; 0% in the case of *Juncus sp* and 3.33% in the case of *J. maritimus* and suddenly it increased in June only in *Juncus* sp (44.33%) and in *J. maritimus* (32.22 %) which they developed in an arid area.

Concerning the presence endomycorrhizae in *Juncus* species, the vesicles which infect the root cortex of *Juncus* have spherical form and which invade the root cortex with dense hyphae ,especially in May and June (Figures 3 and 5). The vesicles of *Vicia faba* L are ovoids and colonized the root cortex during the winter (Figure 6).

DISCUSSION

Kadik (1987), mentioned that the climate in Mecheria was high fresh arid; In Oran was high hot semi arid and in Bouhjar (Ain Temouchent) fresh semi arid.

According to Sauvage (1961) the period of the

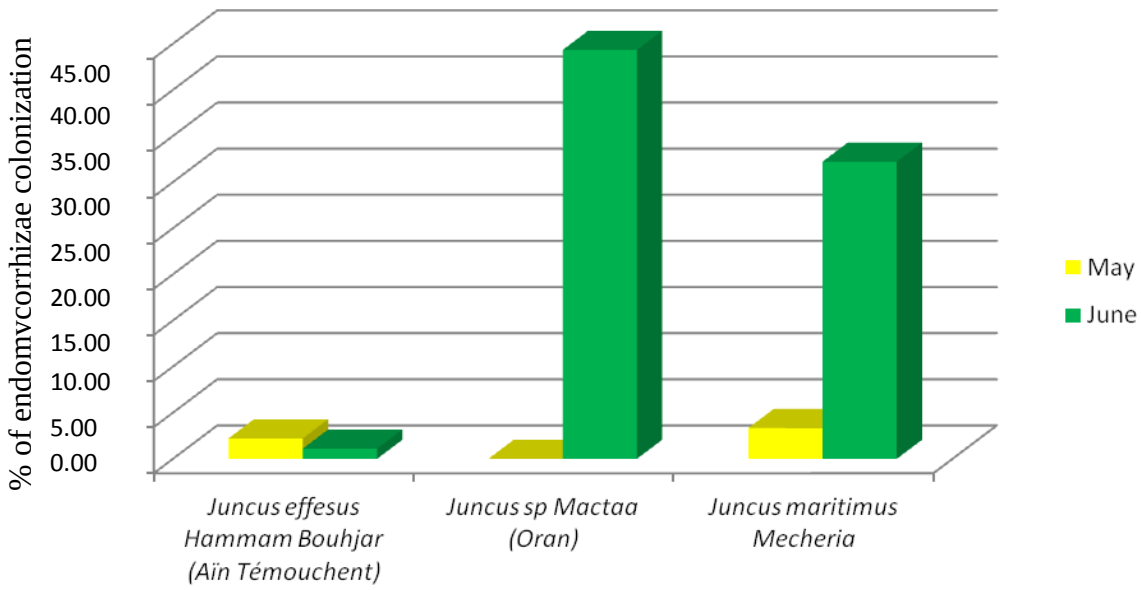

Figure 2. The effect of season on endomycorrhizal colonization percentage in *Juncus* species.

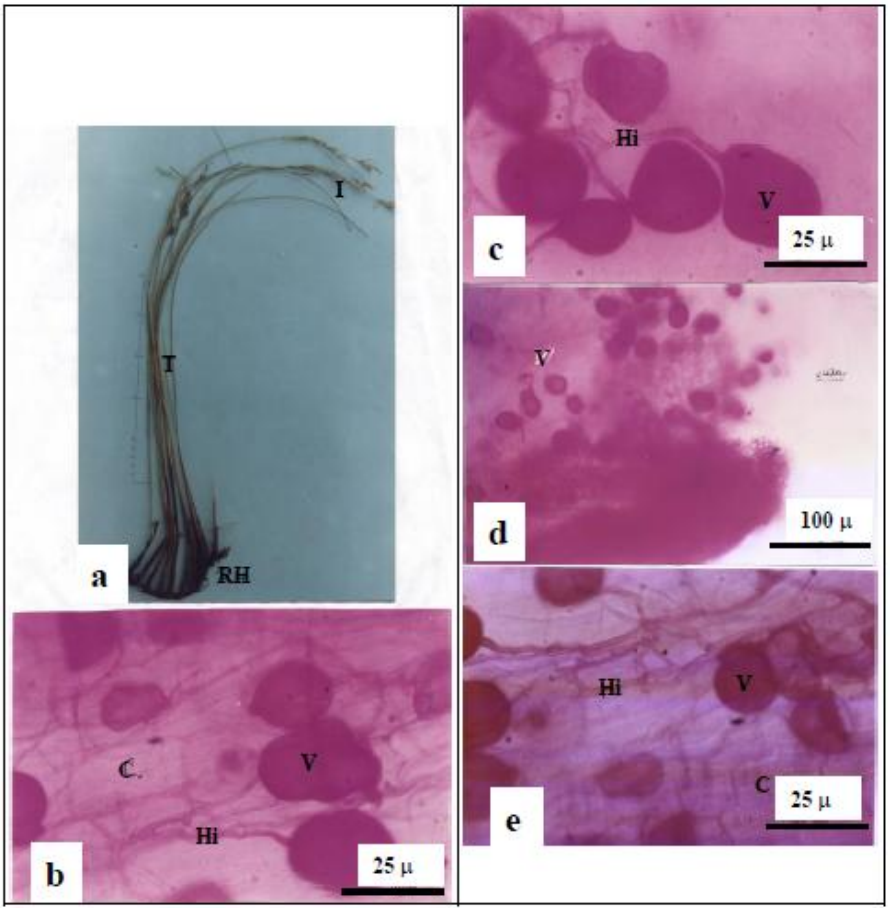

Figure 3. The endomycorrhizae of *Juncus maritimus* developed in Mecheria (arid zone) a: aspect of *Juncus maritimus*; b,c,d,e: endomycorrhizzae in cortex of *Juncus maritimus* V=vesicle; Hi=interhyphae; C= Cortex; RH = Rhizome; T=stem; I=Inflorescence.

Figure 4. *Juncus* sp which develop in station of Mactaa – Wilaya d' Oran RH=Rhizome ; T=Stem.

Table 3. Relationship between bioclimatic stage, season and the endomycorrhizae colonization percentage in three species of *Juncus.*

Station	Q_2	Bioclimatic stage	Species	May (%)	June (%)
Aïn				6.66	3.33
Témouchent	58.23	Semi arid	*Juncus effesus*	0	0
(HammamBouhjar)				0	0
			Average	2.22	1.11
				0	53.33
Oran	28.70	arid	*Juncus sp*	0	40
(Mactaa)				0	40
			Average	0	44.33
				3.33	16.66
Mecheria	21.12	arid	*Juncus maritimus*	6.66	73.33
				0	6.66
			Average	3.33	32.22

winter vegetative rest is characterized by the month when (m) is lower than +3°C.Basing on this admission, the vegetation in Oran and in Mecheria undergoes a winter vegetative rest, which it is absent in Ain Temouchent. The presence of endomycorrhizae in the *Juncus* root cortex confirms that obtained during the first prospecting in Mecheria (Wilaya of Naâma) (Chafi, 1992).

The mycorrhizal fungi are of common occurrence among phanerograms and constitute the rule and not the exception in nature (Siqueira ,1994).Some plant families are considered nonmycorrhizal according to recent data; only 53 from 336 Angiosperm families are nonmycorrhizal fungi (Brundrelt, 2009).In total 86% of all flowering plants are considered mycorrhizal (Druva-lusite and Gederts, 2010).

The families of Juncaceae and Cyperaceae were regarded for a long time as families which did not form any mycorrhizal association (Rouguerol, 1962; Gerderman, 1986) this absence of infection was also cited by Selivanov and Yeleusenona (1974); Dommergues and Mangenot (1980); Trappe (1981) and Mousain (1988). Mason (1928) found *J. maritimus* as non-mycorrhizal.

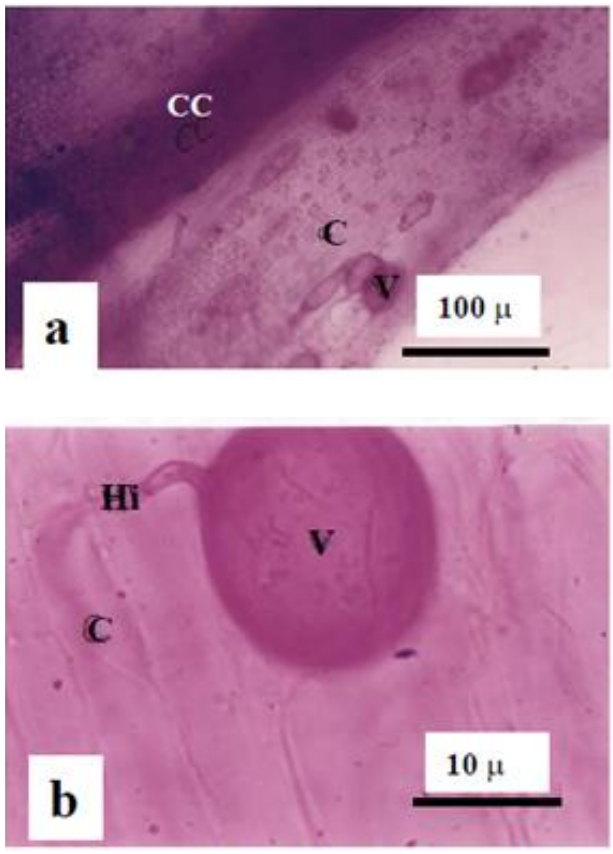

Figure 5. Presence of vesicles and interne hyphae in the root cortex of *Juncus* sp.
V= vesicle; Hi = interhyphae; C= Cortex; CC= Central Cylindre.

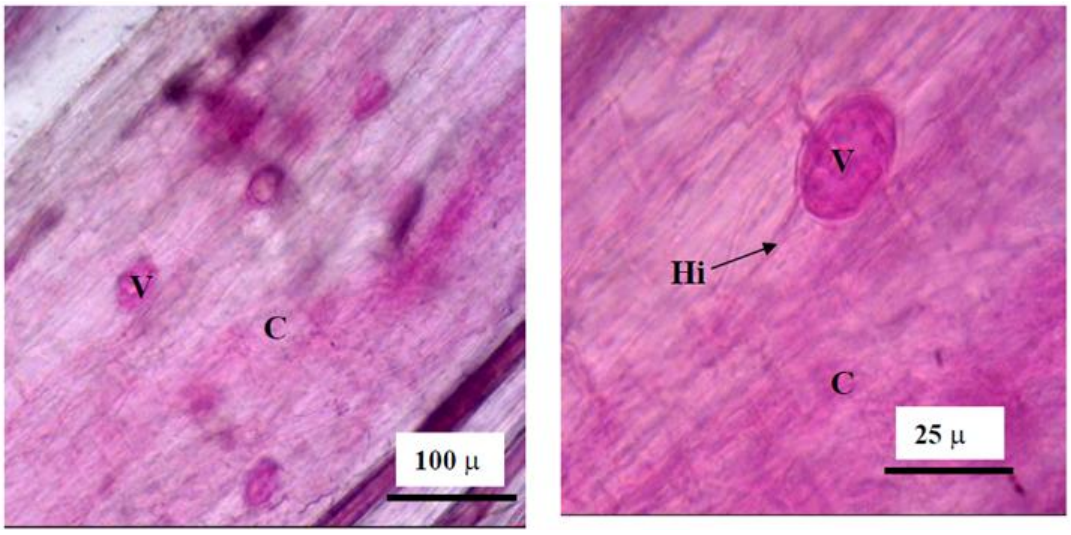

Figure 6. Endomycorrhizae in Vicia faba L. root cortex. V = Vesicle ; Hi = Interhyphae ; C = Cortex.

Harley and Smith (1983) and Silveria (1992) considered that this family as nonmycorrhizal. Bledsoe et al. (1990) examining plants in a Canadian arctic area observed that none of the species of Juncaceae formed mycorrhizae.

Trappe (1987) mentioned that 42 species (1%) on the order Juncales were observed regarding the mycotrophic state, and some of these were colonized by AMF.

Indeed, *Juncus microcephalus*, examined by Gladstone et al. (2001) was colonized by AM and Oliveira et al. (2001) mentioned the presence of these symbiotic fungi in *Juncus effuses.*

Working with Angiosperms of Hawaii, Koske et al. (1992) observed colonization of (*Juncus planifolius* R. Br.) by AMF.

During a literature review about the mycorrhizal condition of the British flora, Harley and Harley (1987) found AMF in 63% of the species of Juncaceae. Tester et al. (1987) mentioned some species of this family forming mycorrhizae (*Juncus articulatu*s L., *J. novaezelandiae* Hook. F., *J. planifolius* R. Br., *J. squarrosus* L., Based on these data it is suggested that Juncaceae should be placed among the families with mycorrhizal and nonmycorrhizal species.

Rare works are showed the presence of mycorrhizae in few member of the family of Cyperaceae it is the case of *Cyperus rotundus* (Shvartsman, 1955).

The absence of mycorrhizal symbiotic association in these two families (Cyperaceae and Juncaceae) was explained by the effects of the environmental conditions where they live (Filer and Broadfoot, 1962; Anderson et al., 1984).

The Monocotyledoneae (Liliopsida) have fasciculated roots what may favour mycorrhizal formation. The presence or not of an arbuscular mycorrhizal association, or even the percentage of colonization, seems to be determined genetically (Janos, 1985; Alexander, 1989), and it is also influenced by physical and chemical environment factors. Thus, a high diversity of factors such as soil, environment and management, age, species and variety of plants determine the formation of this symbiosis and the occurrence of the AMF.

In our work, during the season of autumn and winter, the infection is very low or null in Juncus *maritimus,* suddenly it becomes important in spring and summer (may and june). Otto (1962) and Bolan and Abott (1983) showed that the increase in mycorrhizal colonization percentage was marked during the hot season.

The presence of endomycorrhizae in *Vicia faba* L. during January and February in arid zone, may enhance the development and the flowering of this species (Henrike et al., 2007; Chafi and Bensoltane (2009).

This symbiotic association had been mentioned in the cortex of Vicia faba L in arid zone by Chafi and Bensoltane (2009).

Conclusion

The results obtained in our study, show the presence of the Endomycorrhizal symbiotic association in two species belonging to a genus considered for a long time which never form mycorrhizae, but an invalidation was been indicated by observation and result carried out and repeated at the genus of *Juncus* (Juncaceae) which is developed in arid zone.

The colonization percentage increased during the dry season (May and June). The results confirm and reinforce the beneficial role of the Mycorrhizal symbiosis in the survival of the plants which develop in marginal areas. This work can be complement in the future by a study of the edaphic factors and environment which develop *Juncus* as well as artificial inoculation at the laboratory of this species by endomycorrhizal spores.

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