Ministério da Agricultura do Desenvolvimento Rural e Pescas

DRAALG
Direcção Regional de Agricultura do Algarve

INTRODUCTION OF PROMISSING ORNAMENTAL SPECIES TO THE EUROPEAN MARKET, ADAPTED TO LOW WATER AVAIBILITY AND SALINE CONDITIONS

PROJECTO AIR3-PL94-2472

FINAL REPORT

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SUMMARY

The purpose of this project is introduction of promissing ornamental species to the european market, adapted to low water avaibility ans saline conditions.

The project was developed in differents entities of various european countries: Mediterranean Agronomic Institute of Chania - MAICH (Greece), Agricultural Research Center of Northern Greece – ARCNG (Greece), Aristotle University of Thessaloniki – AUT (Greece), Direcção Regional de Agricultura do Algarve – DRAALG (Portugal), Istituto di Agronomia Generale e Coltivazioni Erbace – IAGC (Italy), Escola Superior d'Agricultura de Barcelona – ESAB (Spain), Instituto Valenciano de Investigaciones Agrarias – IVIA (Spain), Centro de Edafologia y Biologia Aplicada del Secura – CEBAS (Spain), Instituto de Recerca y Tecnologia Agroalimentáries – IRTA (Spain), Centro de Investigación y Tecnologia Agrarias – CITA (Spain) e Instituto Canario de Investigaciones Agrarias – ICIA (Spain).

We investigation the most efficient of ways of propagation for a future commercial prodution, tried a seed propagation (task 1.1.) and a cutting propagation (task 1.2.). The vegetal material obtained was utilized to study the growing techniques for nursery conditions and morphological, phenological and horticultural responses under various growing conditions: greenhouse, shade frame and open air (task 2.1.). To look for production compact, uniform and blooming plants by means of pruning and aplication of growth regulators: Cultar, B-nine and CCC, to improve plant's natural look (task 2.2.).

During the project development had vegetal material changing between the differentes parteners, so as to every entity had a collection with all species in study. Each of us studied a cluster of native plants from yours flora. The DRAALG worked with a species: *Lithodora prostrata, Cistus monspeliensis, Halimium halimifolium, Lavandula luisieri* and *Thymus mastichina.* Only, the task 2.1. embraced all species: *Argyranthemum maderense, Argyranthemum coronopifolium, Centranthus ruber, Cistus creticus, Cistus monspeliensis, Ebenus cretica, Euphorbia characias, Genista thyrrena, Halimium halimifolium, Helychrisum graecum, Lavandula luisieri, Lavandula stoechas, Limonium sinense, Lithodora prostrata, Lotus creticus cyisoides, Lotus creticus creticus, Spartium junceum, Thymus mastichin* and*, Vitex agnus castus.*

INTRODUCTION

In many developed countries ornamental horticulture is an important economic enterprise but some ornamental plants lost their popularity. In order to diversify the market of ornamental plants is necessary to introduce new crops, but carefully. The introduction of species into new areas with climates and ecological conditions similar to those of its origin increases the risks of these species going wild, and subsquently replacing local native flora. In some cases, there is also the risk of introduced species hybridising with closely related native species (Caballero, *et al.*, 19..). Their introducion needs more detailed information about their behaviour and genetic traits in their own habitat.

New wild Mediterranean species interesting for their foliage, flower or for their adapting capabilities to adverse climatic and soil conditions have attracted the consumers. They have become an interesting source for breeding projects as well as ornamentals and for the natural restoration of the degraded landscape areas. These species are usually more tolerant of pest and diseases and also adapted to dry Summer conditions and in certain cases, to soil salinity. For that, could be suitable for garden and landscape use in the urban and touristicaly developed places. The demand for native ornamental plants increased however less than 4% produced in EU are originated from the native Southern Europe flora.

The scarcity of native Mediterranean species in the market is due to the unknowledge of the advantages of their utilization and the correct prodution technology. To cover this fault DRAALG developing in extent of this project studies about wild flora, being a source of vegetal material and knowledge to the nursery industry.

Notwithstanding its relatively small area, the Algarve offers quite a wide variety in what concerns its wild flora, due to their geological formation diversity. Bordered on its Northern side by schistous lands, it has its greatest agrological wealth in a calcareous platform, the Barrocal, bordered, at the Southern littoral, by the sandy zone of the Barlavento and the Sotavento. Such soil diversity allows for a floral richness which attracts not only the botanical researchers but the numerous sightseers of this province as well (Afonso, 1991).

BOTANICAL AND GEOGRAPHIC ASPECTS OF SPECIES

The project general programme research regarded to the species *Lithodora prostrata, Cistus monspeliensis, Halimium halimifolium, Lavandula luisieri* and *Thymus mastichina*. We present their botanical and geographic aspects, integrating each specie in their family (Tab.1).

FAMILY	SPÉCIE
Boraginaceae	*Lithodora prostrata* (Loisel.) Griseb.
Cistaceae	*Cistus monspeliensis* L.
	Halimium halimifolium L.
Labiatae	*Lavandula luisieri* Rivas-Martinez
	Thymus mastichina L.

Tab.1 – Species in study and their botanical family (Franco, 1984).

BOTANICAL ASPECTS OF BORAGINAE

Boraginae family have 100 genera and 2000 species, the maiority of those are herbs, subshrubs and shrubs. Leaves alternate, exstipulate and simple. Flowers usually in cymes, actinomorphics. Corolla tubular, caducous with five round lobules and alternate petals. Five stames, inserted above corolla tuft. Ovary 2 – locular or 4 – locular; style frequently simple, inserted between ovary locules, rarely terminal (Caixinhas *et al,* 1994, Franco, 1984).

Distributed by tropical and temperate regiones, chiefly in the Mediterranean region (Caixinhas *et al*, 1984).

***Lithodora prostrata* Loisel (Griseb.)** (Portuguese Gromwell)

<u>Taxonomy</u>

- Division: Spermatophyta
- Class: Angiospermae
- Subclass: Dicotyledones
- Order: Tubiflorae
- Family: Boraginaceae
- Genus: *Lithodora*

- Specie: *L. prostrata*

<u>Botanical Aspects</u>

A rather small bush, prostrated creeper, with dropped rough branches falling 8 cm; alternate and narrow leaves 1,5 - 2 cm long and 2 - 4 cm width, borders curled down. Small gencian blue tubular flowers, topped by five round lobules, grouped in cymes, heavy lanigerous blue or rosy hairy ring corollas. The fruit divides into four ovoide, obtuse nutlets (Afonso, 1991; Franco, 1984).

It blooms during Winter and in the beginning of Spring (Afonso, 1991).

<u>Geographical Distribution</u>

This gromwell is a calcifuge plant very commonly found in dry scrub, pinewoods and Littoral sands, all along the algarvian coast (Afonso, 1991).

BOTANICAL ASPECTS OF CISTACEAE

The Cistaceae is a relatively small angiosperm group with about 160 species and a mainly circum-Mediterranean distribution.This family are mostly showy-floured shrubs from warm habitats, well adapted to Summer drough.

Herbs, subshrubs and shrubs, often with an indumentum of stellate hairs; leaves evergreen, usually opposite, simple, stipulate or exstipulate. Flowers solitary or in cymes or cymose racemes, actinomorphic, hermaphrodite; sepals 3-5, imbricate, contorted or convolute, frequently unequal, the outer shorter than the inner; petals 5 or 3 (sometimes wanting in cleistogamous flowers), free, imprecate or contorted, often caducous; stamens numerous, free, hypogynous, inserted on a disk-like projection of the receptacle; anthers 2-celled, laterally or introrsely dehiscent; ovary 1-locular, or incompletely 3-10 locular by the intrusion of placentae; placentation parietal; ovules few to many, othotropous or rarely anatropous; funicle often strongly developed 1 style simple, with 1-5 stigmas. Petals often exhibit dark coloured spots at their bases, althought the size and shape of these spots are highly variable, even among individuals within the same population. Fruit a lathery or woody loculicial capsule; seeds usually small, angular, endosperm present; embryo variously curved or conduplicate (Meikle, 1985).

***Cistus monspeliensis* L.** (Montpellier Cistus)

Taxonomy:

- Division: Spermatophyta
- Class: Angiosperm
- Subclass: Dicotyledones
- Order: Violales
- Family: Cistaceae
- Genus: *Cistus*
- Species: *C. monspeliensis*

Botanical Aspects

A rather small shrub forming dense and sticky bushes, with elongated and narrow stalkless leaves, dark green above and densely stellate-tomentose beneath; the small (seldom more than 2.5 cm of diameter) white flowers are disposed in one-sided rather dense cymes (Afonso, 1991). In Spring, its numerous flowers give a very attractive look to the scrub (Afonso, 1991). Fruit is a woody, loculicidal capsule with numerous, small and gled seeds. The embryo is circinnate and the cotyledons are linear. This specie exude anaaromatic, viscid resin.

Geographical Distribution

This very gregarious species prefers dry and warm places, on chalky soils, less commonly on shaly ones (Afonso, 1991).

***Halimium halimifolium L*.** (Sea-purslane-leaved-sunrose)

Taxonomy

- Division: Spermatophyta
- Class: Angiospermae
- Subclass: Dicotyledones
- Order: Viotales
- Family: Cistaceae
- Genus: *Halimium*
- Specie: *H. Halimifolium*

Botanical Aspects

A rather small greyish-green shrub with numerous ascending branches; the branchlets being covered with scale-like hairs; the more or less elliptical (10-40 x 5-20 mm) leaves are white-tomentose when young, the upper surface becoming greyish-green with stellate hairs, when mature; the yellow flowers are arranged in numerous lax cymes, and their cumeate petals usually have a black basal spot (Afonso, 1991).

In Spring, the bushes look beautiful, due to their golden-yellow numerous flowers outsanding the greyish colour of the leaves (Afonso, 1991).

Geographical Distribution

It is very common on Littoral sands or in sandy places not far from the sea, both in Barlavento and in Sotavento in the Algarve (Afonso, 1991).

BOTANICAL ASPECTS OF LABIATAE

Labiatae is the mint family with 180 genera, 3500 species and 8 subfamilies. A very distinctive family of herbs and shrubs with quadrangular stems and simple leaves in opposite pairs without stipules, often aromatic and glandular. Flowers arrange in whorls in the axial of opposite, often leaf like bracts, and the whoris may be punch together to form an elongated terminal spike. Flowers with calyx 5-toothed, often 2-lipped; corolla tubular often 2-lip, with the upper lip often large and the lower divided into 3 lobes; stamens 4, attache to the corolla, rarely 2 fruits of four nutlets (Olea and Huxley, 1987).

An economically important family from which volatile oils such as peppermint, lavender oil, mints, patchoul1, etc, and many culinary herbs such as sage, thyme, rosemary, balm and marjoram are obtain (Olea and Huxley, 1987).

Lavandula luisieri **Rivas-Maetinez** (Iberian short-stalked Lavender)

Taxonomy

- Division: Spermatophyte
- Class: Angiosperm
- Subclass: Dicotyledones
- Order: Tubiflorae
- Family: Labiatae
- Genus: *Lavandula*

- Specie: *L. luisieri*

Botanical Aspects

This Lavender is a low bushy aromatic undershrub with numerous erect flowering branches; the grey-green tomentose leaves are dimorphic; those of the sterile branchlets being small and with strongly revolute margins, those of the fertile ones usually larger, more or less flat and lanceolate; the small lilac flowers and the brood membranous bracts are arranged in dense short-stalked spikes surmounted by a group of conspicuous enlarged bracts which are usually purplish and sometimes white (Afonso, 1991).

During flowering time, the purplish colour of the spikes, well contrasting with the greyish shade of the leaves, gives a very attractive look to these bushes. This specie is very rich of essential oils, thus from aerial parts during flowering (Afonso, 1991).

Geographical Distribution

This under shrub is very common in low scrub, on shaly or chalky soil. In the Algarve, it is frequently seen on mountain slopes and in the Barrocal (Afonso, 1991).

Thymus mastichina L.

Taxonomy

- Division: Spermatophyte
- Class: Angiosperm
- Subclass: Dicotyledones
- Order: Tubiflorae
- Family: Labiatae
- Genus: *Thymus*
- Specie: *T. mastichina*

Botanical Aspects

The Iberian thyme is an aromatic dwarf undershrub with numerous brownish, slender, erect branches; the few small thick leaves are oval to elliptical-lanceolate, and are arranged in remote axillary clusters; the small whitish flowers exhibit calyces with long plumose hairs; the inflorescences are terminal subglobose flower-heads (Afonso, 1991).

The plumose calyces shine beautifully at full sun, giving the bushes a striking appearance, whence the Portuguese common name (Afonso, 1991).

Geographical Distribution

This thyme is very common in dry, shaly or somewhat chalky slopes of the algarvian mountains, where it forms large populations (Afonso, 1991).

MATERIAL AND METHODS

TASK 1 – INVESTIGATION OF WAYS OF EFFICIENT PROPAGATION

1.1. - Seed propagation

The seeds were colected from wild plants cleaned and sellected. After that, were kept in dry place at environment temperature.

On June of 1995, we made a preliminary trial, using two methods to break down physical dormency (cold at 4ºC, 48 h and heat at 70ºC, 1 h).
The experimental design was randomized in blocks, 3 repetitions X 20 seeds.

In the following year (1996) we made eight kinds of treatment to break down physical dormency:
(1) Test;
(2) Cold at 4ºC, 15 days;
(3) Heat at 70-75ºC, 30 min;
(4) Temperature alternation (heat -60ºC-, 30 min and cold -4ºC-, 1 week);
(5) Hot water at 70-75ºC, 24h;
(6) Mechanical scarification;
(7) Chemical scarification -H_2SO_4-, 15 min;
(8) Chemical scarification - KNO_3- (0.2%), 1h.

After that, the seeds were desinfected in a Benlate (a.s.- Benomil) solution at 0.5 g/l for 10 min and washed by sterile distilled water.

The seeds were germinate in petri plates with filter paper satured by destilled water, in a germination chamber at 15ºC and 60% of R.H., with and without light. During germination time, the filter paper was kept moist by routine spraying with sterile distilled water.

The experimental design was randomized in blocks, 50 seeds X 8 pre-treatments X 3 environments (dark and light) X 3 repetitions, for each specie.

We were considering seeds germinated, when presented cotyledons burst throught the seed coat.

1.2. - Cutting propagation

The vegetal material to make the cuttings was collected from algarvian jungle plants growing *in situ* respectively in:

Lavandulaa luisieri – native of Fonte Férrea – S. Brás (A);

Lithodora prostrata – native of Fonte Férrea – S. Brás (A);

Cistus monspeliensis – native of Medronhal – Sta Bárbara de Nexe (B);

Halimium halimifolium – native of Gambelas – Faro (C);

Thymus mastichina – native of Fonte Férrea – S. Brás (A).

On April of 1995 we went to the field in the morning to pick up the turgid cuttings of one specie each day. We transported them in a thermic bag, in order to avoid desidration until made cuttings in the afternoon.

We made three types of cuttings:

- Softwood cuttings – origin from green stems, with 5 cm of length and 2-3 nodes;
- Semi-hardwood cuttings – origin from partly wood stems, with 5-10 cm of length and 3 nodes;
- Hardwood cuttings – origin from wood stems of last year, with 10-15 cm of length and 3 nodes.

The cuttings must be cutted under a node and basal leaves eliminated to avoid putrefaction with substrate contact. They were disinfected with Pomarsol (a.s. – Tirame) solution, 2 g/l, during 5 min. After a little dry time, we immersed the cutting base in a rooting hormone (ANA and IBA in equal shares) at different concentrations (100, 400 and 1600 ppm)

Cuttings were planted in black PE cell plates, filled with peat-perlite misture (1:1 v/v) and placed on a hot bed (± 22º C) with a fog system (± 80% H.R.). They were

mainteined under natural photoperiod, irradiance and air temperature (m = 15.4º C and M = 31.3º C).

Phytosanitary treatments were realized with Rovral (a.s. – Iprodiona) and Captan (a.s. – Captana), 2g/l alternatively, during the rooting time.

About eight weeks after, the rooted cuttings were transplanted to PE pots Ø 12 cm and transfered to greenhouse benches.

The experimental design was randomized in three types of cuttings (softwood, semi-hardwood and hardwood), 20 cuttings of each type, 4 concentrations (0, 100, 400 and 1600 ppm) and 3 repetitions, of each specie.

In order to improve cutting propagation results in Spring of 1996, we repeated this task, utilizing high rooting hormones concentrations (1000, 2000 and 4000 ppm) and the same methodology.

In Spring of 1996, we also made cutting propagation of *Lavandula luisieri, Lithodora prostrata and Halimium halimifolium* from mother plants, which are growing in a greenhouse, using the same methodology and rooting hormones (IBA+ANA) at 2000 ppm.

We just made softwood and semi-hardwood cuttings because it wasn't possible to take hardwood material from these plants.

Measurements:

- Rooted cuttings percentage;
- Root lenght (cm);
- Shoot lenght (distribution in classes).

TASK 2 – GROWING TECHNIQUES FOR NURSERY CONDITIONS

2.1. - Morphological, phenological and horticultural responses of the selected species under various growing conditions

In this task, we made:

- Observations of morphological and phenological parameters, in the three environments.
- Observations about phytosanitary problems in the three environments.
- Observations about plant survival during the Winter.

- Propagation and growing techniques procedure.

Plant material obtained from task 1 was used for the study of task 2. At 28/4/96 plants of the species *Lavandula luisieri, Cistus monspeliensis, Halimium halimifolium, Lithodora prostrata* and *Thymus mastichina,* at 18/6/96 *Centranthus ruber, Euphorbia characias, Genista thyrrena, Spartium junceum, Lavandula stoechas, Cistus creticus, Vitex agnus castus, Ebenus creticus, Lotus creticus creticus* and *Lotus creticus cytisoides*, at 20/8/96 *Argyranthemum maderense* and *Argyranthemum coronopifolium,* at 6/12/96 *Limonium sinense* and at 23/1/97 *Helychrisum graecum* were removed to the three environments (in unheated greenhouse (GH), in shade frame (SF) covered with PE net of 50-60% opacity and in open air (OA)). The plants grew up in 20 cm diameter pots on a substrate of peat, perlite and sand (1:1:1) There were 16 plants of each specie in three repetions of each environment.

All plants were irrigated with a drip irrigation system with a debit of 2l/h. The fertilisation was applied through the irrigation system. They were fertilised in Summer, weekly and in Winter fortnight used mixed manure, applied at 200 ppm de N, 100 ppm de P_2O_5 and 300 ppm de K_2O.

Measurements:

Morphological parameters

- Canopy perimeter (in crown middle);
- Height plant (from the pot rim to the end of the highest stem);
- Secondary and tertiary shoot length;
- Secondary and tertiary node number (from the base to the end of shoot, last node beyond the inflorescence or terminal leaves).

Phenological parameters

- Shooting period;
- Flowering period;
- Frutification period.

The observations began in June of 1996 to our species (*Lavandula luisieri, Lithodora prostrata, Cistus monspeliensis, Halimium halimifolium* and *Thymus mastichina*) and in

February of 1997 to those received from our partners. Measurements of morphological parameters were performed trimestrially and phenological parameters monthly.

Tolerance for cold

The plants were maintained in the 3 environments (Greenhouse, shade frame and open air), during all de year. When the Winter finish theirs were arranged in groups, according with harm caused by low temperatures:

- Tolerant. Species that survive at the Winter in open air, without any harm.
- Semi-tolerant. Species that survive at the Winter in open air, with some harms, but are able to shooting in Spring.
- Not tolerant. Species that don't survive at the Winter in open air.

Phytossanity

Observations of the phytosanity problems in the 3 environments (greenhouse, shade frame and open air).

2.2. - Techniques for building the appropriate plant structure

With the purpose to study the way to improve plant's ornamental look we utilized different growth regulators:

- CCC (clormequato);
- Cultar (paclobutrazol);
- B-Nine (Daminoazida).

CCC, Cultar and B-Nine solutions (2.5 ml/l) were prepared, and at each one was added (0.5 ml/l) of Etaldyne.

Foliar pulverizations with those solutions were made every fortnight, three times, at Spring.

Growth regulators were applied in 6 plants plots with 3 repetitions and 3 environmemts (greenhouse, open air and shading frame), for the species: *Cistus monspeliensis, Halimium halimifolium* and *Thymus mastichina.*

We measured the plants soon after three aplications of growth regulators (1996) and one year past (1997), in order to evaluate the growth regulator persistence. The evaluated parameters were:

- canopy perimeter (cm);

- plant height (cm), from the top container to the highest shoot.
- secondary shoot lenght (cm).

Based to the above results, one year after (1997), we applied the most efficient growth regulator (Cultar) in different concentrations (1 ml/l, 2.5ml/l and 5 ml/l), added 0.5 ml/l of Etaldyne at each one.

We made three pulverizations with these solutions, forntnight, at Spring, in plants with 10 cm of height, on average, being in greenhouse and shade frame.

The experimental design was randomized in 6 plants plots and 3 repetitions, for the species: *Cistus monspeliensis, Lavandula luisieri, Lithodora prostrata, Halimium halimifoliu* and *Thymus mastichina.*

Five growth parameters were estimated, used four plants by plot at each specie:

- canopy perimeter (cm);
- height plant (cm), from the top container to the highest shoot;
- secondary shoot lenght (cm);
- nº of nodes;
- nº of branches.

The plants in the growth regulators experiment had the same preparation techniques as the plants in the three environments experiment: transplantation (size of pots and composition of the substrate), irrigation and fertilization.

RESULTS AND DISCUSSION

TASK 1 – INVESTIGATION OF WAYS OF EFFICIENT PROPAGATION

1.1. – Seed propagation

The results were calculated for fifty seeds, being the values present the average of three repetitions.

For the specie *Thymus mastichina* the best methods of scarification were heat, KNO_3, temperature alternation and cool, however were inferior than the test at the light and near to their at the dark. The seeds treated with H_2SO_4 and soaked in hot water didn't germinate, with and without light (Annex I – Fig.1).

In all the treatments, excepting the test, the number of germinated seeds at the dark was lightly superior to at the light (Annex I – Fig.1).

In the test and in the heat and KNO_3 treatment at light the number of germinated seeds increased very much in the first week, while the others treatments increased more in the second week.

At the dark the germination rate of all the treatments, excepting mechanical scarification, increased very much in the first week.

Germination range (days from first to last germinating seed) of *Thymus mastichina* in the light was three weeks for KNO_3, heat, alternation temperatures and cool treatments and four weeks for mechanical scarification treatment and test. At the dark the germination range was less than which in the light, for alternation temperatures, KNO_3 and cool treatments.

For the specie *Lavandula luisieri* the most efficient methods of scarification were heat and mechanical scarification. The seeds treated with H_2SO_4 and KNO_3, with and without light and alternation temperatures, also with cool treatments at dark didn't germinate (Annex I – Fig.2).

In both situations (with and without light) the germination rate of test and seeds treated with heat, KNO_3, cool and mechanical scarification was higher in the first two weeks, decreasing from here. The seeds that were soaked in hot water germinated a litle in the first week, in the second week there was a higher germination.

Seed germination had better results at light than at dark.

Lavandula luisieri at light had a small germination range, two weeks for heat, cool, mechanical scarification and alternation of temperatures treatments and three weeks for hot water treatment and test. At the dark the germination range was three weeks for all treatments.

Mechanical scarification (with and without light), KNO_3 and hot water (both at light) were the most efficient treatments to break dormency of *Cistus monspeliensis* seeds. The rest of the procedures revealed germination low values and similar to the test (Annex I – Fig.3).

Cistaceas retain wax within or on the seed coat, thus making it impermeable to water. This impermeability protects the seed by preventing loss of water. The seed can be soaked in hot water or in a organic solvent. These wax solves better in organic solvent

than in water, thus it should be utilized organic solvent as acetona or alcool in lieu of hot water (Borges, 1988).

On the other hand, the most of seeds germinated after the fire, which showed that a rise in temperature increases the sucess and rate of germination. This happens because temperature improves the breaking of seeds shell, faciliting germination (Santos *et al.*, 1996, Valbuena *et al.*, 1992). According to Viullemin and Bulard (1981) the germination rate of their seeds is dramatically increased by dry heat pre-treatment, thus we expected to obtain the same results through heat treatment, but it didn't happen.

In the first week, the number of germinated seeds was low, increasing from the second week for the test and mechanical scarification and KNO_3 treatments with and without light.

Cistus monspeliensis at the light and at the dark had four weeks of germination range in all of the treatments.

All the scarification methods used in the treatment of *Halimium halimifolium* seeds revealed low efficience, presenting germination values similar amongst them, and in both situations (with and without light). The germination rate increased very slow along the time in both situations (Annex I – Fig.4).

The germination range of *Halimium halimifolium* was four or five weeks according to the treatment.

According to Peña *et al.* (1988) *Halimium halimifolium* seeds are endowed with complex dormancy mechanisms. The lipidic nature of exotesta is probably the first factor causing dormancy in this species, acting both as a water and oxygen barrier.

The adverse effect of high temperatures (superior to 30º C) can be correlated with a secondary dormancy imposed at embryo level. This mechanism could have two meanings. First, at this temperature oxygen solubility can be low enough to impose a limitation at embryo level. On the other hand, it is possible that phenolic compounds present in the tegmen layers could be involved, reducing even more the oxygen availibility to the embryo. If this is the case, we can envisage two types of independent controls (at exotesta and tegmen levels), which can sometimes be simultaneous in non-scarified seeds (Peña *et al.*, 1988).

Any scarification methods was efficient enought to break dormency of *Lithodora prostrata* seeds presenting very low germination values, however alternation

temperature at light was lightly superior than the others. The seeds at the light began to germinate at the third week, while those at the dark were in fifth week. *Lithodora prostrata* had the longer germination range, six weeks, for all treatments with and without light.

Most of *Lithodora prostrata* seeds didn't germinate, but they were swelling due to the water absortion.

We observed that the seeds infected by fungi germinated better than the others, probably that can alter seed coats.

All the seeds trials occurred at 15º C, according to Argyris (1977) and Mitrakos (1981), the optimal temperature for seed germination of typical Mediterranean species.Thus, under natural conditions, seeds of Mediterranean species germinate during Autumn, when temperatures are optimal and water is available.

The poor results of seed propagation are probably due to the utilization of seeds collected from will plants, undomesticated.

1.2. – Cutting propagation

1.2.1. - Cutting propagation from wild plants

The rooting percentage for each species was calculated for twenty cuttings, being the values present the average of three repetitions. Now, we will present the results obtained in cutting propagation at Spring of 1995.

The number of softwood and semi-hardwood *Thymus mastichina* cuttings rooted was similar for all the treatments except for the 1600 ppm the ANA+ IBA. Low to medium results was registred in softwood cuttings (varied between 18.2 and 36.4%) and semi-hardwood cuttings (varied between 16.3 and 27.4%). In softwood cuttings the best rooting percentage was verified in treatment with 1600 ppm and in semi-hardwood cuttings in the test. In hardwood cuttings only those treated with 400 ppm the ANA+IBA had a little rooting percentage (Annex II(I) – Fig.1).

The number of rooted cuttings was very low and similar to the test for all types and treatments (100, 400 and 1600 ppm) of *Lavandula luisieri* cuttings (Annex II(I) – Fig.2).

The best type of *Cistus mospeliensis* cuttings was the softwood, following by the semi-hardwood and at last the hardwood with very low results. The cuttings treated with 1600 ppm of ANA+IBA gave the best results (80% to softwood, 48.3% to semi-hardwood and 3.3% to hardwood cuttings) (Annex II(I) – Fig.3).

The *Halimium halimifolium* softwood cuttings gave good results, varied between 42.9 and 82.5%, being the higest value (82.5%) verified for the test. The semi-hardwood cuttings gave medium values, varied between 6.9 and 38.1% registered the best value (38.1%) at 1600 ppm. Only hardwood cuttings treated with 1600 ppm the ANA+IBA rooted (Annex II(I) – Fig.4).

In *Lithodora prostrata* can be observed that only softwood cuttings were rooted. The rooting percentage was low for all the treatments (100, 400 and 1600 ppm), being the highest value (15.9%) for the test (Annex II(I) – Fig.5).

Low rooting of *Lavandula luisieri* and *Lithodora prostrata* cuttings was due mainly to physiological stage of shoot development. Cuttings came from soft shoots in Spring which were already in bloom. Such cuttings usually have low rootings ability (hartmann and Kester, 1991).

In this trial, the number of cuttings rooted was more dependent of the cutting type than the hormones'concentration, perhaps because this one was too low. In all the species in study the best results were obtained with softwood cuttings, except in *Lavandula luisieri*, which the best cutting type was the hardwood (Annex II(I)).

After that, we display the results of cuttings propagation obtained on Spring of 1996.

The *Thymus mastichina* showed good rooting capacity for softwood (between 86.7 and 100%) and semi-hardwood cuttings (between 65.0 and 88.3%). The best results (100% and 88.3%, respectively) were obtained for the cuttings treated with 4000 ppm the ANA+IBA.Hardwood cuttings had similar results for the several treatments, the were lower (varied between 26.7 and 31.7%) (Annex II(II) – Fig.1).

The *Lavandula luisieri* cuttings had good results to the softwood (between 68.3 and 81.7%) and semi-hardwood cuttings (between 50.0 and 68.3%). The hardwood cuttings presented inferior results to the others, varing between 21.7 and 28.3%. The treatments

with 2000 and 4000 ppm the ANA+IBA had similar results to the three types of cuttings (Annex II(II) – Fig.2).

The *Cistus monspeliensis* cuttings presented medium results for the softwood cuttings (varied between 50.0 and 68.3%), being the highest value (68.3%) for the cuttings treated with 4000 ppm the ANA+ IBA. The semi-hardwood cuttings treated with different ANA+IBA concentration had similar results; however the highest value (50%) was for the treatment with 4000 ppm. The hardwood cuttings didn't root, for any treatment (Annex II(II) – Fig.3).

The *Halimium halimifolium* showed medium rooting capacity for the softwood and semi-hardwood cuttings. These types of cuttings had similar results, the softwood varied between 31.7 and 61.7% and the semi-hardwood between 26.7 and 53.3%. In both of cuttings type the highest value was in the treatment with 4000 ppm the ANA+IBA. Only the hardwood cuttings treated with 4000 ppm the ANA+IBA were rooted, but presented a very low rooting percentage (3.3%) (Annex II(II) – Fig.4).

The *Lithodora prostrata* showed a weak rooting capacity. The best results were obtained (50.0, 38.3 and 18.3% for softwood, semi-hardwood and hardwood cuttings respectively) in the cuttings treated with 4000 ppm the ANA+IBA (Annex II(II) – Fig.5).

In the rooted cuttings, the root system was the medium to good, and the roots had a good structure. Root systems were symmetrical and well balanced. Roots were evenly distributed around the perimeter and emerged in the cut basal portion. In general, IBA+ANA increased the length root, which was the best for high concentrations, for three of the cutting kinds. Root length reflects the potential volume of soil that is accessible to the plant. Thus, root length may be a good indicator for future plant performance. Consequently, the higher IBA+ANA concentration may produce a higher quality cutting and more vigorous plants.

In *Cistus monspeliensis, Halimium halimifolium, Lavandula luisieri, Lithodora prostrata* and *Thymus mastichina*, cutting propagation in 1995 and 1996 Spring, the softwood cutting rooted better than semi-hardwood and at last by the hardwood cuttings, excepting *Lavandula luisieri* in first trial (1995).

These results were supported by Browse (1979) and Hartmann and Kester (1990) opinion, according to them the softwood cuttings have higger capacity of root production. In their opinion the increased rooting success of these cuttings can be explained by a higher concentration of root promoting endogeneous substances (auxinis and co-factors), produced by terminal bud. On the other hand, the softwood cuttings are younger and less differentiate, and for that reason have more cells able to return meristematic cells.

The rooting capacity is highly dependent on the type of cutting and it's can seasonable variation. Heidi (1968) *in* Hartmann and Kester (1990) and Peixe (1992) report that these variations maybe caused by internal modifications on a hormone level. These internal changes were largely influenced by environment alterations in temperature and light (intensity and photoperiod).

From results observations we can say that to the greate number of species, the best auxinic treatment (ANA + IBA) utilized was the highest concentration (1600 ppm in the first trial and 4000 ppm in the second trial). These results are consistent with Hartmann and Kester (1990) and Peixe (1992) opinion, that a syntetic auxinic application of ANA and/or IBA (when cutting are made) can be favourable to the development of the root. However the same authors say that this only happens if other natural factors are present and it's not just limited to an increase of auxinic concentration.

Comparing the cutting propagation of various species in 1995 and 1996, we can say that the best rooting percentage was obtained in Spring of 1996, except for the *Cistus monspeliensis* and in softwood cuttings of *Halimium halimifolium*. These results can be explained by the use, during a second trial (1996), of a higher concentration of ANA + IBA hormone treatment. As it was mentioned before the first cutting propagation (1995) produced better results than the second (1996). This can be explained either by the best physiologic conditions of the plant-mother in 1995 or by the excessive concentration used of hormones (4000 ppm) in 1996, that revealed to be toxic for this specie.

In the first year (1995) the species *Lavandula luisieri* and *Lithodora prostrata* were in bloom when we made the cuttings. As Hartmann and Kester (1990) and Peixe (1992) that experience difficulties. In rooting on desfavorable element, in some cases there seems to be an incompatibility between the vegetative regeneration and blooming on the

auxinic level. If this occurs the specie should propagated before the beginning of Spring.

The length shoots of rooted cuttings were measured and classified according the several classes:

- D class (0 < s < 2 cm)
- C class (2 < s < 4 cm)
- B class (4 < s < 6 cm)
- A class (s > 6 cm)

The softwood cuttings of *Thymus mastichina* had shoots of D class, excepting the test, that had shoots uniformly distributed in the different classes. The shoots of semi-hardwood cuttings untreated and treated with 100 ppm were mainly of B class, the shoots of cuttings treated with 400 ppm of ANA+IBA were of D class and those which the cuttings were treated with 1600 ppm were of A class. Only shoots emited from hardwood cuttings had length superior of 6 cm (class A) (Annex II(III) – Fig.1).

The shoots emited from softwood cuttings of *Lavandula luisieri* untreated had length between two and four cm. Those emited from softwood cuttings treated with 100 ppm of ANA+IBA were mainly of D class. The semi-hardwood cuttings, untreated, had shoots more or less uniformly distributed by several classes. Those treated with 400 ppm the ANA+IBA emited shoots with length between four and six cm (C class). The shoots of semi-hardwood cuttings treated with 1600 ppm and hardwood cuttings were mainly of A class (Annex II(III) – Fig.2).

The shoots of softwood cuttings of *Cistus monspeliensis* were uniformly distributed in four classes, excepting the shoots of cuttings treated with 1600 ppm the ANA+IBA, that were from A class. The semi-hardwood cuttings had mainly shoots of C class, excepting those treated with 100 ppm of ANA+IBA, that were from A class. The shoots distribution of hardwood cuttings, varied with the treatment. The test had shoots of C class, the cuttings treated with 400 ppm of ANA+IBA had shoots of B and C classes and the cuttings treated with 1600 ppm had shoots of A class (Annex II(III) – Fig.3).

The softwood cuttings of *Halimium halimifolium* had the majority of shoots in the A class. The semi-hard and hardwood cuttings had majority of shoots in the D class. Hardwood cuttings emited only shoots of class D (Annex II(III) – Fig.4).

In the *Lithodora prostrata*, only softwood cuttings emited shoots, their length increased with ANA+IBA increasing concentration. The shoots of test were in D and C classes, the shoots of cuttings treated with 100 and 400 ppm were in C and B classes and those which the cuttings were treated with 1600 ppm, were in B and A classes (Annex II(III) – Fig.5).

TASK 2. – GROWING TECHNIQUES FOR NURSERY CONDITIONS

Task 2.1. – Morphological, phenological and horticultural response of the selected species under various growing conditions

Lavandula luisieri

For the greenhouse plants the biggest growth was verified in Spring and in the beginning of Summer in two years of study. Those had grown up more in the first year than in the second one due probably to the pot limitation. Shade frame plants presented the biggest growth in Spring and in the beginning of Summer. Their biggest growth was verified in the second year because in the first plants had grown little and the pot wasn't a limiting factor (Annex III – Tab 1).

The growth of plants in open air was bigger in Spring and in the beginning of Summer, in the two years. However plants in open air had an inferior growth than those in two other environments. In the second year they grew up more than the in first one (Annex III – Tab 1).

In the first year (1997) *Lavandula luisieri* bloomed from March to April in the 3 ENV. In 1998 the flowering time varied with the environment, in greenhouse occurred in March-May, in shade frame in March-June and in open air in March-April (Annex IV – Tab 1).

Cistus monspeliensis

Greenhouse plants showed a bigger growth along all year. In the last three months we verified a growth reduction, probably because the pot became a limiting factor to the growth. In the second year (1998) the plants in greenhouse had a growth superior to the first one (Annex III – Tab 2).

In shade frame plants grew up more in Spring and in the beginning of Summer. In the second year growth was superior to the one of first year (Annex IV – Tab 1).

Open air plants grew up more in Spring and in the beginning of Summer. In the second year growth was bigger than in the first one (Annex IV – Tab 1).

In 1997 only plants in shade frame and open air bloomed, which occurred in March-April. In 1998, the plants in greenhouse flowered in April-May, in shade frame in April and in open air in March-April. (Annex IV – Tab 1)

Thymus mastichina

Plants in greenhouse showed a bigger growth during the Spring and in the beginning of Summer. The plants grew up more in the first year than in the second one (Annex III – Tab 3).

In shade frame plants grew up more in Spring and in the beginning of Summer. High growths were verified in the first and second year, although the second one had showed a light increase comparing to the first year (Annex III – Tab 3).

Open air plants, in the first year had a bigger growth in Spring of 97 and in the beginning of 1998 Summer. The growth of the second year was superior to the one of the first year (Annex III – Tab 3).

The plants in greenhouse bloomed between April and June, in shade frame from April to May / June and in open air from March / April to May (Annex IV – Tab 1).

Halimium halimifolium

Greenhouse plants presented a bigger growth from the end of Winter to Spring, in the first and second year, however the second year growth was superior (Annex V – Tab 4).

In shade frame, plants in the first year had a bigger growth in the end of the Winter / Spring and in the second one in Spring. The growth of the two years was similar (Annex III – Tab 4).

Open air plants had two intensive growth periods, between June and Setember of 97 and between March and June of 98, comparing the first and the second year of study we were able to verify that those plants in the first year grew up more in height, while in the second year grew up more in width (Annex III – Tab 4).

Only plants in shade frame and open air bloomed, which was in March-April for both environments (Annex IV – Tab 1).

Lithodora prostrata

Greenhouse plants had a bigger growth between June and September of 97, shade frame plants between December and March of 98 and in open air between March and June of 98 (Annex III – Tab 5).

This specie had a small growth compared to the others, what it was expected according to the specie characteristics (small size of the adults) (Annex III – Tab 5).

Lithodora prostrata presented a long flowering time (four months). In 1997, the plants in shade frame and open air bloomed from January to April, in greenhouse which was two months later (March – June), in 1998 the flowering time was similar (Annex IV – Tab 1).

In general, the plants in greenhouse presented a more significant growth in Jan-Jun of 97 and Dec-Mar of 98, excepting *Lithodora prostrata* which grew up more in Jun-Set of 97 and *Cistus monspeliensis* that grew up regulatity along the year.

In shade frame we verified that the biggest growth was in Jan-Jun of 97 and in Mar-Jun 98, however the period of Dec-Mar of 98 had a big growth too.

All of species in open air had a superior growth in Mar-Jun of 98.

Comparing the first and the second year of study we were able to verify that the majority of plants in the second year grew up more than in the first one. However the plants in greenhouse of the species *Lavandula luisieri, Thymus mastichina* and *Halimium halimifolium* had a superior growth in the first year, due probably to the pot limitation. The plants of *Halimium halimifolium* in shade frame and open air environment had similares growths in two years of study.

The majority of the species had their flowering time between March and May, for two or three months. The plants of *Lithodora prostrata* in shade frame and open air blooming before the others (from January to April) and for more time. They began to sprout in Autumn.

Helychrisum graecum

Canopy perimeter was bigger in the greenhouse, but the plants were higher in shade frame, during all the year. The length of secondary shoot was similar in the greenhouse and in shade frame, also in the tertiary shoot length, wich had similar nº of nodes (Annex III – Tab 6). This specie had a regular and big growth along all the time in the 3 ENV.

The flowering period occurred from February/March to May in the 3 ENV (Annex IV – Tab 2).

Argyranthemum maderense

Plants in greenhouse had a larger canopy perimeter than the others; however had similar height to the plants in shade frame. The secondary shoots were longer in greenhouse followed by the shade frame and at last in open air, which had also similar node number in the two first environments (Annex III – Tab 7).

The plants in greenhouse had a big and regular growth along the time, while the plants in shade frame and open air grew up more in one period, the first in the last six months (Nov-May of 98) and the seconds in the last three months (Feb-May of 98) (Annex III – Tab 7).

In the second year flowering time was longer than in the first one. In 1997 the blooming occurred during two months (Jan-Feb) while in 1998 during four months (Jan-April). In June/July occurred the second bloom in the secondary shoots of plants in shade frame and open air. In 1998 the blooming period was larger in the 3 ENV because had a great number of flower buds which bloomed one after another (Annex IV – Tab 2).

Vitex agnus castus

In May of 98 the plants in greenhouse showed a superior perimeter and height than the plants in the others environments, but their secondary and tertiary shoots were smaller than those of plants in shade frame. Plants in open air were the smallest (< perimeter, < height and < secondary and tertiary shoot length) (Annex III – Tab 8).

In February of 98, plants were dormant and without leaves, for that reason we didn't measured them in this time. Plants in greenhouse and shade frame began to sprout in March, in open air it began a month later (April). This specie is deciduous, but in greenhouse maintained their leaves (Annex IV – Tab 2).

Lotus creticus cytisoides

Plants had a larger canopy perimeter during Spring of 97 in greenhouse. In the rest of the year, plants had better results in shading environment. The open air plants had always inferior sizes than those from the greenhouse that breed bigger secondary shoots. However plants in shade frame had a higher number of nodes during all year (Annex III – Tab 9).

This specie grew up more from Feb-May of 97 (>12.5 cm in perimeter) and Nov-Feb of 98 (>15 cm in perimeter and >11.5 cm in secondary shoot length) in greenhouse. In shading environment the plants had an important growth on May-Aug of 97 (>50 cm in perimeter and >11.7 cm in secondary shoot length) and Feb-May of 98 (>27.5 cm in perimeter and >12 cm in secondary shoot length). In open air environment the biggest growth was on Feb-

May of 97 (>10 cm in perimeter and >2.1 cm in secondary shoot length) and in Feb-May of 98 (>27.6 cm in perimeter and >14.5 cm in secondary shoot length) (Annex III – Tab 9).
In 1997, plants in open air and shade frame bloomed from March to May, while plants in greenhouse bloomed one month after. Flowering time in the second year occurred between April and June, in greenhouse and in open air environments and from April to June in shade frames (Annex IV – Tab 2).

Lotus creticus creticus

Plants in shade frame had a bigger canopy perimeter followed by that in open air and in greenhouse. The shoot length was bigger in shading frame than in the others environments. The number of nodes in shade frame was slightly superior to those in open air (Annex III – Tab 10).
The plants in greenhouse had a constant growth along the year, however lightly superior on May-Aug of 97 (>8 cm in perimeter and >14.9 cm in height) and on Nov-Feb of 98 (>9 cm in perimeter and >10.7 cm in height). The plants in shade frame grew up more on Feb-May of 98 (>31.8 cm in perimeter and >17.1 cm in height). The plants in open air grew up more in two periods, Feb-May of 97 (>39 cm in perimeter and >0.9 cm in secondary shoot length) and Feb-May of 98 (>14.3 cm in perimeter and >4.3 cm in secondary shoot length) (Annex III – Tab 10).
In 1997, the plants in shade frame bloomed on December-March, in open air on March-May and in greenhouse in April-May. In 1998, this specie bloomed one month later and for a shorter time than in 1997 (Annex IV – Tab 2).
In open air this specie produced many fruits (cylindrical leguminae).

Centranthus ruber

Plants in greenhouse had a bigger canopy perimeter than the others along the year. Secondary shoot′s length was bigger in the greenhouse and in shade frame, with similar values during Winter and Spring of 1997, while from to August of 97 the greenhouse had superior values. The plants in shade frame had a greatest number of nodes than in the others environments, excepting on February of 97 which open air plants had higher number of nodes (Annex III – Tab 11).
The plants in greenhouse had the most important growth on Feb-Aug of 97 (>116.2 cm in perimeter and >49.6 cm in secondary shoot length) while the plants in shade frame and open air grew up more on Feb-May of 97 (>65.2 cm in perimeter and >14.3 cm in secondary shoot length; >123.7 cm in perimeter and >19.2 cm in secondary shoot length,

respectively) and on Feb-May of 98 (>20 cm in perimeter and >16 cm in secondary shoot length; >45.8 cm in perimeter and >25.8 cm in secondary shoot length, respectively). (Annex III – Tab 11).

This specie bloomed from April/May to August in the 3 ENV. They had a longer flowering time because after the bloom on primary shoots, the secondary bloomed too (Annex IV – Tab 2).

Limonium sinense

In greenhouse canopy perimeter was superior, followed by shading frame and at last in open air during all two years. The plants in the 3 ENV grew up more on Feb-May of 98 (greenhouse: >12.3 cm; shade frame: >8.1 cm; open air: >22.6 cm in perimeter) (Annex III – Tab 12).

In 1997 the plants in greenhouse didn't bloom, while in 1998 it's happened in shade frame. The flowering time was from April/May to August in 1997 and from April to June in 1998, in both environments (Annex IV – Tab 2).

In the first year the plants in shade frame had less floral stems but longer than those in open air. In the second year, the plants in greenhouse had more floral stems and longer than those in open air (Annex IV – Tab 2).

Spartium junceum

The biggest canopy perimeter and height were in shade frame plants followed by those that were in greenhouse and in open air, during all two years. Secondary shoots were slightly bigger in the greenhouse than those in shade frame. The node number was slightly superior for plants in shade frame than in the other environments (Annex III – Tab 13).

Between the period Feb-May of 97 and Nov-Feb of 98 the plants in greenhouse had a more significant growth, by increasing 47.7 cm in perimeter, 5 cm in height and 20 cm in perimeter, 23 cm in height, respectively. The plants in shade frame, on Nov-Feb of 98, increased 21.3 cm in perimeter, 7.5 cm in height and 11 cm in secondary shoot length, while on Feb-May of 98, increased 44.3 cm in perimeter, 5.6 cm in height and 5.8 cm in secondary shoot length. The parameters didn't develop the same way; some increased more in a period and others in another period. The plants in open air grew up more on May-Aug of 97 (>24.7 cm in perimeter, > 6.2 cm in height and >4.5 cm in secondary shoot length) and Feb-May of 98 (>71.1 cm in perimeter, >17.3 cm in height and >25.5 cm in secondary shoot length) (Annex III – Tab 13).

In 1997 only plants in open air bloomed. The flowering period occurred between May and July. In 1998, plants in greenhouse didn't bloom; the rest bloomed from April to July (Annex IV – Tab 2).

Genista thyrrena

The biggest canopy perimeter was in plants in greenhouse, followed by those that were in shade frame and in open air, excepting on February of 97. From May to November of 97 the highest values were verified on plants in shade frame, in the rest of the year the plants in greenhouse and shade frame had similar values. The length and node number was superior in greenhouse, meanwhile the plants in shade frame had near values (Annex III – Tab 14).

In greenhouse the plants grew up more on Feb-May of 97 (> 69 cm in perimeter, >17.4 cm in height and > 12.1 cm in secondary shoot length) and in Nov-Feb of 98 (>9 cm in perimeter, > 6.3 cm in height and >11.3 cm in secondary shoot length) (Annex III – Tab 14).

The plants in shade frame had a more important growth along the period Feb-Nov of 97 (>91.5 cm in perimeter, >52.1 cm in height and >29.1 cm in secondary shoot length). Those in open air grew up more in two periods, May-Aug of 97 (>32 cm in perimeter, >5.7 cm in height, and >1.6 cm in secondary shoot length) and on Feb-May of 98 (>57 cm in perimeter, >15.5 cm in height and >39.3 cm in secondary shoot length) (Annex III – Tab 14).

Only plants in shade frame and open air bloomed. Flowering time was from April/May to June, for both environments (Annex IV – Tab 2).

Euphorbia characias

The highest canopy perimeter was in plants in greenhouse, which were always the highest, but in the course of the year the height of plants in shade frame came close to the values veified in greenhouse. The secondary shoots were longer in greenhouse; however plants in open air had more secondary shoots. On May of 98 the plants had more nº of tertiary shoots which were longer than in Feb of 98, in the 3 ENV but they were much stonger on plants in greenhouse (Annex III – Tab 15).

On Feb-May of 97 and Feb-May of 98 there was an important growth in plants in greenhouse that increased 28.3 cm in perimeter, 1.5 cm in height; and 53.3 cm in perimeter, 6.8 cm in height, respectively. The growth was regular along the time in the plants, in shade frame and open air environments (Annex III – Tab 15).

Euphorbia characias bloomed from December to March/April in greenhouse plants and from December to February/March in the other environments. Plants in open air in 1997 and those in all environments in 1998 presented a second flowering in the secondary shoots in the Summer. The flowering period was longer because had many flowers per shoot, blooming at different times and had two flowering time (one in primary shoots and other in secondary shoots) (Annex IV – Tab 2).

Cistus creticus

Canopy perimeter and secondary shoot length of plants was higher in shade frame than in the other environments along the year. On Feb and May of 97, the highest plants were in shade frame, from this time the plants were in greenhouse. In the beginning, the node number was similar in the 3 ENV. From November of 97 the plants in the greenhouse had more nodes (Annex III – Tab 16).

On Nov-Feb of 98 the plants in greenhouse and in shade frame had an important growth, by increasing 13.7 cm in perimeter, 4.7 cm in height and 18.3 cm in secondary shoot length; 30.3 cm in perimeter, 4.5 cm in height and 14.5 cm in secondary shoot length, respectively. The plants in open air had two periods of intense growth May-Aug of 97 (>20.2 cm in perimeter, >7 cm in height and >2.4 cm in secondary shoot length) and Feb-May of 98 (>10.6 cm in perimeter, >2.8 cm in height and >10.1 cm in secondary shoot length) (Annex III – Tab 16).

This specie bloomed from March to April/May in the 3 ENV (Annex IV – Tab 2).

Lavandula stoechas

Plants in shade frame had larger canopy perimeter than in the other 2 ENV, excepting on Feb of 97 which were those in the greenhouse. Plants in greenhouse and in shade frame had similar height and secondary shoot length; these parameters were superior to those in open air. Node number was a little superior in shade frame than in the others environments, excepting on Feb of 97 (Annex III – Tab 17).

The plants in greenhouse grew up more on May-Aug of 97 (>25.8 cm in perimeter and >9 cm in height) and on Nov-Feb of 98 (>24 cm in perimeter and >4 cm in height). While those in shade frame grew up more on Feb-May of 97 (>89.5 cm in perimeter and >24.5 cm in height) and on Feb-May of 98 (>35.3 cm in perimeter and >6.8 cm in height). The best growth in open air plants occurred on Feb-May of 97 (>33.5 cm in perimeter and >16 cm in height) and on Nov-Feb of 98 (>13.5 cm in perimeter and >2.3 cm height) (Annex III – Tab 17).

Plants in greenhouse and in shade frame bloomed from February to May and in open air it began one month before (Annex IV – Tab 2).

Ebenus creticus

Canopy perimeter of plants in shade frame was higher than the others; however in November of 97 open air plants had a superior canopy perimeter. The height of the plants in shade frame was bigger than the others. The secondary shoot length and node number was similar to the plants in the 3 ENV (Annex III – Tab 18).
The plants in greenhouse presented a big growth in Autumn (Aug-Nov of 97), while those in shade frame and open air grew up more in Spring (Feb-May of97 and 98).
This specie in shade frame and open air flowered from April to May in the first year and in July in the second one. Plants in greenhouse flowered only in the first year (1997), from May to June (Annex IV – Tab 2).

The species *Argyranthemum maderense, Centranthus ruber, Euphorbia characias* and *Genista thyrrena* had a better development (larger canopy perimeter, bigger plant height and longer secondary and tertiary shoots) in greenhouse. Plants of *Limonium sinensis* had a better development in greenhouse, however in the first year (1997) those didn't bloom in this environment.
On the other hand, the species *Ebenus creticus, Lavandula stoechas, Lotus creticus creticus* and *Spartium junceum* grew more in shade frame environment. The others species (*Cistus creticus, Helychrisum graecum, Lotus creticus cytisoides* and *Vitex agnus castus*) had a similar growth in greenhouse and shade frame.
Plants of all species in open air had an inferior growth than those which were in the other environments.
Althought some species had a better development in greenhouse and others had grown up more in shade frame, all species in shade frame and open air had a better ornamental look species were also more resistant to pest infestation and diseases.
Generally, plants in the greenhouse presented a more important growth in Feb-May of 97 and in Nov-Feb 98. Plants in shade frame and open air grew up more in Feb-May of 97 and 98) when temperatures increased.
We emphasise, that the presented results, referring to pot plants, had their growth conditioned by the pot size. Such plants in the soil would have another development.
The species *Argyranthemum coronopifolium, Argyranthemum maderense, Euphorbia characias, Lavandula stoechas* and *Lotus creticus* blooming in Winter, for three or four

months. Another group, formed by *Centranthus ruber, Cistus creticus, Ebenus creticus, Genista thyrranea, Helychrisum graecum, Limonium sinense, Lotus creticus cytisoides, Spartium junceum* flowering later, in Spring. Their flowering occurred time during more or less three months, excepting to the *Centranthus ruber* and *Limonium sinense* that mantained in blooming for four-five months.

Note - The collection plants weren't pinched, only some dry branches and flowers were removed.

These species are ideal for gardening and landscaping in the shade or at the sun, where they should get a favourable development and ornamental look.
Pay attention to the seeds of *Lotus cytisoides, Lotus creticus, Centranthus ruber* and *Euphorbia characias* that germinate very well, appearing new plants in the surrounding area. In gardening and landscaping should be utilised limited spaces in order to avoid invader plants, which could be it is favourable for recuperation and re-population of degraded areas.
Argyranthemum maderense has higher hydric needs than the other species and isn't being adequate for dry areas.

Due to *Lavandula luisieri* and *Thymus mastichina* ornamental shapes and fragrances they are possible to be used inside or outside pot plant.

In Summer, numerosus brown fruits covered *Cistus creticus, Cistus monspeliensis* and *Halimium halimifolium* shrubs give a very attractive ornamental look.

Centranthus ruber showed a small number of shoots, but had very high. This specie had a long blooming time (in 1997 more or less five months) as much in shading frame as well as in open air. With such features this plant can be used as inside or outside hanging plant.

Spartium junceum and *Genista thyrrena* showed a weak adaptability to the greenhouse environment, they didn't bloom and manifested themselves susceptible to pest and diseases.

Euphorbia characias in open air presented a lower canopy perimeter and plants were higher and had more secondary shoots. Those features gave them a compact crown and a better ornamental look.

Argyranthemum maderense, Lavandula stoechas and *Lithodora prostrata* would be interesting as flowered pot plants sold in Winter (St. Valentines) or at the beginning of Spring (for gardens).

After those observations we can say:

- The species *Argyranthemum coronopifolium, Argyranthemum maderense*, *Lavandula luisieri, Lavandula stoechas, Ebenus creticus, Helychrisum graecum* and *Thymus mastichina* show to be appropriate as an outside pot plant;
- The species *Cistus monspeliensis, Cistus creticus, Ebenus cretica, Halimium halimifolium, Helychrisum graecum, Lavandula luisieri, Lavandula stoechas, Lithodora prostrata, Lotus creticus cytisoides, Lotus creticus creticus, Euphorbia characias, Genista thyrrena, Spartium junceum* and *Vitex agnus castus* are interesting for gardening and landscaping plants. For their foliage, flowers, textures, colours, sizes and shapes they can be used in informal compositions, as perennial borders, mixed borders, wild gardens, rock gardens or as formal compositions. This type of plants showed interesting for public gardens, more than your ornamental value, they are rustic and have good soil covered capacity and control by infesting plants, decreasing maintenance cares.
- The species *Lotus creticus cytisoides* and *Lotus creticus creticus* can be used as covered plants in gardening and landscaping;
- The specie *Centranthus ruber* may be used as inside or outside hanging plant;
- The specie *Limonium sinense* can be cultivated as cut flower, commercialised in fresh or dry conditions.

<u>Phytossanity</u>

The most frequent pest and diseases were:

- *Lotus creticus creticus* and *Lotus creticus cytisoides* - cochineal (*Pseudococus citri*) in the base of the main stem, in the three enviroments.
- *Argyranthemum maderense, A. coronopifolium* - aphids (*Aphis spiraecola* and *Mysus persicae*) in Spring and Summer, small caterpillars (*Spodoptera litorallis*) and serpentine leafminer (*Liriomyza trifolli*), in the three enviroments.
- *Centranthus ruber* – acarids (*Polyphagotarsonemus latus* and *Tetranychus urticae*) in the greenhouse.
- *Limonium sinense* – caterpillars (*Spodoptera litorallis*) in the greenhouse.

- *Spartium junceum* – cotton cochineal (*Pseudococus citri*) in all environments Icerya purchasi in the shade frame and open air, and acarids (*Polyphagotarsonemus latus* and *Tetranychus urticae*) in the greenhouse.
- *Cistus creticus* – *Bemisia tabaci* and cotton cochineal (*Pseudococus citri*) in the greenhouse.
- *Lavandula stoechas* and *L. luisieri* - aphids (*Aphis spiraecola* and *Mysus persicae*) and *Bemisia tabaci* in the greenhouse.
- *Helychrisum graecum* – acarids (*Polyphagotarsonemus latus* and *Tetranychus urticae*) in the greenhouse.
- *Halimium halimifolium* – small caterpillars (*Pieris brassicae*) in the shade frame and open air.
- *Vitex agnus castus* - *Bemisia tabaci* in the greenhouse.

Note: Phytossanity had bigger problems in the greenhouse than in the other environments. The chemical treatments are needed during the plant growth, which increases the cost of production.

Tolerance for cold

The plants were maintained in the three environments all the year.

The species were classified in the following categories, according to the damages caused by Winter's low temperatures:

- Tolerant (species that survive outside during Winter without any morphological damage): *Lotus cytisoides, Lotus creticus, Centranthus ruber, Euphorbia characias, Cistus creticus, Lavandula stoechas, Ebenus creticus, Argyranthemum maderense, Argyranthemum coronopiifolium, Vitex agnus castus, Helichrysum graecum, Lavandula luisieri , Cistus monspeliensis, Lithodora prostrata, Thymus mastichina,* and *Halimium halimifolium.*
- Semi tolerant (species that survived with small damages and were able to sprout in Spring): *Limonium sinense* – presented red and damaged leaves. *Spartium junceum* and *Genista thyrrena* presented damaged shoots.

Task 2.2. - Techniques for building the appropriate plant structure

The application of the growth regulators produces an opposite effect to giberlines, reducing plant height and lenght of internodes, and higher branching. Sometimes, it causes secondary effects, as early bloom.
The development of many side shoots gives it a more attractive and compact profile. The classic structure pruning shows some inconveniences like high manual work and increase of the expenses. In some species unsatisfying results were reported hence they didn't provide adequate branching and foliage density.

The application of 2.5 ml/l the diferent growth regulators (CCC, Cultar and B-Nine) revealed different degrees of efficiency, in accordance with the specie and the environment.

For the *Halimium halimifolium* and *Cistus monspeliensis,* in the three environments (greenhouse, open air and shading frame), the growth regulators efficiency (Annex V(I) – Fig.1 and 2) can be represented by the following formula, for all evaluate parameters:

CULTAR > CCC > B-NINE (decreasing order of efficiency)

For the *Thymus mastichina* in the shading frame and greenhouse environments B-Nine revealed them more efective than CCC, but both were less effective than Cultar (Annex V(I) – Fig.3).

CULTAR > B-NINE > CCC (decreasing order of efficiency)

In open air, these specie showed a similar behaviour with aplication of different growth regulators (Annex V(I) – Fig.3).

CULTAR ≈ CCC ≈ B-NINE

All growth regulators utilized shown efficienty, because the treated plants were shorter (little canopy perimeter, small plant height and small length of secondary shoot) than the plant test. For the three growth regulator, Cultar (2.5 ml/l) has shown to be the most

efective, obtained the lower values for the evaluated parameters. The action of this growth regulator is the inhibition of giberelines biosynthesis (Jose Ballester-Olmos, 1998), limiting shoots growth and promoting the compactness of the canopy.
According to the same author, CCC and B-Nine are more efective in the winter (they are photodegrading). This trial was less efficient due to an inadequate time of application, for it was applied in spring.
The treated plants bloomed earlier than the test and have shorter stem internodes without affecting the number of leaves. Stems are thicker and leaves are shorther and greener due to a greater chlorophyll concentration.
The plants with tendence to a vigorous growth and open structure, when treated with growth regulators are forced to develop well and compact shaped, with a more attractive look, adequating for the pot plant production.

One year after the application (1997), we return to evaluate all the parameters and obtained the following formulas to represent the efficiency of the growth regulators:

Halimium halimifolium

CULTAR > CCC > B-NINE (decreasing order of efficiency)

The growth regulators effect resented in the three parameters (canopy perimeter, height plant and shoot length) (Annex V(II) - Fig. 1a, b and c). One year after, the diference beteween the plants treated with Cultar and the test increased (in all of the parameters) respecting to the last year.

Cistus monspeliensis

CULTAR > CCC ≅ B-NINE (decreasing order of efficiency)

In this specie the growth regulators were effective only in the plant height (only for the plants treated with Cultar) and shoot length parameters (Annex V(II) - Fig. 2b and c). Concerning the canopy perimeter there weren't differences between the treatments and between the treatments and the test, neither in shade nor on open air, obtaining in this last environment higher values than the test (Annex V(II) - Fig. 2a). In 1996, the

values of canopy perimeter of treated plants were near to the ones of test (in all of environments), maintaining the same tendence in 1997.

Thymus mastichina

CULTAR > CCC ≅ B-NINE (decreasing order of efficiency)

One year after, the differences in several parameters (canopy perimeter, height plant and shoot length) between plants treated with CCC and B-Nine and the test, decreased. Nevertheless plants treated with Cultar continue to be smaller and more compact than the test (Annex V(II) - Fig. 3a, b and c). The action of growth regulaters was bigger to the height and shoot length parameters than to canopy perimeter. The growth regulators effect was stronger to the plants in open air environment.

One year after the application of growth regulators (Cultar, CCC and B-Nine) its effect was still felt in plants, these showing inferior values than the test. May further mention that keep up order of efficiency of growth regulators. According to Jose Ballester-Olmos (1998) a greate number of growth regulators still have its effects in growth and bloom 12 to 18 months after the original application.

Based to the above results, one year after (1997), we applied the most efficient growth regulator (Cultar) in different concentrations (1 ml/l, 2.5ml/l and 5 ml/l), to test the best concentration.

The plants of *Lavandula luisieri* treated with a high concentration of Cultar (5 ml/l) showed a smaller canopy perimeter, plant height and shoot length, than the plants treated with lower concentrations (1 ml/l and 2.5ml/l) (Annex V(III) - Fig. 1a). It was find an inverse proportional relation between the evaluated parameters (canopy perimeter, plant height, shoot length, nº of nodes and branches) and the increment of Cultar concentrations (Annex V(III) - Fig. 1a and b). Growth regulators application decreased the number of nodes. The plants treated with 2.5 ml/l and 5 ml/l of Cultar had a smaller number of branches than the test and those that were treated with 1 ml/l of Cultar (Annex V(III) - Fig. 1b).

The canopy perimeter of *Lithodora prostrata* plants treated with Cultar was lower than the test; however there weren't differences between closes adopted. The plant height, the shoot length, the nº of nodes and branches of treated plants, were lower than the test and very similar to the different concentrations (Annex V(III) - Fig. 2a). The nº of nodes parameter showed an inverse proportional relation to the increment of Cultar concentrations. The branching was similar between the different treatments and the test (Annex V(III) - Fig. 2b).

The application of Cultar was profitable, because the values of the parameters: canopy perimeter, plant height and shoot length decreased according to the test. The application of different concentrations produced similar results except for the number of branches that was slightly superior in the treatment with 5ml/l of Cultar, but it was similar to the test.

In *Cistus monspeliensis* plants were treated with different concentrations of Cultar, all the parameters observed were very close to the test, although a little lower (Annex V(III) - Fig. 3a and b).

In 1996, the application of 2.5ml/l Cultar was efficient, decreasing the plant height, shoot length and slightly the canopy perimeter. In 1997 this application was not efective, maybe because the plant development wasn't susceptive to the growth regulator's action or the Cultar application was later, after the synthesis of necessary giberelines quantity to promote plant growth. The produt photodegrading hypothesis was excluded, because it was applied at the same time as the other species, when it was efficient.

The canopy perimeter, height plant and the shoot length of the treated *Halimium halimifolium* plants were lower as compared to the test, although not existing any differences among the several concentrations of Cultar (Annex V(III) - Fig. 4a). Plants treated with 1ml/l and 5 ml/l of Cultar had lesser nodes but more branches than the test (Annex V(III) - Fig. 4b).

The plants of *Thymus mastichina* treated with Cultar, presented a canopy perimeter, plant height and shoot length lower than the test, although there weren't differences among the several treatments (Annex V(III) – Fig.5a). Plants treated with 2.5 ml/l and 5

ml/l of Cultar had lesser nodes and branches than the test. Plants treated with 1 ml/l of Cultar showed higher nodes and branches than the others (Annex V(III) – Fig. 5b).

The results from the application of different concentrations of Cultar were similar. None of the different concentrations excelled as optimal. *Lavandula luisieri* was the only specie that showed proportionality between the applied concentration and the effect on the plant being the best concentration the 5ml/l of Cultar. Some species didn't have differences among the several concentrations of Cultar, we suppose that the concentrations were very close. In a next trial the biggest concentration of the growth regulator could be higher and the smallest could be lower. Could be interesting too the application of growth regulator in several plants stage, in order to determine what give best results.

CONCLUSION

TASK 1 – INVESTIGATION OF WAYS OF EFFICIENT PROPAGATION

1.1. – Seed propagation

<u>Task 1 - Propagation and growing techniques procedure</u>

A great number of mediterranean species can be propagated by seed. Some as *Thymus mastichina* don't need any treatment to germinate, others like *Cistus monspeliensis, Halimium halimifolium, Lavandula luisieri* and *Lithodora prostrata* need a specific treatment to break down physical dormency. However the species *Lithodora prostrata* and *Halimium halimifolium* showed low capacity to germinate in all of scarification methods.

The eficiency of scarification methods changes with the specie, so to *Lavandula luisieri* the method with the best results was heat and mechanical scarification, to the *Cistus monspeliensis* was mechanical scarification, $KNO3^-$ and hot water, to the *Halimium halimifolium* was mechanical scarification and to the *Lithodora prostrata* was temperature alternation.

All the seeds trials occurred at 15º C, according to Argyris (1977) and Mitrakos (1981), the optimal temperature for seed germination of typical Mediterranean species.Thus,

under natural conditions, seeds of Mediterranean species germinate during Autumn, when temperatures are optimal and water is available.

The seed propagation has proven to be a good method however the permanency time of plants in nursery is higher than to cutting propagation.

1.2. – Cutting propagation

The cutting propagation has shown to be an appropriate method to propagate the species: *Cistus monspeliensis, Halimium halimifolium, Lavandula luisieri* and *Thymus mastichina*. *Lithodora prostrata* obtained very poor results using this method.

In analysis of the different tried cuttings, we can say that the softwood cuttings showed better rooting capacity, followed by the semi-hardwood and at last by the hardwood cuttings. However the rooting capacity depends on the type of cutting, and is affected by several factors, such as the: physiological stage of the mother plant, season, concentration and type of rooting hormones, environment conditions where the rooting takes place, etc.

The utilization of auxinic treatment (ANA + IBA) increased the root cutting and obtained best results using a high concentration (4000ppm).

TASK 2. – GROWING TECHNIQUES FOR NURSERY CONDITIONS

Task 2.1. – Morphological, phenological and horticultural response of the selected species under various growing conditions

The species *Argyranthemum maderense, Centranthus rubber, Euphorbia characias, Genista thyrrenea* and *Limonium sinense* showed the best development (the highest values for all parameters: canopy perimeter, plant height, shoot length and number of nodes of secondary and tertiary shoots) in the greenhouse. On the other hand, the shade frame environment was most favourable to the development of the species: *Ebenus cretica, Lavandula stoechas, Lotus creticus creticus* and *Spartium junceum.* The other species (*Cistus creticus, Helychrisum graecum, Lotus creticus cytisoides* and *Vitex agnus castus*) showed a similar growth in the greenhouse and on shade frame.

In open air all the species shower a slower growth rate than in the greenhouse and shade frame, but had a higher ornamental look (canopys more compacts and branching) and was healthier (lower number of plagues and diseases).

Generally, exposing the species to an inferior temperature in the greenhouse resulted in a higher growth rate. By increasing the temperature we observed a higger development of the plants in open air and shade frame. But when the temperature was too high the plant development started to slow down.

The species *Argyranthemum coronopifolium, Argyranthemum maderense, Euphorbia characias, Lavandula stoechas* and *Lotus creticus creticus* blooms in the Winter, during three to four months. One other group, formed by *Centhranthus rubber, Cistus creticus, Ebenus cretica, Genista thyrranea, Helychrisum graecum, Limonium sinense, Lotus creticus cytisoide* and*, Spartium junceum* blooms later, in the Spring, for more or less three months, except for *Centranthus rubber* and *Limonium sinense* that were in bloom for four or five months.

Task 2.2. - Techniques for building the appropriate plant structure

The growth regulators Cultar, CCC and B-Nine shown efficienty, because the treated plants were shorter (little canopy perimeter, small plant height and small length of secondary shoot) than the plant test. From the three growth regulators, Cultar has shown to be the most effective in vegetative growth control of the species in study.

One year after the application of growth regulators (Cultar, CCC and B-Nine) its effect was still felt in plants, these showing inferior values than the test.

None of Cultar concentrations has proven to be optimal, being the results similar in the different concentrations. *Lavandula luisieri* was the only specie that showed proportionality between the applied concentration and the plant effect, being the best concentration the 5ml/l of Cultar.

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ANNEX

ANNEX I – RESULTS OF SEED PROPAGATION

Fig.1 - *Thymus mastichina*

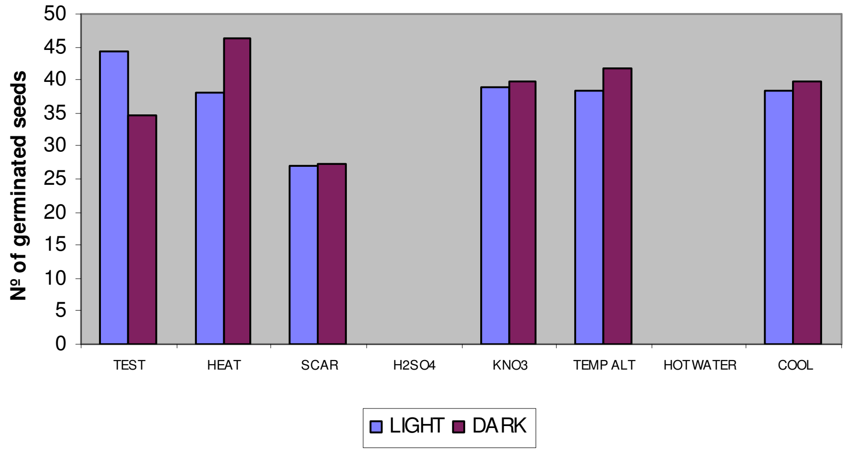


Fig.2 - *Lavandula luisieri*

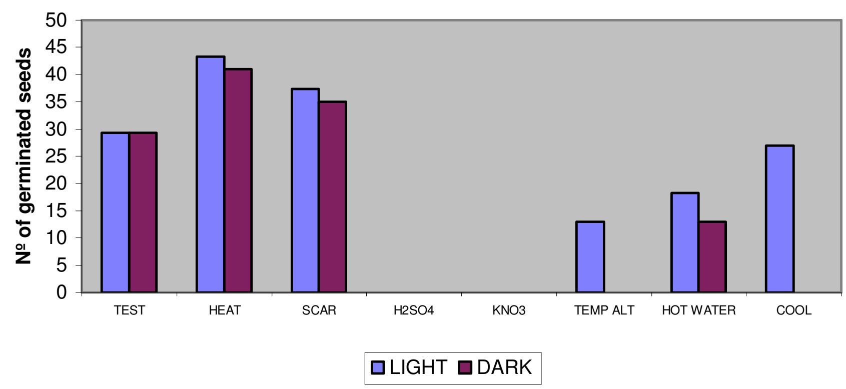


Fig.3 - *Cistus monspeliensis*

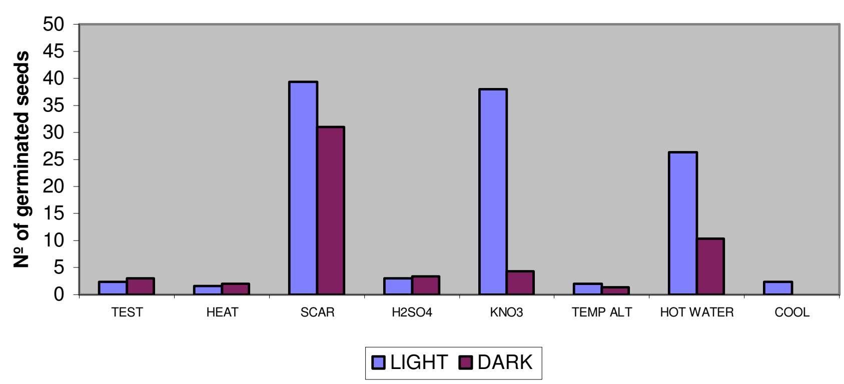


Fig.4 - *Halimium halimifolium*

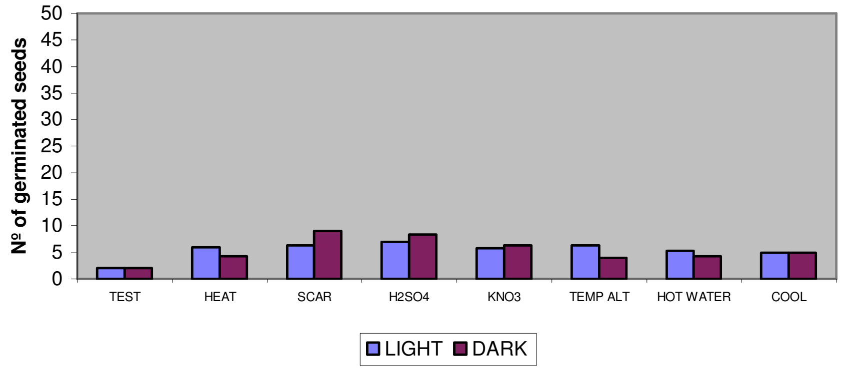
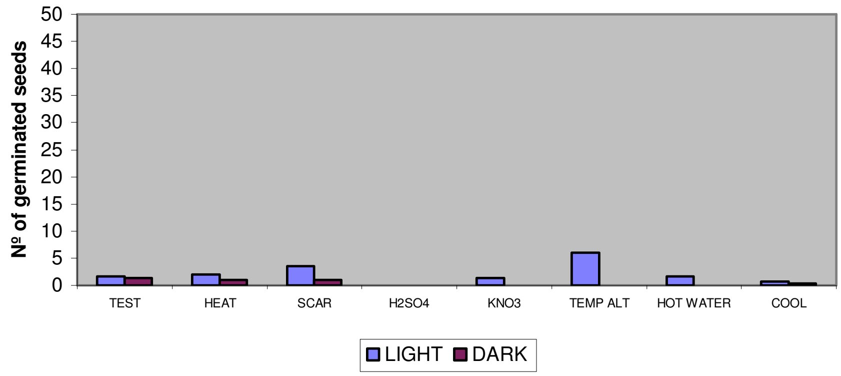
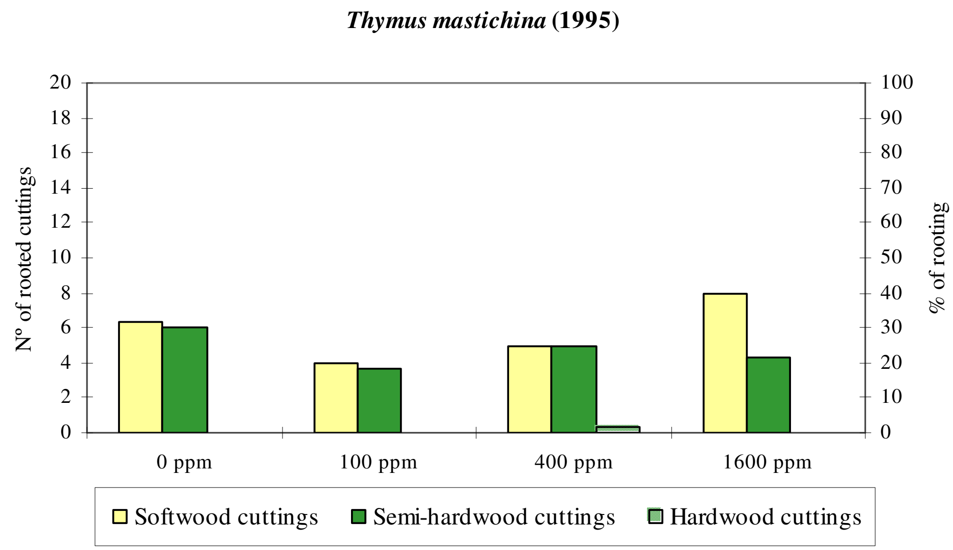
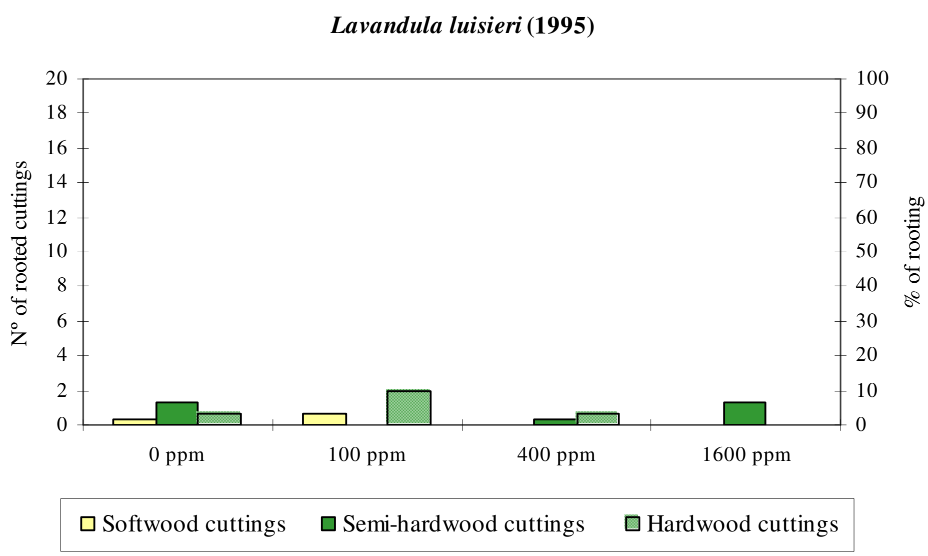


Fig.5 - *Lithodora prostrata*

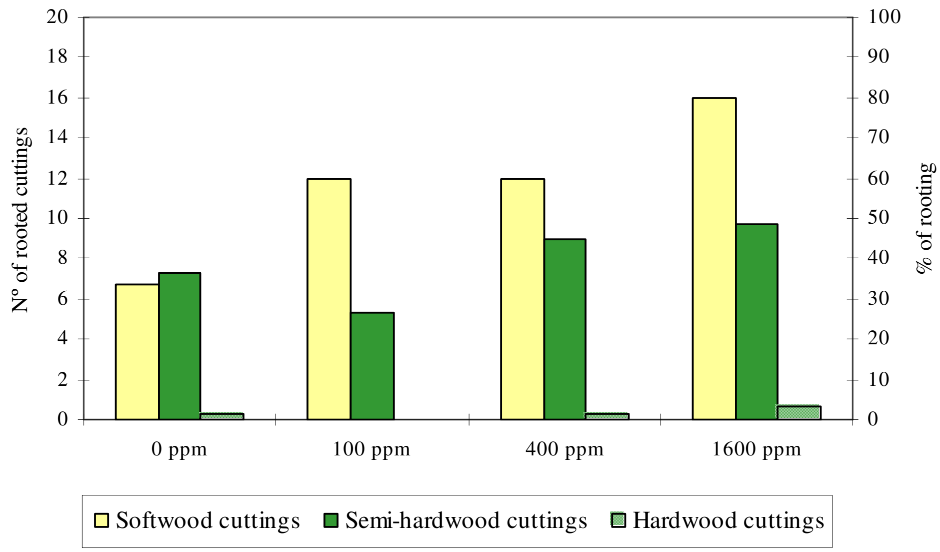


ANNEX II (I)– RESULTS OF CUTTING PROPAGATION (1995)

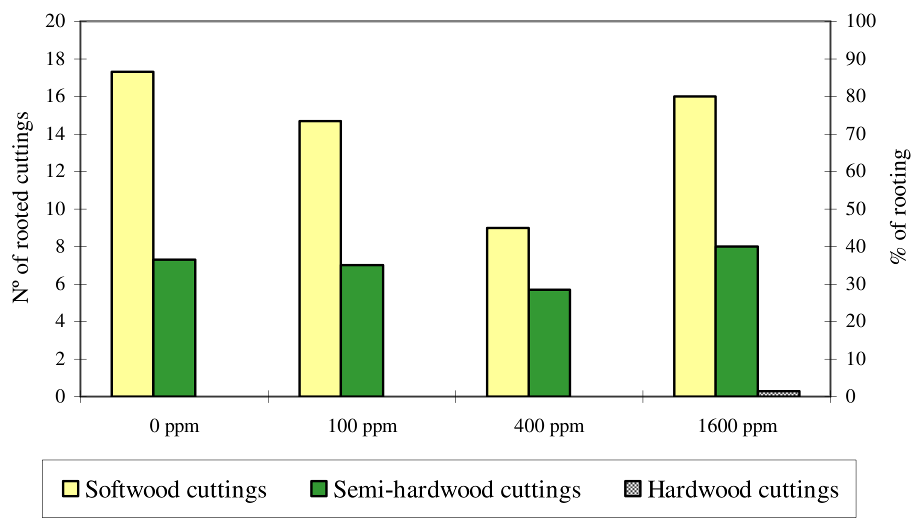




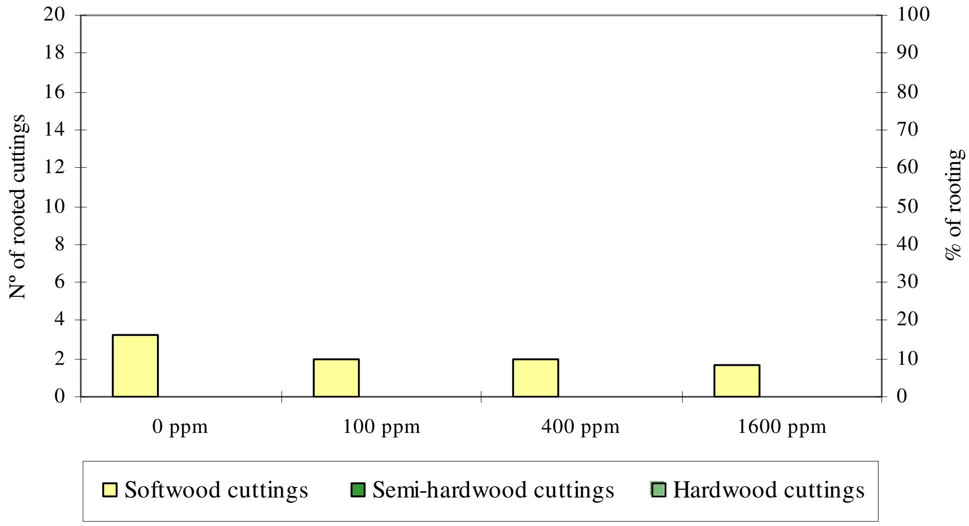
***Cistus monspeliensis* (1995)**



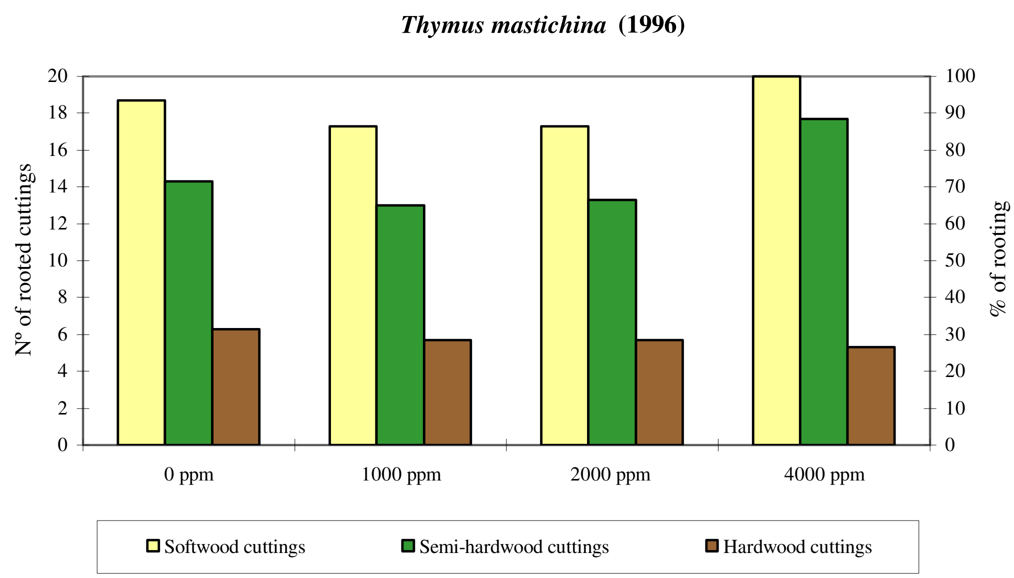
***Halimium halimifolium* (1995)**

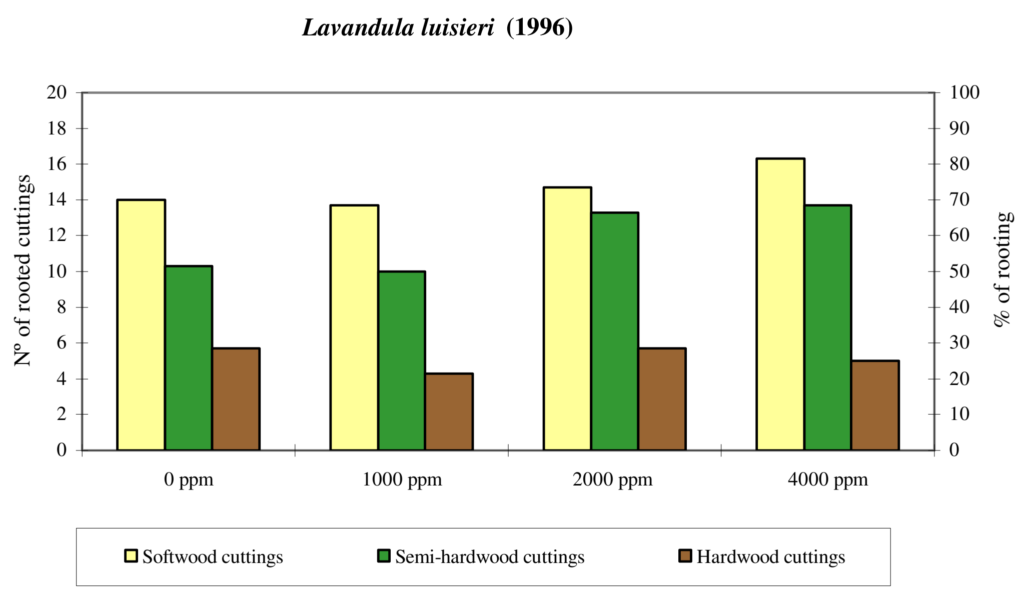


***Lithodora prostrata* (1995)**

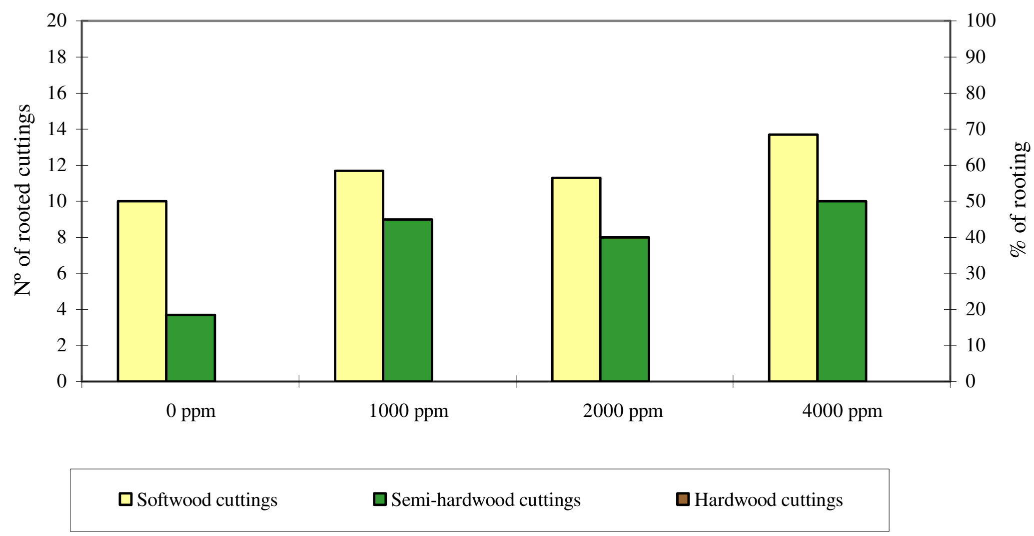


ANNEX II(II) – RESULTS OF CUTTING PROPAGATION (1996)

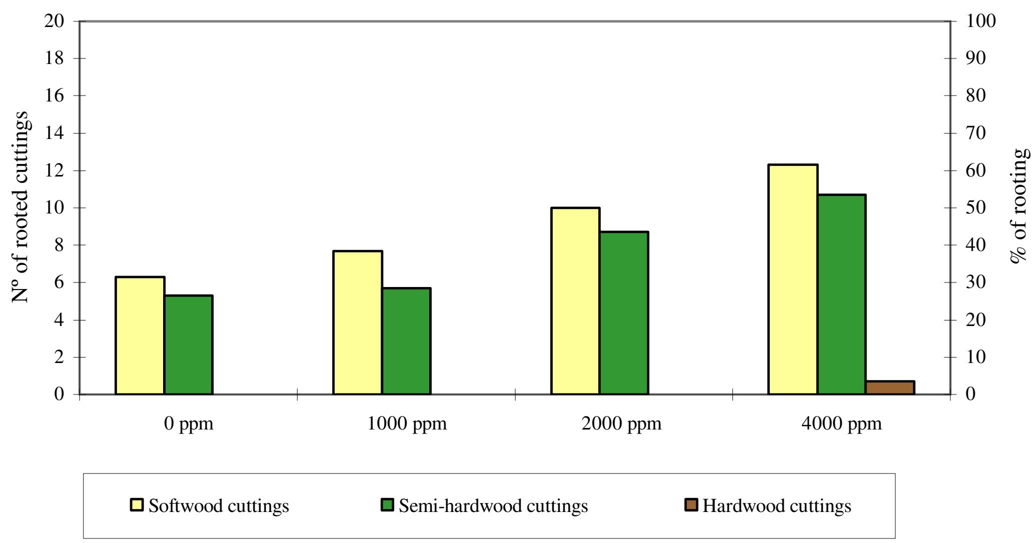


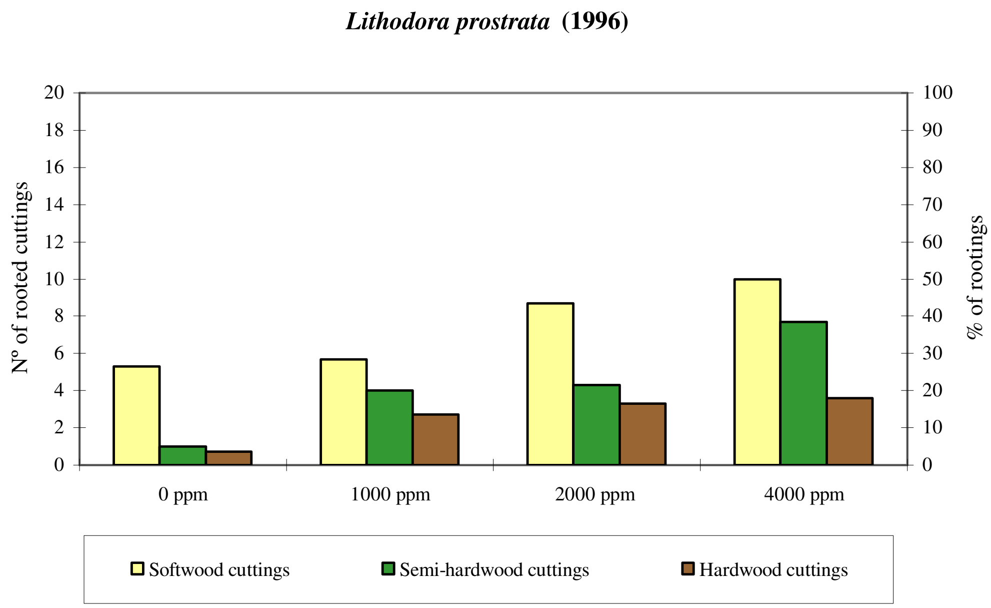


***Cistus monspeliensis* (1996)**

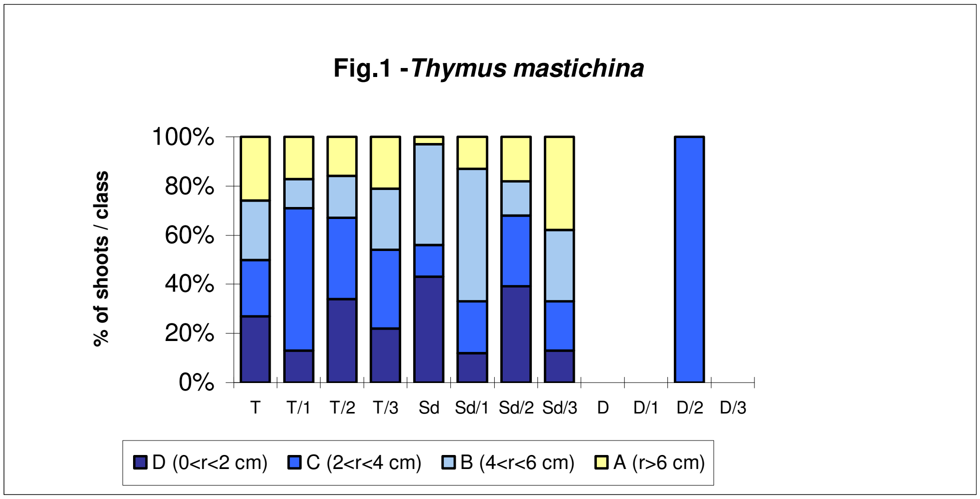


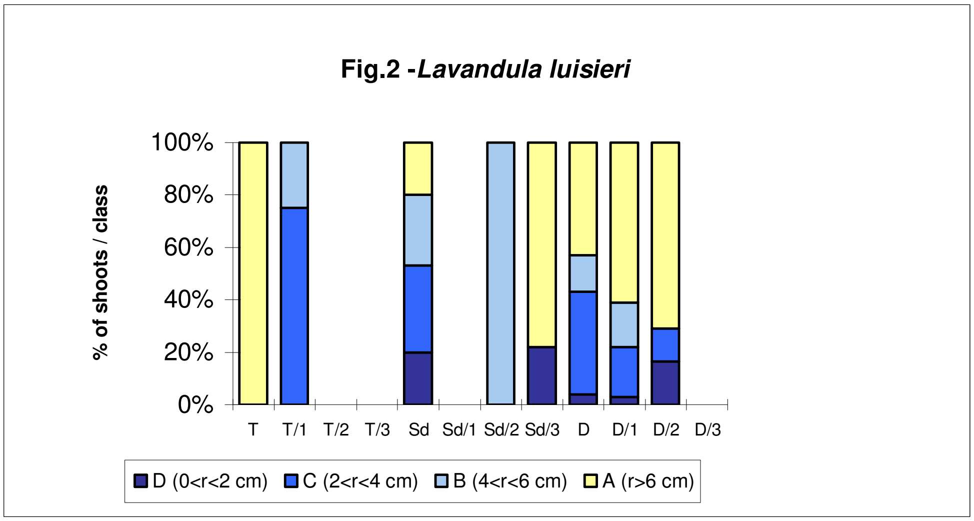
***Halimium halimifolium* (1996)**




Lithodora prostrata (1996)
Nº of rooted cuttings
% of rootings
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100
0 ppm
1000 ppm
2000 ppm
4000 ppm
Softwood cuttings
Semi-hardwood cuttings
Hardwood cuttings

ANNEX II(III) – SHOOT LENGTH OF CUTTINGS





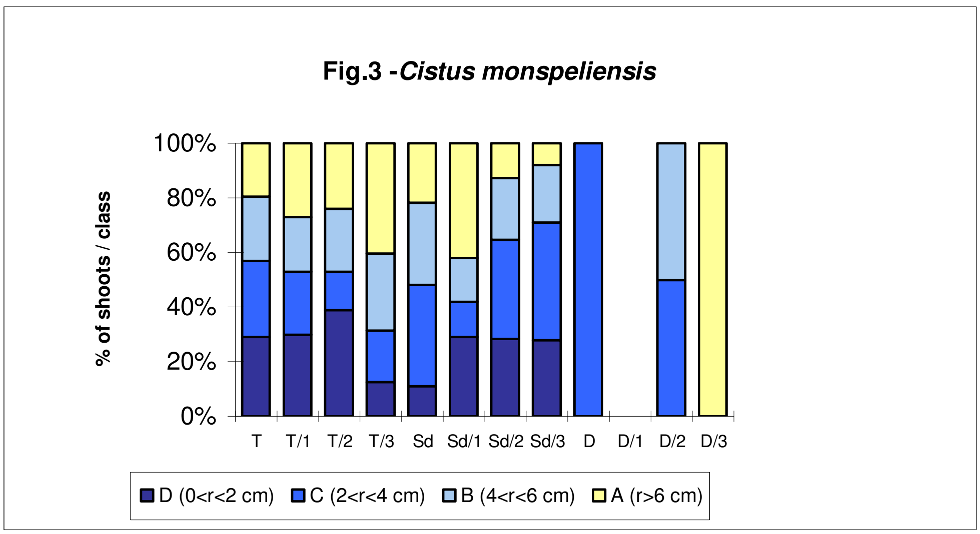


Fig.4 -*Halimium halimifolium*

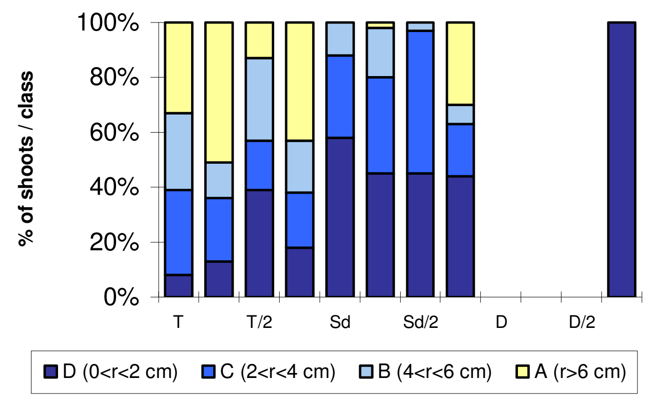
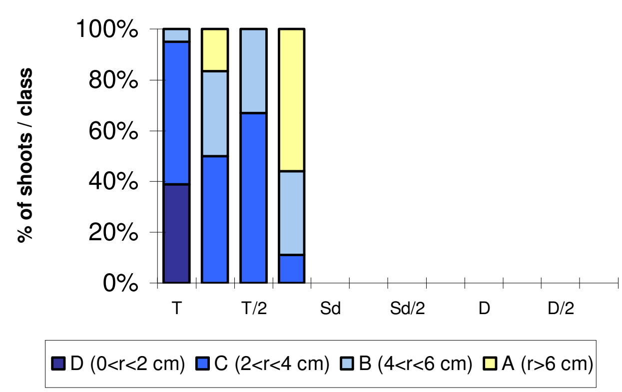


Fig.5 -*Lithodora prostrata*



ANNEX III – MORPHOLOGICAL OBSERVATIONS IN THREE ENVIRONMENTS

Lavandula luisieri (Tab.1)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Jun 96	GH	88.8+2.0	42.2+3.4	12.0+1.4	*		
	SF	79.0+6.9	41.2+2.2	10.8+1.5			
	OA	69.3+5.4	37.3+3.6	10.0+1.7			
Jan 97	GH	94.7+3.4	54.5+2.6	15.7+1.7	*		
	SF	86.2+3.5	44.7+4.1	11.5+1.3			
	OA	74.7+3.8	41.2+3.0	10.5+1.3			
Jun 97	GH	120.5+7.1	65.7+3.8	19.7+1.5	13.2+1.5		
	SF	107.0+10.1	48.7+5.3	12.5+1.0	12.2+2.6		
	OA	87.0+4.2	46.5+3.1	12.0+1.8	11.7+1.0		
Set 97	GH	135.7+3.8	69.2+3.8	22.7+2.2	17.2+2.2		
	SF	110.0+7.1	51.2+3.0	13.7+1.7	15.0+2.9		
	OA	99.5+4.2	49.0+4.2	12.1+1.7	13.2+1.7		
Dec 97	GH	142.5+4.5	74.2+4.3	27.2+2.2	21.0+1.8		
	SF	114.5+5.5	56.3+3.4	16.0+1.8	19.7+1.7		
	OA	103.7+3.5	55.0+3.7	14.2+1.3	15.0+2.2		
Mar 98	GH	151.5+2.7	87.0+5.3	34.7+2.5	28.7+4.9	12.7+2.5	26.0+2.9
	SF	140.7+4.3	62.5+3.7	23.2+3.8	26.0+3.6	10.7+3.8	24.2+2.9
	OA	108.7+3.0	57.0+3.2	15.7+1.7	20.5+3.4	3.9+0.8	11.7+1.7
Jun 98	GH	164.5+7.1	92.5+4.9	37.0+3.4	31.0+1.8	18.0+2.8	30.0+3.6
	SF	170.8+5.8	74.5+6.6	32.8+5.3	28.8+3.0	18.8+2.5	28.0+3.3
	OA	154.3+7.7	59.5+5.6	44.0+4.5	51.5+3.4	11.5+2.6	17.3+2.6

* Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

Cistus monspeliensis (Tab.2)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Jun 96	GH	88.7+6.7	33.3+3.4	21.8+2.6	*		
	SF	81.3+2.3	29.5+3.7	16.2+2.6			
	OA	73.3+4.4	24.7+1.2	14.2+2.1			
Jan 97	GH	92.2+2.5	39.0+2.2	23.2+1.7	*		
	SF	95.0+5.7	40.5+3.3	18.4+2.6			
	OA	88.5+7.5	32.0+2.8	15.5+2.1			
Jun 97	GH	125.7+5.3	53.0+8.5	33.5+2.9	12.0+2.8		
	SF	109.2+8.3	45.2+5.2	22.0+3.2	14.0+2.9		
	OA	102.2+8.8	35.7+5.6	17.0+1.7	9.2+1.9		
Set 97	GH	147.5+6.4	78.5+5.1	39.5+3.0	16.5+2.5		
	SF	121.2+4.6	49.5+3.3	23.2+2.7	19.5+1.7		
	OA	105.5+5.4	38.0+3.6	19.5+2.6	12.5+1.7		
Dec 97	GH	168.0+5.9	81.2+3.0	43.5+3.1	20.0+2.8		
	SF	129.5+4.2	57.7+3.9	29.0+2.6	23.5+2.6		
	OA	108.2+3.9	47.2+5.4	23.5+2.6	16.0+2.5		
Mar 98	GH	192.0+6.8	91.5+6.6	51.5+2.9	26.5+3.4	16.0+4.7	10.0+1.8
	SF	154.0+5.9	63.7+4.8	38.7+3.0	30.2+3.4	13.7+2.2	18.0+2.4
	OA	117.5+4.9	49.5+4.2	25.2+2.5	19.7+2.5	1.7+0.5	4.0+1.4
Jun 98	GH	207.0+6.2	103.0+7.7	54.0+5.3	32.3+3.6	17.5+3.9	12.0+1.8
	SF	190.0+7.1	67.8+7.5	41.3+5.7	33.3+3.6	18.5+2.4	24.0+3.2
	OA	137.0+6.8	53.0+4.2	40.3+4.3	37.0+3.2	15.8+2.9	21.5+2.6

* Experimental error.

Thymus mastichina (Tab.3)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Jun 96	GH	80.0+3.4	26.3+2.7	21.5+2.1	*		
	SF	65.8+5.4	28.8+4.3	19.8+2.1	*		
	OA	67.5+4.8	26.3+1.2	18.5+2.1	*		
Jan 97	GH	90.2+4.1	29.7+3.9	24.2+2.7	*		
	SF	91.2+7.2	31.1+2.7	22.4+2.7	*		
	OA	72.7+3.6	27.5+3.8	20.5+2.6	*		
Jun 97	GH	155.0+9.1	43.0+4.8	32.0+2.8	29.2+2.7		
	SF	135.0+7.1	39.2+4.3	26.2+3.3	21.0+1.8		
	OA	88.5+5.2	31.5+1.3	24.2+3.3	21.5+2.4		
Set 97	GH	168.7+7.2	47.2+4.6	36.2+2.1	32.2+3.1		
	SF	145.0+7.0	41.2+3.9	28.0+2.2	24.2+1.7		
	OA	91.0+4.5	33.5+4.6	25.7+3.3	23.7+1.7		
Dez 97	GH	177.0+5.0	51.2+3.0	40.0+2.8	39.7+1.7		
	SF	149.7+4.6	47.7+4.8	30.0+3.7	27.2+3.3		
	OA	100.0+4.3	36.7+2.4	27.0+2.4	24.7+1.3		
Mar 98	GH	187.0+4.7	56.0+2.9	42.5+3.7	49.2+5.8	18.0+4.3	22.7+4.9
	SF	170.2+6.8	54.0+4.3	34.5+4.2	38.0+4.5	11.0+0.8	17.5+4.2
	OA	109.2+3.8	38.2+4.0	30.5+2.1	31.2+4.0	4.2+1.3	15.5+2.9
Jun 98	GH	195.3+6.0	59.3+5.1	46.0+5.5	52.8+4.1	26.5+3.7	27.5+3.3
	SF	206.3+6.2	64.8+6.4	50.5+5.0	46.8+5.0	27.5+4.0	19.8+3.3
	OA	167.8+5.3	44.3+4.2	44.5+4.9	42.3+4.3	15.3+3.0	16.5+2.6

* Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

Halimium halimifolium (Tab.4)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Jun 96	GH	70.7+6.0	18.7+1.4	15.0+1.4	*		
	SF	67.8+2.9	17.7+1.6	14.3+2.4	*		
	OA	66.3+5.2	16.8+2.4	12.0+1.4	*		
Jan 97	GH	80.5+8.4	25.7+1.7	16.0+1.4	*		
	SF	80.2+5.0	25.5+2.4	14.7+2.1	*		
	OA	78.7+7.8	26.7+3.0	13.6+1.7	*		
Jun 97	GH	116.2+4.8	58.2+4.3	29.5+2.9	11.5+1.0		
	SF	99.0+7.0	37.5+2.1	20.1+1.8	11.2+1.0		
	OA	85.2+5.7	39.5+3.5	19.2+3.2	6.7+2.1		
Set 97	GH	126.7+7.0	71.7+3.9	36.2+2.7	14.5+1.7		
	SF	106.0+8.8	42.7+3.9	24.5+1.3	13.0+1.8		
	OA	90.5+7.0	41.2+3.0	20.7+3.0	11.0+1.8		
Dez 97	GH	129.0+5.0	80.0+2.2	38.7+3.0	25.5+2.5		
	SF	116.2+3.5	51.2+3.0	28.5+3.1	16.0+1.8		
	OA	92.2+5.3	44.7+3.4	22.5+2.6	14.0+1.4		
Mar 98	GH	139.5+4.2	85.2+3.3	44.5+4.2	30.0+3.6	14.7+2.5	14.7+2.7
	SF	123.2+7.7	53.5+2.9	34.2+4.3	22.5+4.2	13.2+2.7	9.5+1.9
	OA	104.7+5.2	46.2+3.0	24.2+2.6	16.2+2.5	2.7+1.0	5.0+0.8
Jun 98	GH	147.8+6.5	89.0+5.3	48.5+5.0	34.8+4.3	18.0+2.7	18.0+3.2
	SF	144.8+4.8	62.0+5.7	39.5+5.5	27.8+4.5	17.3+3.0	12.8+1.7
	OA	125.8+5.6	51.8+5.6	27.5+5.0	19.0+2.9	11.5+1.9	13.3+1.7

* Experimental error.

Lithodora prostrata (Tab.5)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Jun 96	GH	*	*	*	*		
	SF						
	OA						
Jan 97	GH	*	*	*	*		
	SF						
	OA						
Jun 97	GH	73.2+4.6	26.5+3.1	10.0+2.9	14.5+2.9		
	SF	56.2+4.3	30.7+3.4	7.9+2.8	14.0+1.8		
	OA	39.0+2.6	22.5+2.4	7.5+1.3	13.7+2.2		
Set 97	GH	93.2+5.4	33.7+3.5	15.7+1.7	18.3+2.1		
	SF	67.5+6.4	41.2+3.0	12.7+1.0	15.0+1.4		
	OA	45.7+4.3	32.0+3.6	12.0+1.6	14.0+1.4		
Dez 97	GH	96.2+3.5	36.2+3.5	19.0+2.6	21.0+1.7		
	SF	73.7+3.5	46.5+2.6	15.2+2.7	16.5+2.4		
	OA	47.2+2.2	33.0+3.0	14.2+1.7	15.5+1.7		
Mar 98	GH	101.5+6.6	40.7+3.0	23.2+2.7	25.7+3.5	4.7+1.0	11.2+2.2
	SF	98.2+7.7	56.5+3.1	19.5+2.6	24.2+3.3	2.5+0.6	4.2+1.3
	OA	52.0+3.6	37.0+2.6	18.5+4.4	22.0+2.9	2.0+0.8	7.2+1.7
Jun 98	GH	111.3+7.4	43.8+4.8	26.3+3.5	38.8+3.9	6.8+1.3	13.5+2.1
	SF	113.3+7.1	65.5+4.4	30.5+5.5	28.3+3.6	13.0+2.2	24.3+2.6
	OA	64.3+5.4	41.0+5.0	20.5+5.3	29.5+3.7	10.8+1.7	14.5+2.6

* Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

Lotus cytisoides (Tab.6)

Date	ENV	Perimeter (cm)	Sec.shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	260.0 + 14.1	*	*		
	SF	256.0+9.4	*	*		
	OA	220.7+7.6	10.9+0.7	11.5+1.9		
May 97	GH	272.5+9.6	15.9+2.5	10.5+1.3		
	SF	259.5+5.9	19.5+3.3	12.5+1.7		
	OA	230.7+6.5	13.0+1.2	11.7+1.7		
Aug 97	GH	280.0+10.8	36.2+3.9	24.7+2.9		
	SF	309.5+10.0	31.2+2.2	31.2+2.2		
	OA	232.5+8.9	33.7+3.9	29.5+3.5		
Nov 97	GH	282.5+10.4	49.7+5.7	25.5+4.0		
	SF	314.5+8.7	44.2+3.0	34.2+2.6		
	OA	243.2+4.8	35.7+3.8	30.7+3.8		
Feb 98	GH	297.5+6.4	61.2+6.1	31.5+5.2	18.7+2.7	11.5+2.4
	SF	318.0+6.8	54.5+4.0	35.7+3.9	17.0+2.9	11.0+1.8
	OA	248.2+7.0	45.5+4.4	38.2+2.1	9.0+2.2	9.7+1.3
May 98	GH	306.8+6.1	63.3+5.0	34.3+4.8	37.5+2.9	18.8+3.1
	SF	345.5+5.8	66.5+4.8	44.8+4.6	32.5+1.3	20.0+1.8
	OA	275.8+7.1	60.8+5.2	49.0+5.3	14.3+2.2	17.8+3.3

*Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

Lotus creticus (Tab.7)

Date	ENV	Perimeter (cm)	Sec.shoot (cm)	Nºnodes	Thir.shoot. (cm)	Nºnodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	165.0+10.0	*	*		
	SF	261.2+4.8	*	*		
	OA	139.2+14.2	13.6+0.2	11.7+1.0		
May 97	GH	168.0+10.5	14.6+3.9	7.0+1.4		
	SF	264.5+4.9	18.4+3.8	12.0+1.8		
	OA	178.2+7.7	14.5+2.9	11.2+2.2		
Aug 97	GH	176.0+8.5	29.5+3.4	19.0+2.2		
	SF	272.5+9.0	28.5+3.3	27.5+2.5		
	OA	199.0+10.4	23.5+3.7	23.5+3.7		
Nov 97	GH	183.0+9.1	31.5+2.4	20.2+2.1		
	SF	279.2+9.3	32.2+2.5	28.2+2.4		
	OA	205.7+6.4	29.0+2.9	26.7+5.7		
Feb 98	GH	192.0+6.8	42.2+6.2	23.5+2.4	22.2+2.2	19.0+2.2
	SF	291.2+8.5	48.7+6.4	31.0+2.9	21.0+2.2	9.0+0.8
	OA	218.0+5.4	38.0+2.9	28.7+4.2	5.7+2.4	4.7+1.0
May 98	GH	197.0+7.2	44.5+5.3	26.0+3.6	40.5+2.9	19.0+3.2
	SF	323.0+8.4	65.8+7.6	38.3+5.1	36.8+2.6	12.0+2.9
	OA	232.3+6.3	42.3+5.3	34.3+5.1	13.0+2.2	10.5+2.4

*Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

Centranthus ruber (Tab.8)

Date	ENV	Perimeter (cm)	Sec.shoot (cm)	Nºnodes	Thir.shoot. (cm)	Nºnodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	177.5+5.0	16.9+4.2	7.2+1.7		
	SF	118.5+16.2	16.4+3.7	9.2+1.7		
	OA	118.0+16.8	10.0+1.8	12.7+2.9		
May 97	GH	242.7+9.6	31.2+3.8	15.5+2.4		
	SF	212.5+10.0	35.0+4.1	21.0+2.2		
	OA	241.7+10.7	29.2+3.0	18.2+2.9		
Aug 97	GH	293.7+7.5	66.5+5.1	26.2+2.6		
	SF	242.7+10.9	36.5+3.7	31.7+3.9		
	OA	245.5+6.4	30.2+3.4	21.2+2.2		
Nov 97	GH	301.5+9.3	75.2+5.8	31.2+5.2		
	SF	250.5+8.2	50.2+6.4	35.2+4.1		
	OA	254.0+5.3	30.7+3.0	23.5+3.1		
Feb 98	GH	316.2+7.7	91.2+3.5	34.0+1.8	14.7+2.6	8.7+2.1
	SF	254.5+6.6	60.0+3.7	40.5+3.1	11.7+4.0	6.7+0.5
	OA	257.5+5.6	40.2+3.1	29.7+3.1	7.7+3.6	7.0+2.2
May 98	GH	323.0+6.3	96.3+5.8	40.0+5.2	44.0+2.9	18.0+2.5
	SF	274.5+7.3	76.0+9.8	45.0+5.6	41.3+2.6	16.8+1.9
	OA	303.3+8.9	66.0+5.7	34.3+4.6	16.3+2.6	11.5+2.4

GH - Greenhouse SF - Shade frame OA - Open air

Limonium sinense (Tab.9)

Data	ENV	Perimeter (cm)	Nº flo.stem	Height (cm)
		mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	119.2+7.2	0	0
	SF	101.2+15.4	0	0
	OA	79.5+15.7	0	0
May 97	GH	121.0+8.2	0	0
	SF	107.7+10.4	4.7+1.0	62.7+6.6
	OA	58.0+10.0	4.0+1.5	21.3+4.1
Aug 97	GH	140.5+9.1	0	0
	SF	113.2+7.9	4.7+1.0	66.5+6.0
	OA	62.2+6.8	7.0+1.6	23.3+3.0
Nov 97	GH	158.5+8.7	0	0
	SF	117.2+6.9	0	0
	OA	73.2+6.6	0	0
Feb 98	GH	160.2+6.8	0	0
	SF	118.2+6.8	0	0
	OA	76.7+3.6	0	0
May 98	GH	172.5+7.6	10.8+0.5	68.2+15.5
	SF	126.3+7.7	0	0
	OA	99.3+7.4	5.3+3.8	60.1+12.4

Spartium junceum (Tab.10)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	207.5+17.1	98.7+8.2	30.5+3.0	3.7+0.5		
	SF	258.7+19.3	122.0+8.0	17.5+1.0	5.5+1.3		
	OA	218.7+17.5	73.2+7.7	13.9+2.5	3.5+0.6		
May 97	GH	255.2+11.0	103.7+6.3	31.2+1.5	7.7+1.5		
	SF	260.2+6.3	129.5+9.5	31.5+3.5	7.0+1.4		
	OA	222.5+9.3	77.0+10.1	14.7+4.0	5.5+1.7		
Aug 97	GH	260.5+10.0	115.2+10.5	50.5+6.0	8.2+2.6		
	SF	275.5+10.9	134.0+7.2	45.0+5.3	11.2+2.2		
	OA	247.2+8.5	83.2+8.5	19.2+2.2	6.7+1.7		
Nov 97	GH	265.0+9.1	117.0+9.6	53.2+5.4	11.2+2.6		
	SF	277.7+8.8	136.7+6.7	47.5+3.1	11.7+2.4		
	OA	257.7+6.1	94.5+6.4	31.5+2.4	11.2+1.5		
Feb 98	GH	285.0+7.0	140.0+4.1	68.5+6.6	15.5+3.4	35.5+3.1	6.2+1.5
	SF	299.0+7.4	144.2+6.5	58.5+4.6	18.5+4.4	26.0+3.6	9.7+1.5
	OA	264.2+5.7	102.2+6.0	38.0+5.3	13.2+3.0	4.5+1.9	3.0+0.8
May 98	GH	290.3+7.5	143.5+6.2	70.3+6.2	18.8+3.0	40.0+2.9	19.0+1.8
	SF	343.3+7.0	149.8+4.6	64.3+4.3	20.5+3.7	51.0+3.5	19.5+2.6
	OA	335.3+5.6	119.5+5.2	63.5+5.4	19.0+4.2	35.3+1.7	15.8+1.9

GH - Greenhouse SF - Shade frame OA - Open air

Genista thyrrena (Tab.11)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	171.0+13.7	62.1+8.6	19.1+3.0	19.5+2.4		
	SF	104.5+12.8	54.2+6.5	16.0+2.5	17.7+2.1		
	OA	113.5+17.7	41.2+7.9	14.8+2.1	10.0+1.4		
May 97	GH	240.0+11.4	79.5+9.7	31.2+3.3	22.5+2.4		
	SF	212.5+11.0	98.0+6.7	29.2+3.8	18.5+2.6		
	OA	129.7+4.6	69.5+4.8	17.6+3.4	10.7+2.2		
Aug 97	GH	256.2+8.3	85.0+8.5	47.5+4.6	25.0+2.2		
	SF	239.0+9.9	105.2+10.4	36.7+5.4	20.2+2.6		
	OA	161.7+7.4	75.2+8.5	19.2+1.9	11.2+2.2		
Nov 97	GH	262.5+9.6	114.2+7.1	48.2+4.1	25.8+2.5		
	SF	259.0+7.8	111.7+13.1	44.0+3.6	24.5+2.4		
	OA	169.2+7.9	80.0+9.1	21.7+2.4	11.7+2.4		
Feb 98	GH	271.5+7.8	120.5+4.2	59.5+5.4	44.0+3.6	19.7+1.5	15.0+1.4
	SF	262.0+6.8	116.2+7.5	58.0+4.8	43.0+2.2	26.0+4.5	15.5+2.5
	OA	173.5+5.5	85.5+6.6	26.2+6.2	14.2+2.9	9.7+2.6	6.2+0.9
May 98	GH	273.5+6.0	124.0+5.3	61.5+4.8	45.5+3.7	22.3+2.7	17.5+3.3
	SF	265.8+5.3	121.3+6.9	68.0+4.7	45.8+3.5	36.3+3.3	19.3+2.2
	OA	230.5+8.1	101.0+5.3	65.5+6.0	38.3+5.6	26.5+2.6	13.5+1.3

GH - Greenhouse SF - Shade frame OA - Open air

Euphorbia characias (Tab.12)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº sec.shoot	Thir. Shoot (cm)	Nº thir.shoot
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	59.7+5.5	67.7+8.1	28.7+2.7	4.5+1.3		
	SF	57.0+18.0	50.7+8.4	22.4+1.2	3.5+0.6		
	OA	51.7+17.2	40.5+6.8	20.2+2.1	5.2+2.1		
May 97	GH	88.0+6.4	69.2+7.1	37.1+3.9	4.5+1.3		
	SF	67.2+3.2	55.7+7.8	33.4+3.6	4.0+0.8		
	OA	63.2+8.8	45.2+3.3	24.5+2.0	6.0+1.4		
Aug 97	GH	94.7+7.1	70.7+6.5	50.0+5.1	5.0+0.8		
	SF	74.0+6.7	67.0+6.6	41.2+4.0	4.2+1.5		
	OA	69.7+3.7	54.2+5.1	25.7+3.4	6.2+1.9		
Nov 97	GH	99.2+11.9	83.7+11.1	64.7+10.8	5.0+0.8		
	SF	78.0+5.9	83.0+4.7	43.7+4.8	4.2+1.5		
	OA	70.5+2.9	55.0+4.1	28.7+3.5	6.2+1.9		
Feb 98	GH	113.7+6.2	96.0+6.6	75.5+10.7	2.0+0.8	10.2+5.2	6.0+4.1
	SF	81.7+7.0	92.5+5.0	40.4+10.7	3.0+1.1	12.7+6.0	0.7+0.9
	OA	72.5+2.1	63.0+5.3	27.5+10.8	4.5+0.6	8.2+1.1	0.5+1.0
May 98	GH	167.0+6.8	102.8+7.6	49.4+13.3	5.5+2.5	15.7+8.2	18.0+5.5
	SF	87.5+6.6	94.5+3.7	39.2+7.7	3.0+1.1	15.8+6.0	3.3+3.4
	OA	81.0+6.5	65.3+4.6	27.1+8.4	4.5+0.6	8.5+1.0	1.0+1.1

GH - Greenhouse SF - Shade frame OA - Open air

Cistus creticus (Tab.13)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	85.0+8.1	40.5+7.6	25.7+2.9	6.0+1.4		
	SF	102.0+12.3	41.0+6.2	13.5+3.5	7.2+1.7		
	OA	73.0+16.4	30.2+6.8	7.5+1.7	7.0+0.8		
May 97	GH	87.0+10.4	47.0+8.8	29.1+1.0	6.7+1.7		
	SF	107.2+3.2	51.5+8.4	19.9+1.3	8.7+2.4		
	OA	78.5+6.6	40.0+7.8	12.2+2.8	8.0+1.6		
Aug 97	GH	118.0+6.8	85.5+6.6	31.5+3.7	12.5+2.6		
	SF	138.7+9.5	62.0+7.4	28.7+2.6	13.2+2.2		
	OA	98.7+8.5	47.0+5.0	16.2+2.2	14.5+3.0		
Nov 97	GH	129.0+7.3	103.0+6.8	46.7+5.7	24.5+3.3		
	SF	154.7+9.5	65.0+7.1	31.0+3.7	15.5+1.7		
	OA	99.7+7.8	49.2+4.3	18.5+1.9	15.2+3.3		
Feb 98	GH	142.7+5.2	107.7+5.3	65.0+6.8	34.5+4.4	13.7+3.3	14.5+2.4
	SF	185.0+7.0	69.5+4.4	45.5+3.8	24.7+5.2	19.7+5.4	16.2+1.9
	OA	101.7+6.2	51.5+2.6	24.2+4.4	18.0+2.9	4.2+1.5	5.0+2.2
May 98	GH	154.8+6.9	111.8+8.3	71.3+4.8	40.0+5.1	20.8+3.0	19.0+1.8
	SF	195.8+8.1	72.0+3.2	48.0+4.7	27.3+4.4	21.8+2.7	19.5+2.6
	OA	112.3+6.8	54.3+5.0	34.3+4.3	25.5+3.4	14.8+2.1	15.8+1.9

GH - Greenhouse SF - Shade frame OA - Open air

Lavandula stoechas (Tab.14)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	97.0+8.5	44.0+7.8	26.6+2.6	12.5+1.3		
	SF	93.0+12.2	42.5+3.8	12.9+1.9	11.5+1.7		
	OA	73.0+10.4	32.0+3.6	11.2+1.5	11.5+1.3		
May 97	GH	103.2+11.3	63.0+6.7	27.5+1.5	13.2+1.9		
	SF	182.5+9.9	67.0+12.1	17.5+2.6	15.7+2.2		
	OA	106.5+12.9	48.0+9.8	16.1+2.8	15.0+2.6		
Aug 97	GH	129.0+8.2	65.7+5.3	29.0+2.5	24.7+2.9		
	SF	207.7+9.0	69.2+4.8	25.6+2.8	26.0+4.1		
	OA	119.5+8.0	49.0+6.7	17.2+2.6	15.7+2.1		
Nov 97	GH	132.2+5.6	68.0+5.7	31.0+1.5	27.5+3.1		
	SF	217.0+9.3	72.2+5.9	30.2+3.7	27.0+4.8		
	OA	139.2+8.5	50.2+6.1	18.2+3.3	17.0+3.7		
Feb 98	GH	156.2+4.8	72.0+3.7	48.2+6.2	41.5+5.4	12.0+2.9	22.0+2.2
	SF	240.7+4.3	75.5+5.5	44.2+5.7	49.0+5.9	14.7+0.5	26.2+1.5
	OA	152.7+7.4	59.0+6.0	30.0+5.3	30.0+5.3	3.5+1.3	11.7+2.5
May 98	GH	175.3+7.5	75.5+5.6	50.5+5.9	44.0+5.0	17.5+2.1	27.5+1.7
	SF	276.0+6.7	82.3+5.9	50.0+3.6	52.3+4.4	15.0+2.2	29.0+2.6
	OA	160.5+7.3	61.3+5.7	43.3+5.4	44.3+4.6	19.0+2.6	15.5+2.4

GH - Greenhouse SF - Shade frame OA - Open air

Ebenus creticus (Tab.15)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	117.5+7.0	22.3+5.0	15.5+1.3	10.2+1.5		
	SF	143.2+11.3	31.0+6.0	17.7+1.5	10.7+1.7		
	OA	98.0+7.8	32.0+3.2	25.0+2.2	8.0+0.8		
May 97	GH	122.0+8.8	39.6+6.7	17.2+2.7	11.7+1.7		
	SF	162.5+11.7	59.7+4.8	22.5+3.3	12.5+1.0		
	OA	158.0+9.3	47.0+8.0	26.4+1.3	9.0+1.4		
Aug 97	GH	134.7+5.7	49.2+3.6	26.0+4.5	17.7+2.9		
	SF	183.7+10.2	61.5+3.9	23.7+3.3	13.2+1.0		
	OA	170.0+5.2	48.2+5.1	27.0+2.2	10.5+1.3		
Nov 97	GH	158.0+7.2	55.2+7.3	33.7+3.1	22.7+3.2		
	SF	189.2+6.5	67.5+5.8	25.7+3.5	15.7+2.6		
	OA	190.2+4.6	52.5+6.1	28.0+2.4	11.7+1.7		
Feb 98	GH	162.5+4.2	67.0+5.7	39.2+2.2	32.2+3.9	12.5+2.4	17.5+2.4
	SF	205.5+8.4	71.7+4.6	35.0+5.2	22.2+5.8	7.7+3.2	10.7+2.9
	OA	195.0+7.3	57.0+3.6	32.0+2.4	15.2+2.7	3.0+0.8	8.0+1.6
May 98	GH	170.3+6.3	71.0+4.7	45.3+9.7	33.8+3.3	17.3+2.2	20.8+2.7
	SF	232.8+5.6	76.0+5.7	39.0+5.9	29.8+4.6	13.0+3.2	19.5+2.6
	OA	206.8+5.3	59.0+2.9	45.5+5.3	30.8+4.4	11.3+1.5	15.0+3.6

GH - Greenhouse SF - Shade frame OA - Open air

Argyranthemum maderense (Tab.16)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	72.0+8.1	14.7+2.5	6.7+1.0	9.7+1.0		
	SF	70.0+8.3	10.7+2.2	4.0+0.8	8.2+1.7		
	OA	68.2+7.4	8.2+1.7	2.6+0.5	7.0+0.8		
May 97	GH	117.5+10.4	20.0+4.1	8.7+1.9	16.2+2.1		
	SF	87.5+6.1	23.7+2.9	4.7+1.2	11.0+1.1		
	OA	84.2+7.4	12.5+1.3	3.1+0.5	8.7+0.5		
Aug 97	GH	122.0+2.8	28.7+6.1	19.7+4.6	24.5+2.6		
	SF	88.5+8.3	25.5+4.9	8.5+1.7	29.0+2.9		
	OA	91.5+4.4	13.7+1.3	4.0+0.7	12.2+2.6		
Nov 97	GH	161.0+10.4	31.7+1.7	35.7+4.6	34.7+3.4		
	SF	100.0+7.1	28.0+3.4	18.0+3.7	36.5+2.4		
	OA	108.7+4.1	20.7+3.6	12.7+2.1	19.2+3.8		
Feb 98	GH	206.0+7.0	38.5+3.4	43.7+5.2	60.7+5.8	17.7+1.5	24.5+2.6
	SF	156.7+7.0	40.7+2.9	29.7+2.6	56.0+3.4	8.0+2.5	17.0+4.8
	OA	124.7+4.1	33.2+3.8	24.2+2.9	49.7+5.1	3.7+1.0	4.2+1.0
May 98	GH	245.5+5.3	53.8+5.1	45.3+5.4	70.5+5.3	28.5+3.1	40.3+4.0
	SF	198.0+8.0	47.8+4.0	41.5+5.3	78.3+5.1	20.0+3.2	23.3+2.2
	OA	160.0+6.0	36.3+6.3	28.5+3.9	60.0+3.6	13.0+2.6	24.3+4.3

GH - Greenhouse SF - Shade frame OA - Open air

Vitex agnus castus (Tab.17)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	*	100.2+9.0	**	**		
	SF		126.5+8.2				
	OA		97.5+7.6				
May 97	GH	194.7+10.4	147.5+14.4	30.5+3.0	8.0+1.4		
	SF	216.2+10.9	156.7+13.4	32.5+3.1	9.2+1.9		
	OA	143.7+7.5	114.2+14.6	24.5+3.9	8.2+1.3		
Aug 97	GH	227.2+10.6	166.5+10.1	32.7+5.0	9.0+0.8		
	SF	222.2+8.8	167.2+9.3	33.5+3.7	10.0+1.8		
	OA	148.0+9.2	116.0+5.1	26.5+3.0	13.2+3.3		
Nov 97	GH	240.2+7.8	169.0+7.4	33.0+4.8	9.2+0.5		
	SF	223.0+8.0	169.7+8.6	34.2+4.3	10.5+1.3		
	OA	149.2+8.7	123.5+8.0	30.0+4.4	13.7+2.7		
Feb 98	GH	**	**	**	**		
	SF	**	**	**	**		
	OA	**	**	**	**		
May 98	GH	286.0+9.0	171.8+6.2	44.3+7.7	12.8+2.4	18.5+2.6	6.3+1.3
	SF	277.0+4.5	190.5+5.3	56.3+6.2	17.5+3.5	27.0+2.7	8.0+1.4
	OA	218.8+5.1	129.0+5.9	48.3+7.7	20.8+3.1	15.8+2.2	6.0+0.8

* Experimental error.

** The plant is in dormancy.

GH - Greenhouse SF - Shade frame OA - Open air

Helychrisum graecum (Tab.18)

Date	ENV	Perimeter (cm)	Height (cm)	Sec. Shoot (cm)	Nº nodes	Thir. Shoot (cm)	Nº nodes
		mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt	mean+sdt
Feb 97	GH	*	*	*	*		
	SF						
	OA						
May 97	GH	208.2+9.2	28.5+3.4	19.5+1.3	30.0+1.4		
	SF	140.0+10.5	33.2+3.3	18.1+2.2	30.2+2.6		
	OA	88.0+7.3	27.0+2.2	10.1+1.6	19.5+2.1		
Aug 97	GH	238.5+6.2	30.0+4.3	25.7+2.2	47.2+4.8		
	SF	158.7+10.5	35.0+2.9	24.5+3.7	44.2+3.9		
	OA	101.0+7.3	29.0+5.6	12.9+1.6	39.2+2.1		
Nov 97	GH	255.7+4.3	37.5+4.4	35.7+4.1	54.2+4.3		
	SF	193.7+9.8	38.7+5.5	34.0+4.1	56.7+3.4		
	OA	110.5+7.3	30.2+4.6	15.0+1.6	41.0+3.6		
Feb 98	GH	269.5+5.5	49.0+5.8	42.0+2.8	61.5+5.8	18.5+3.4	46.5+3.1
	SF	220.7+6.4	53.2+5.0	41.0+3.4	72.5+5.3	25.5+5.8	43.7+2.4
	OA	123.5+7.3	35.5+4.2	20.5+3.7	62.0+4.3	7.5+0.6	23.5+4.4
May 98	GH	275.0+7.5	54.0+6.3	46.5+4.6	65.5+4.5	24.5+2.6	56.5+2.6
	SF	238.3+5.1	57.0+4.2	49.0+4.7	77.8+3.3	26.8+2.7	47.0+5.3
	OA	131.5+7.3	38.0+4.4	23.5+3.7	65.5+3.1	10.0+2.2	25.8+1.7

* Experimental error.

GH - Greenhouse SF - Shade frame OA - Open air

ANNEX IV – PHENOLOGICAL OBSERVATIONS IN THREE ENVIRONMENTS

Table 1 – Species spontaneous in Portugal

		1997												1998								
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set
Cistus monspeliensis	GH	S	S	S	S					S	S	S	S	S	S	S	SF	F	f	f		
	SF	S	S	F	F	f	f	f			S	S	S	S	S	S	F	f	f			
	OA	S	S	F	F	f	f	f			S	S	S	S	S	SF	F	f	f			
Halimium halimifolium	GH	S	S	S	S	S					S	S	S	S	S	S	F	Ff	f			
	SF	S	S	S	F	F	f	f			S	S	S		S	S	F	Ff	Ff			
	OA	S	S	S	F	F	f	f			S	S	S		S	S	F	Ff	f			
Lavandula luisieri	GH	S	S	F	F	f	f				S	S	S	S	S	F	F	Ff	f			
	SF	S	S	F	F	f	f	f			S	S	S	S	S	F	F	Ff	Ff			
	OA	S	S	F	F	f	f	f				S	S	S	S	F	F	f	f			
Lithodora prostrata	GH	S	S	F	F	F	F	f		S	S	S	S	S	SF	F	F	Ff	f			S
	SF	F	F	F	F	f	f			S	S	S	S	S	F	F	Ff	Ff	f			S
	OA	F	F	F	F	f	f			S	S	S	S	F	F	F	f	f	f			S
Thymus mastichina	GH	S	S	S	F	F	F	f			S	S	S	S	S	S	SF	F	F	f		
	SF	S	S	S	F	F	f	f			S	S	S	S	S	S	F	F	F	f		
	OA	S	S	F	F	F	f	f				S	S	S	S	S	F	Ff	f	f		

S - Shooting F - Flowering **f - Frutification**

GH - Greenhouse SF - Shade Frame AO - Open Air

ANNEX IV – PHENOLOGICAL OBSERVATIONS IN THREE ENVIRONMENTS

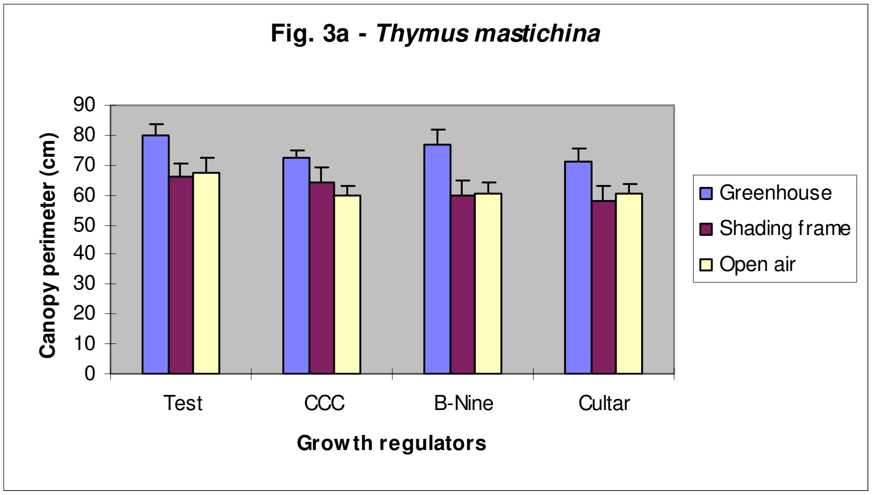
Table 2 – Species spontaneous in Spain, Italy and Greece

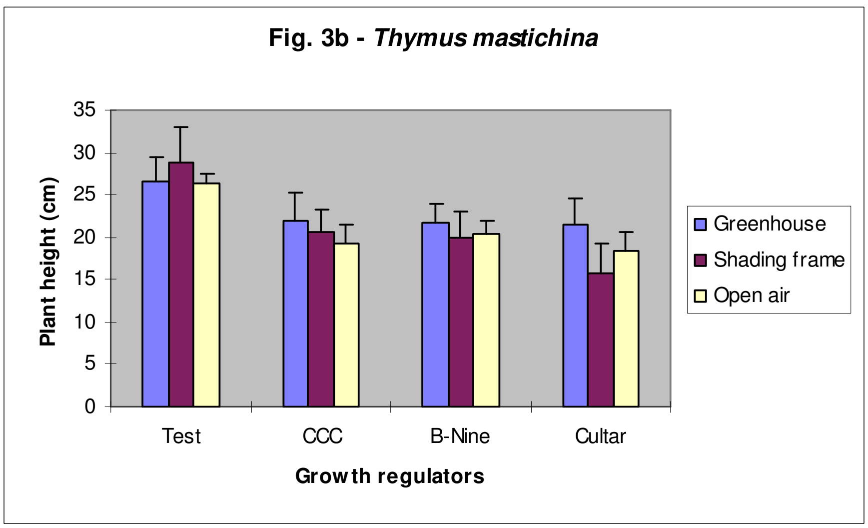
		1997												1998								
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set
Argyranthemum coronopifolium	GH								S	S	S	F	F	F	F	F	F	f	f		S	S
	SF	F	F	f	f				S	S	S	F	F	F	F	F	F	f	f		S	S
	OA									S	S	S	F	F	F	F	F	f	f			S
Argyranthemum maderense	GH	F	F	Ff	f			S	S	S	S	S	S	F	F	F	F	Ff	f			
	SF	S F	F	f	f	f	F*	f*	f*	S	S	S	S	F	F	F	f	f	f	F*	f*	
	OA	F	F	f	f	f	f F*	f*	f*	S	S	S	S	F	F	F	F	f	f	F*	f*	
Centranthus ruber	GH	S	S	S	F	F	F	F f	f	S	S	S	S	S	S	S	S	F	f	F	Ff	FS
	SF	S	S	S	S F	F	F	F	F f	f	S	S	S	S	S	S	S	F	f	F	F	f
	OA	S	S	S	S F	F	F	F	F f	f	S	S	S	S	S	S	S	F	F	F	F	f
Cistus creticus	GH	S	S	F	F	F f	f	f		S	S	S	S	S	S	SF	SF	f	f			S
	SF	S	S	F	F	F	f	f		S	S	S	S	S	S	S	F	Ff	f			S
	OA	S	S	F	F	F f	f	f		S	S	S	S	S	S	SF	F	f	f			S
Ebenus creticus	GH	S	S	S	S	S F	F	f	S	S	S	S	S	S	S	S	S	S	S			S
	SF	S	S	S	S F	F	f	f		S	S	S	S	S	S	S	S	S	S	F	f	S
	OA	S	S	S	F	F	f	f		S	S	S	S	S	S	S	S	S	S	F	f	S
Euphorbia characias	GH	F	F	F	f	f	f			S	S	S	S F	F	F	F	F	fS*	fS*	S*	F*	f*
	SF	F	F	f	f	f				S	S	S	S F	S	S	F	F	fS*	fS*	S*	F*	f*
	OA	F	F	f	f			F*	f*	f*	S	S	S F	F	F	Ff	f	fS*	S*	S*	F*	F*
Genista thyrranea	GH	S	S	S	S	S	S	S				S	S	S	S	S	S	S	S			
	SF	S	S	S	F	F	F f	f	f			S	S	S	S	S	S	F	F	f	f	
	OA	S	S	S	F	F	F f	f				S	S	S	S	S	S	F	F	f	f	
Helichrysum graecum	GH	S	S	F	F	F	f	f			S	S	S	S	S	F	F	F	f			
	SF	S	S	F	F	F	f	f			S	S	S	S	F	F	F	Ff	f			
	OA	S	S	F	F	F	f	f	f			S	S	S	F	F	F	Ff	f			
Lavandula stoechas	GH	S	S F	F	F	f	f	f			S	S	S	S	S	SF	F	Ff	f		S	
	SF	S	S F	F	F	f	f			S	S	S	S	S	SF	F	F	Ff	Ff		S	
	OA	S F	F	F	F	f	f			S	S	S	S	S	F	F	F	f	f		S	
Limonium sinense	GH	S	S	S	S	S	S	S		S	S	S	S	S	S	S	F	F	F	f		
	SF	S	S	S	F	F	F	F f	F f	f	f	S	S	S	S	S	S	S	S			
	OA	S	S	S	S	F	F	F	F f	F f	f		S	S	S	S	F	F	F	f		
Lotus creticus creticus	GH	S	S	S	F	F	f	f		S	S	S	S	S	S	F	F	f	f			S
	SF	F	F	F	f	f	f			S	S	S	S F	S	S	F	F	F	F	f	f	
	OA	S	F	F	f	f	f			S	S	S	S	S	S	S	Ff	f	f			S
Lotus creticus cytisoides	GH	S	S	S	F	F	f	f		S	S	S	S	S	S	S	SF	F	f			S
	SF	S	S	F	F	F	f	f		S	S	S	S	S	S	S	F	F	F	f	f	
	OA	S	S	F	F	F	f			S	S	S	S	S	S	S	Ff	f	f			S
Spartium junceum	GH	S	S	S	S	S	S			S	S	S	S	S	S	S	S	S	S			S
	SF	S	S	S	S	S				S	S	S	S	S	S	S	SF	F	F	f		S
	OA	S	S	S	S	F	F	F	f	S	S	S	S	S	S	S	SF	Ff	Ff	f	S	S
Vitex agnus castus	GH		S	S	S	S	S	S	S					L	L	S	S	S	S	S	S	S
	SF			S	S	S	S	S	F	f	L	L	L	L	L	S	S	S	S	S	F	f
	OA			S	S	S	S	S	S	S	S	L	L	L	L	L	S	S	S	S	S	S

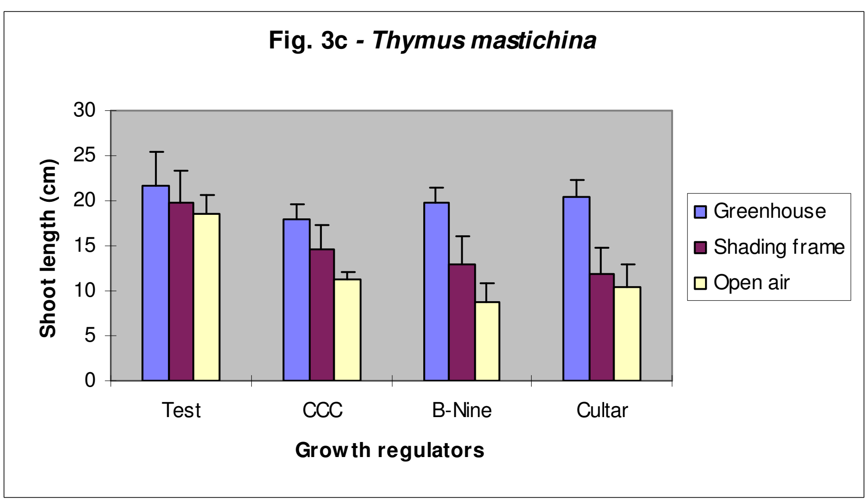
S - Shooting F - Flowering **f - frutification** L - Leaffall

GH - Greenhouse SF - Shade Frame AO - Open Air

ANNEX V(I) – RESULTS OF DIFFERENT GROWTH REGULATORS (1996)







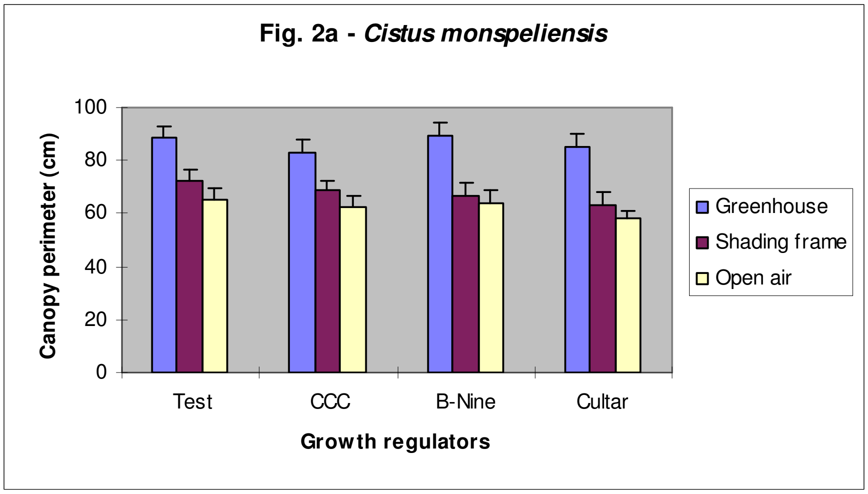


Fig. 2a - Cistus monspeliensis
Canopy perimeter (cm)
100
80
60
40
20
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

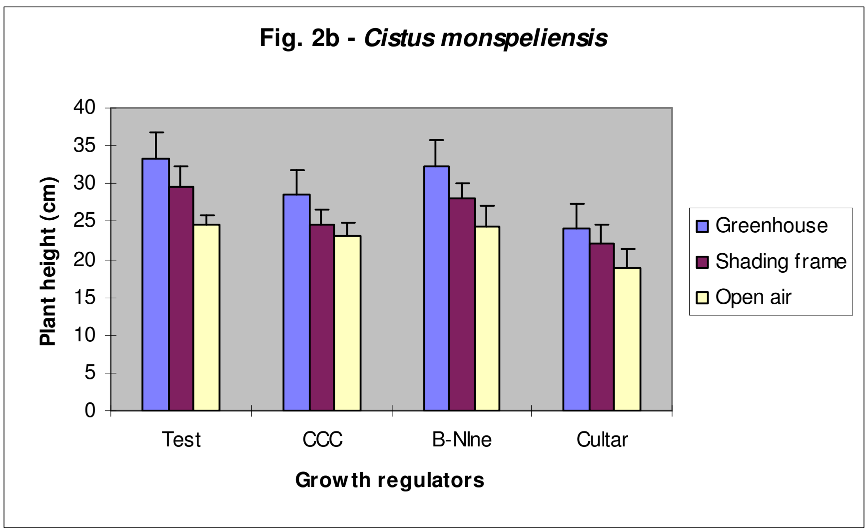


Fig. 2b - Cistus monspeliensis
Plant height (cm)
40
35
30
25
20
15
10
5
0
Test
CCC
B-NIne
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

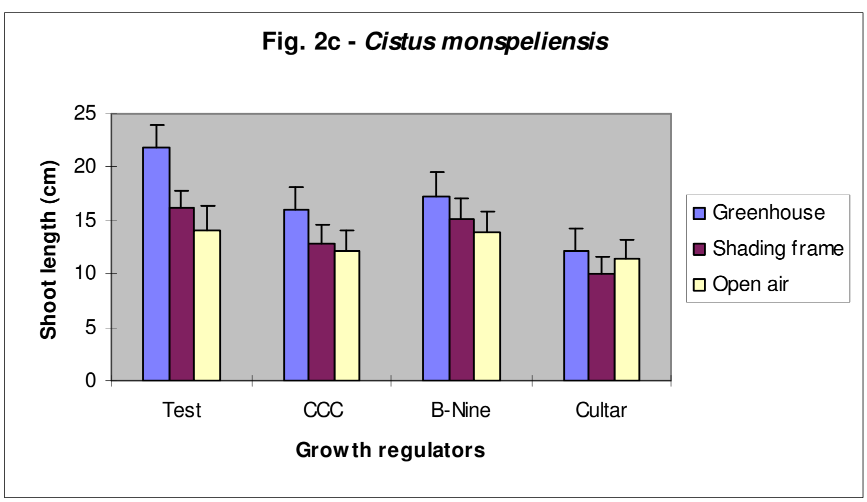


Fig. 2c - Cistus monspeliensis
Shoot length (cm)
25
20
15
10
5
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

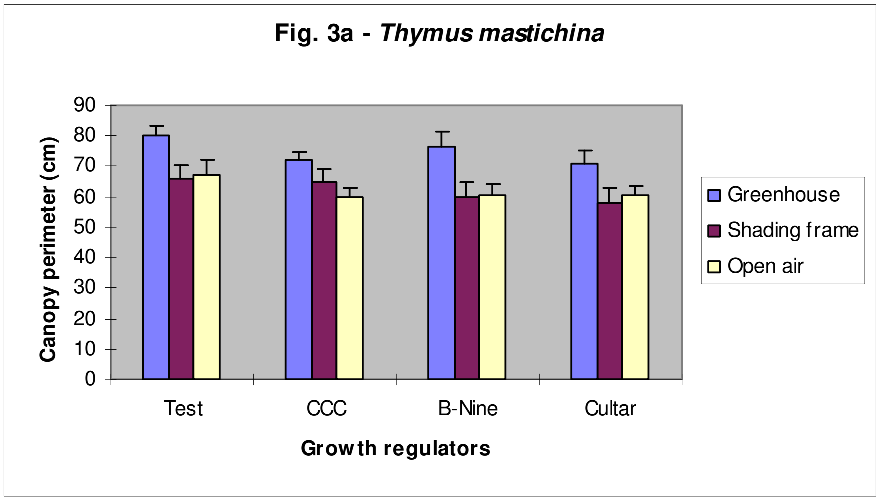


Fig. 3a - *Thymus mastichina*
Canopy perimeter (cm)
90
80
70
60
50
40
30
20
10
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

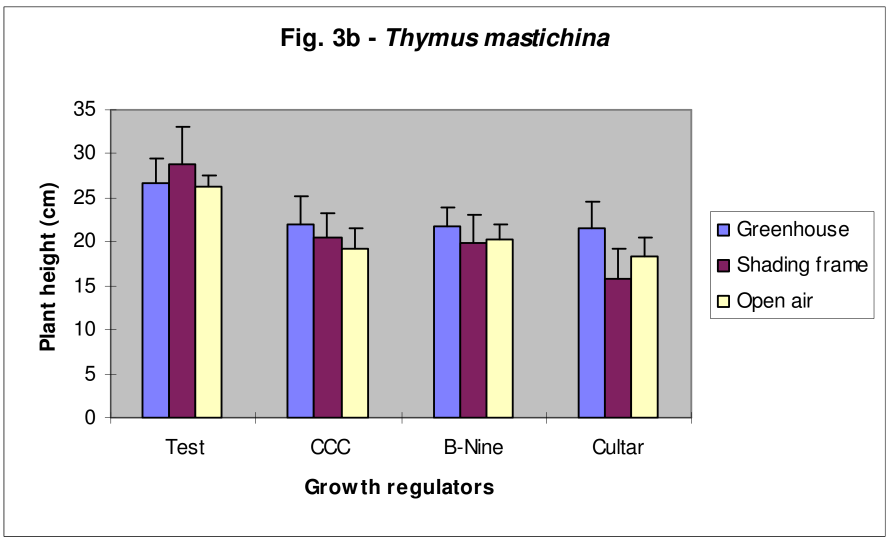


Fig. 3b - *Thymus mastichina*
Plant height (cm)
35
30
25
20
15
10
5
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

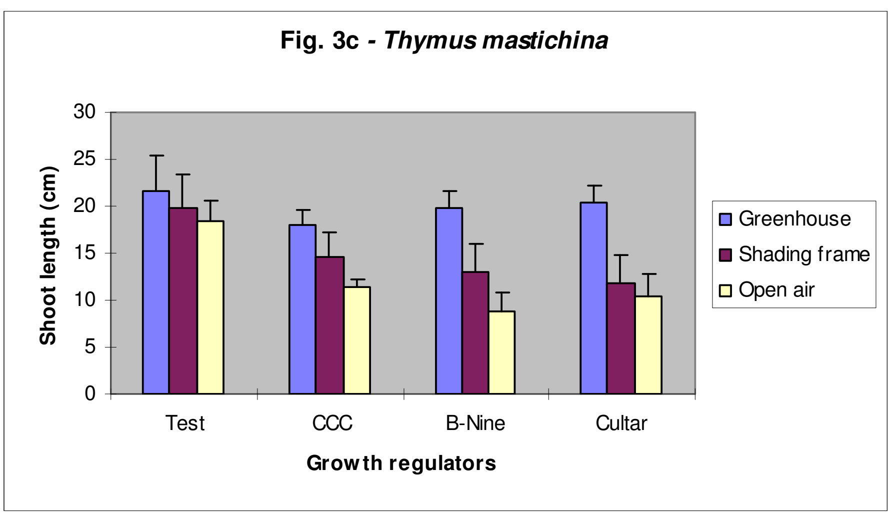
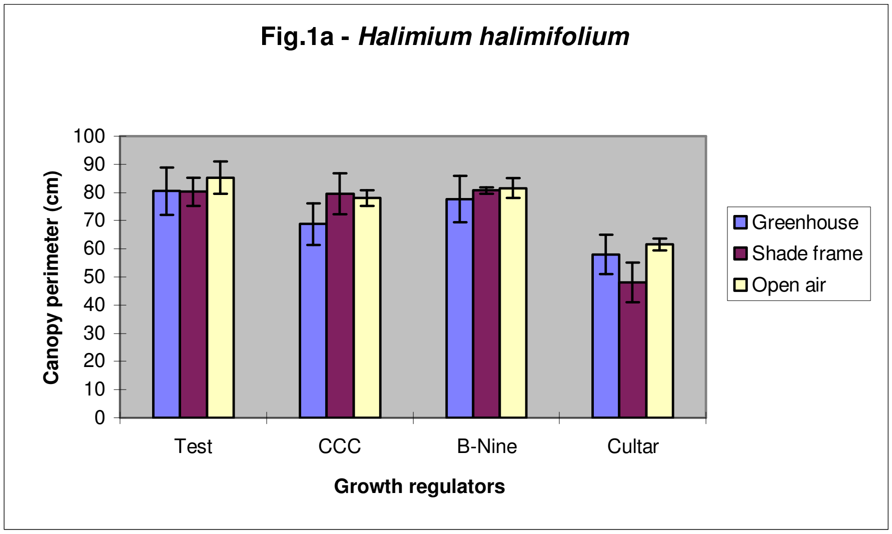
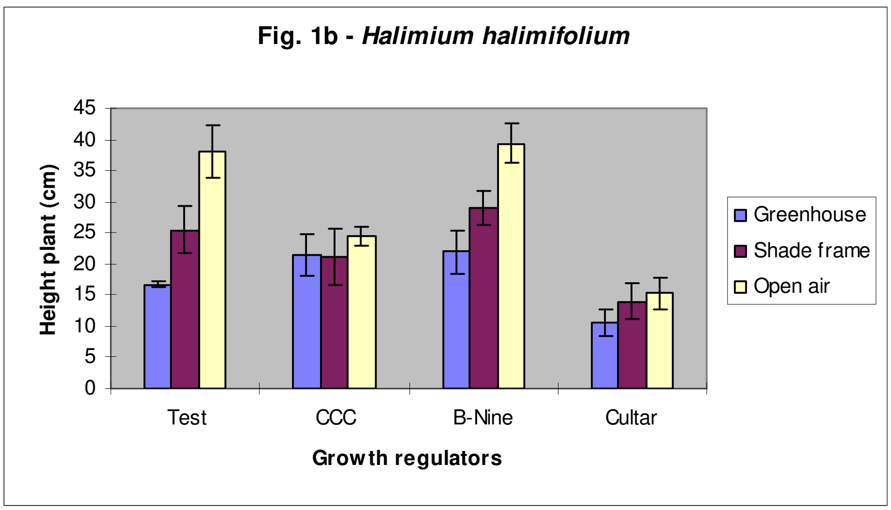


Fig. 3c - *Thymus mastichina*
Shoot length (cm)
30
25
20
15
10
5
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shading frame
Open air

ANNEX V(II) – RESULTS OF DIFFERENT GROWTH REGULATORS (1997)





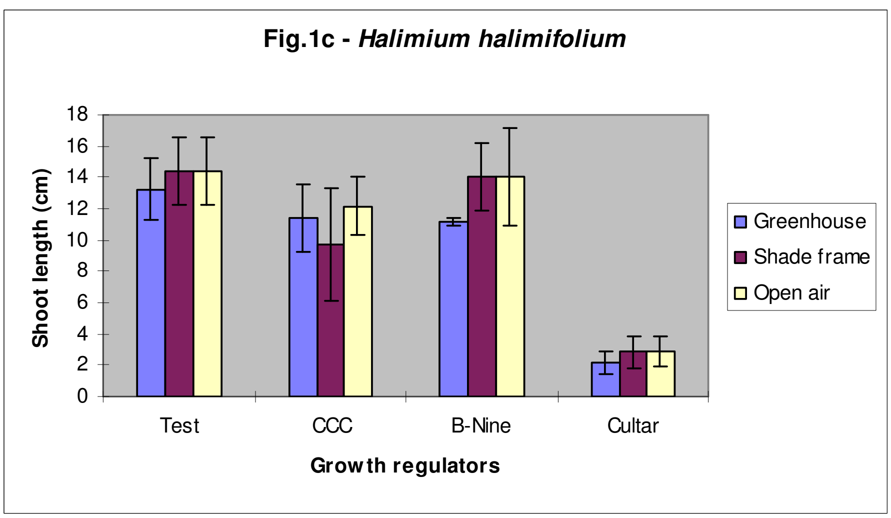


Fig.2a - *Cistus monspeliensis*

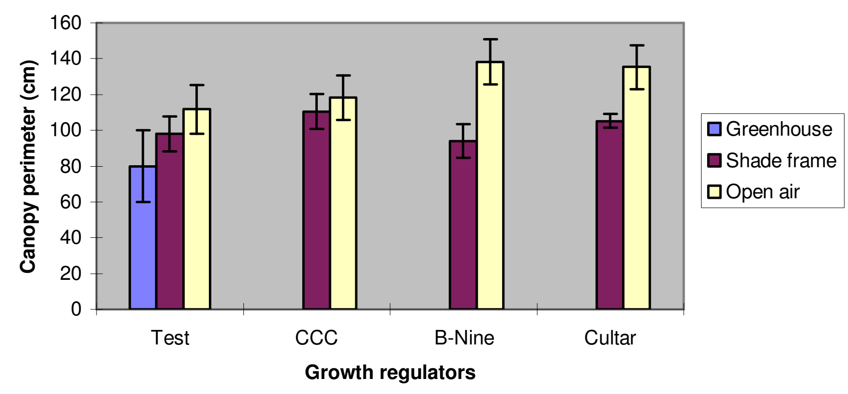


Fig.2b - *Cistus monspeliensis*

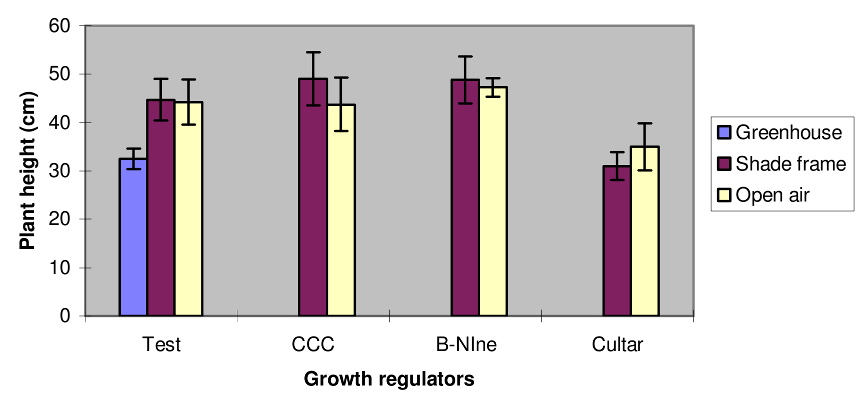
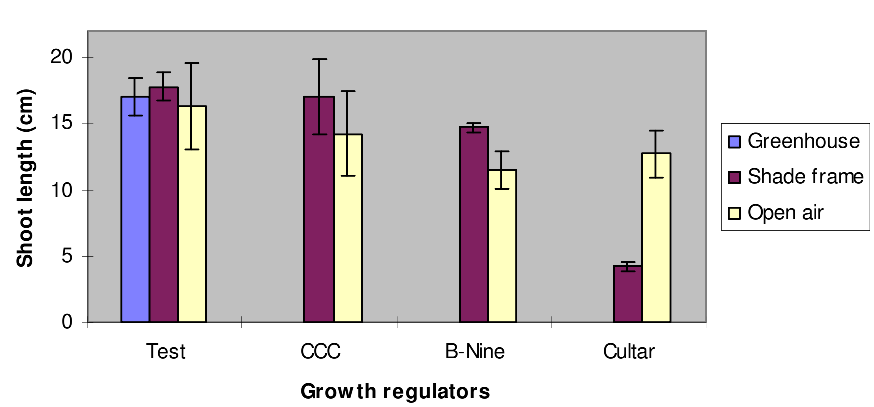


Fig.2c - *Cistus monspeliensis*



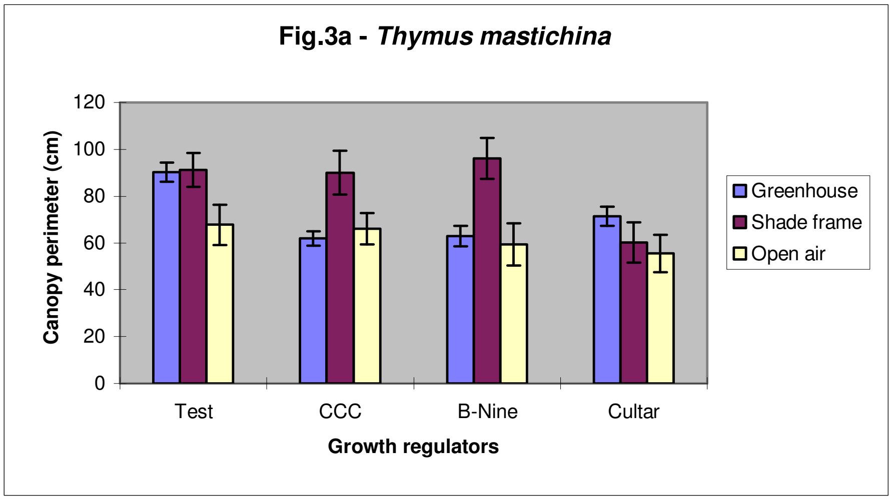


Fig.3a - *Thymus mastichina*
Canopy perimeter (cm)
120
100
80
60
40
20
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shade frame
Open air

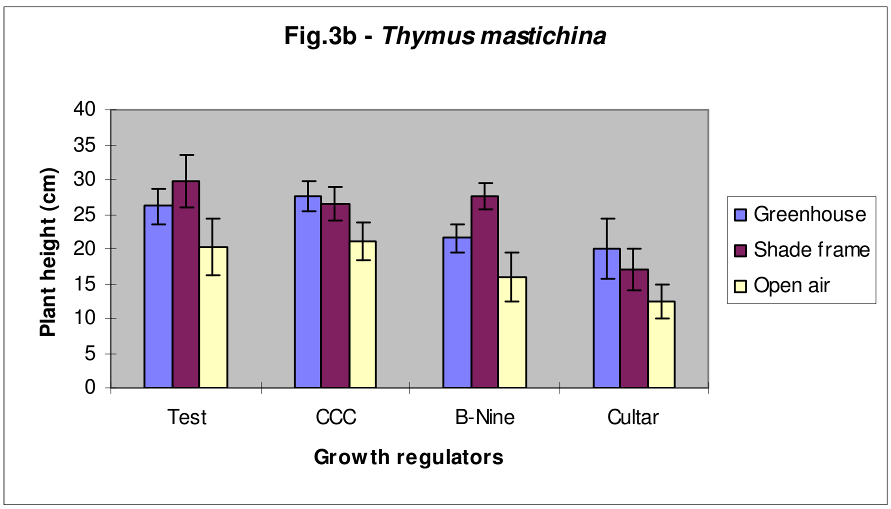


Fig.3b - *Thymus mastichina*
Plant height (cm)
40
35
30
25
20
15
10
5
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shade frame
Open air

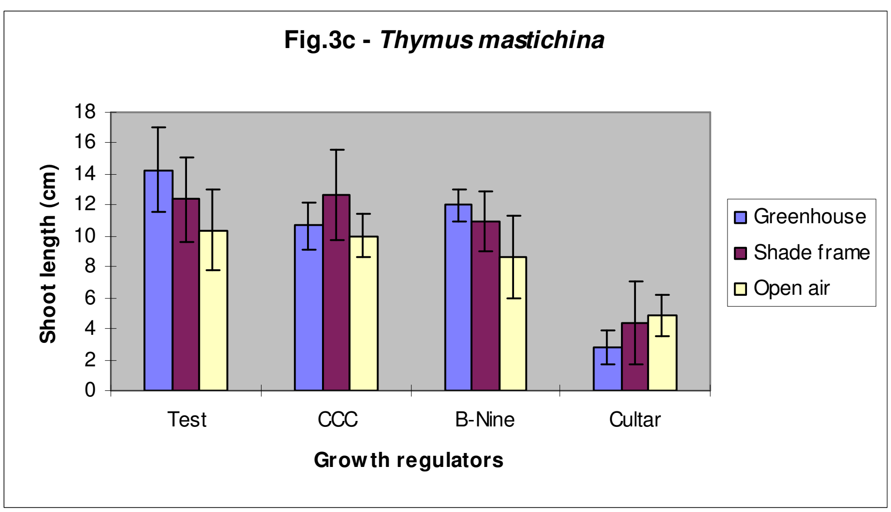
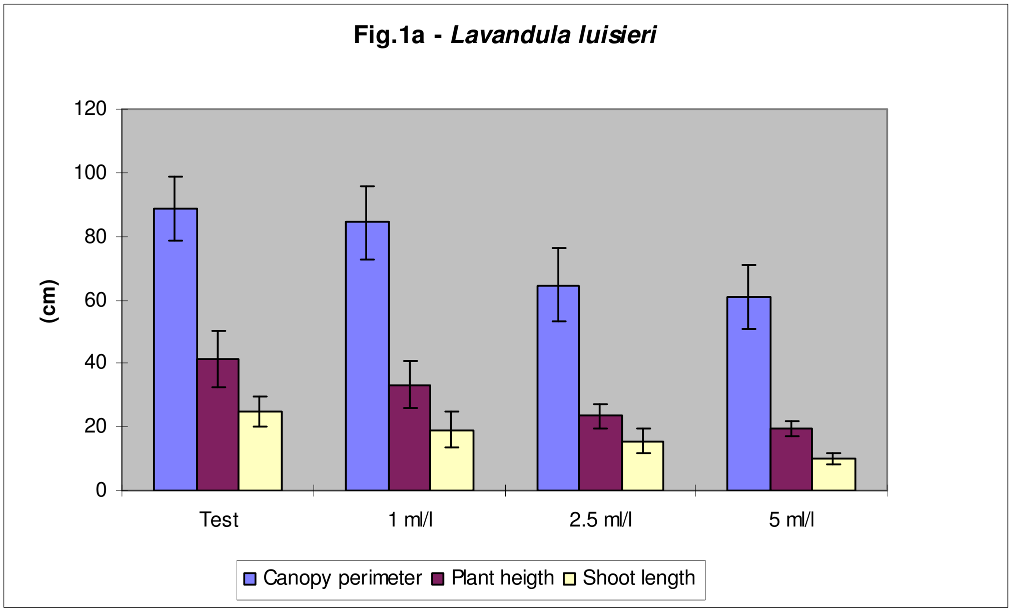
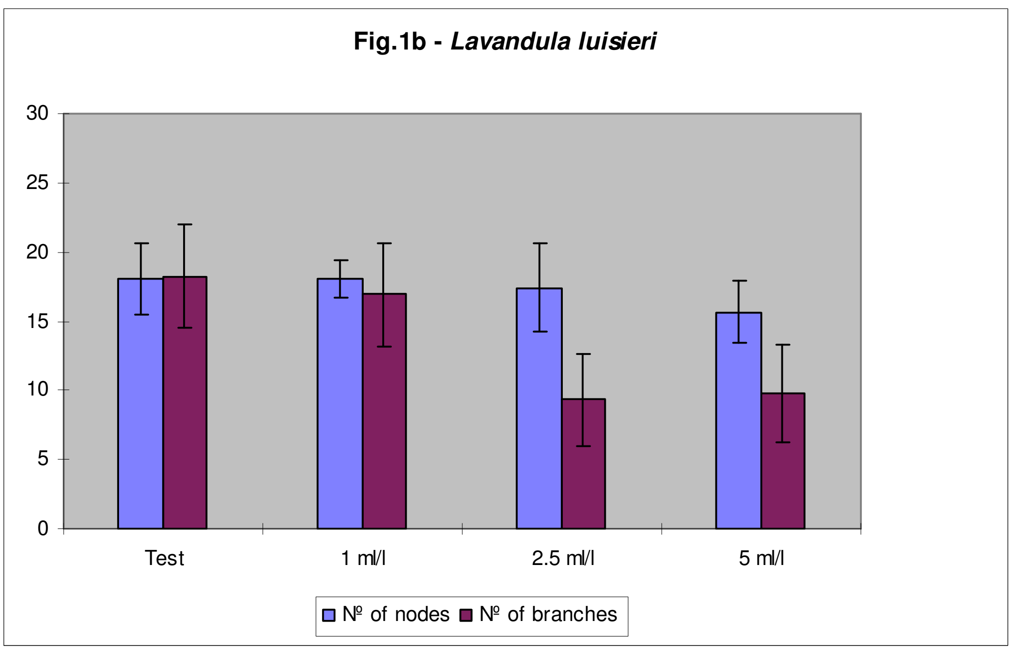


Fig.3c - *Thymus mastichina*
Shoot length (cm)
18
16
14
12
10
8
6
4
2
0
Test
CCC
B-Nine
Cultar
Growth regulators
Greenhouse
Shade frame
Open air

ANNEX V (III) – RESULTS OF CULAR APPLICATION





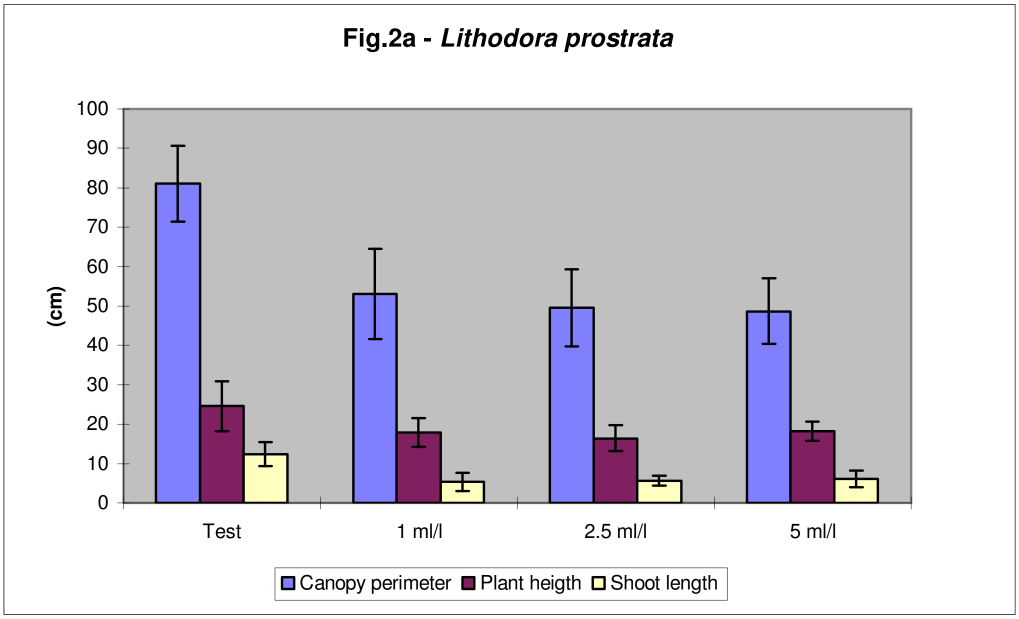


Fig.2a - *Lithodora prostrata*
100
90
80
70
60
50
40
30
20
10
0
(cm)
Test
1 ml/l
2.5 ml/l
5 ml/l
Canopy perimeter
Plant heigth
Shoot length

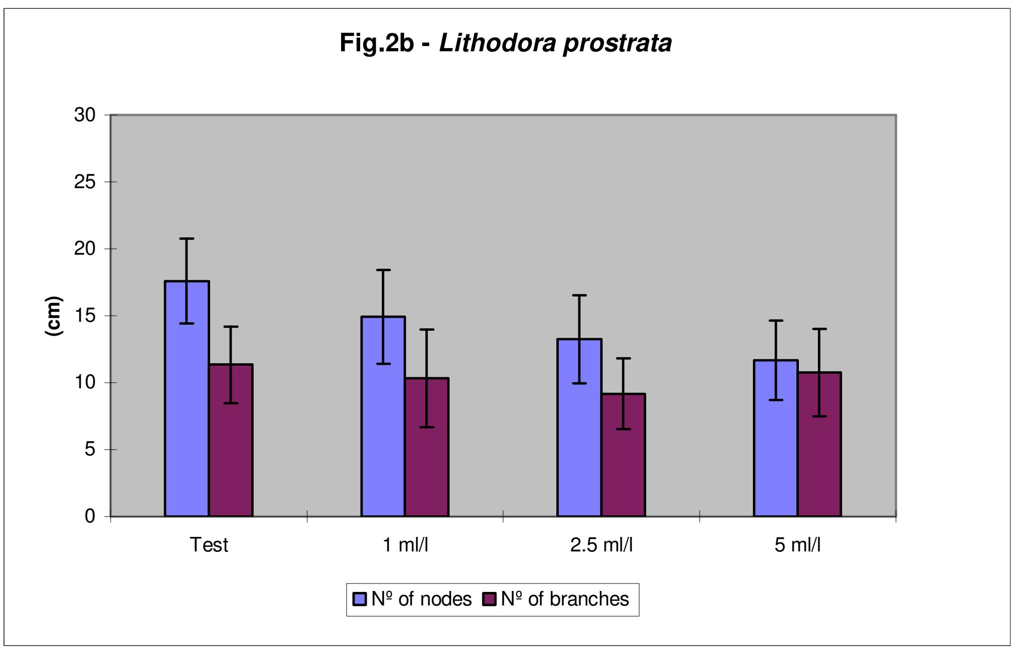


Fig.2b - *Lithodora prostrata*
30
25
20
15
10
5
0
(cm)
Test
1 ml/l
2.5 ml/l
5 ml/l
Nº of nodes
Nº of branches

Fig.3a - *Cistus monspeliensis*

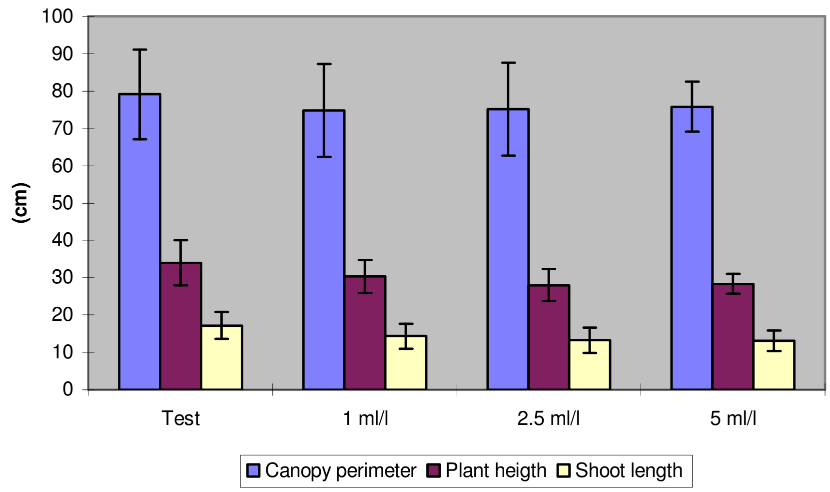
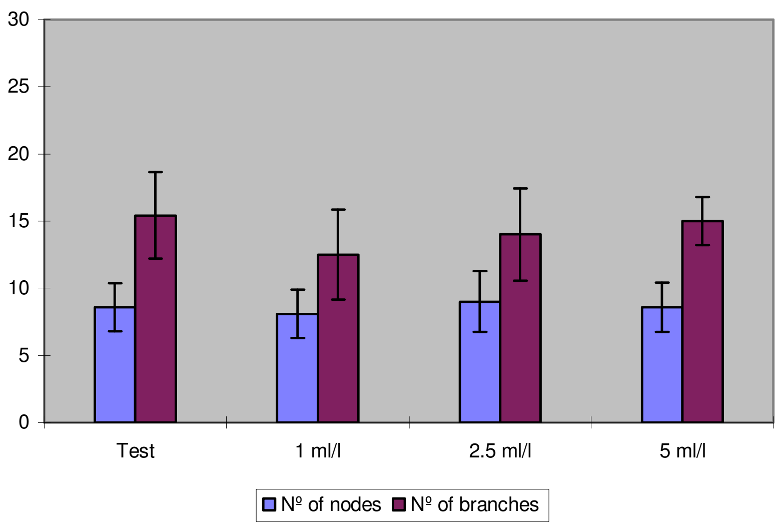


Fig.3b - *Cistus monspeliensis*



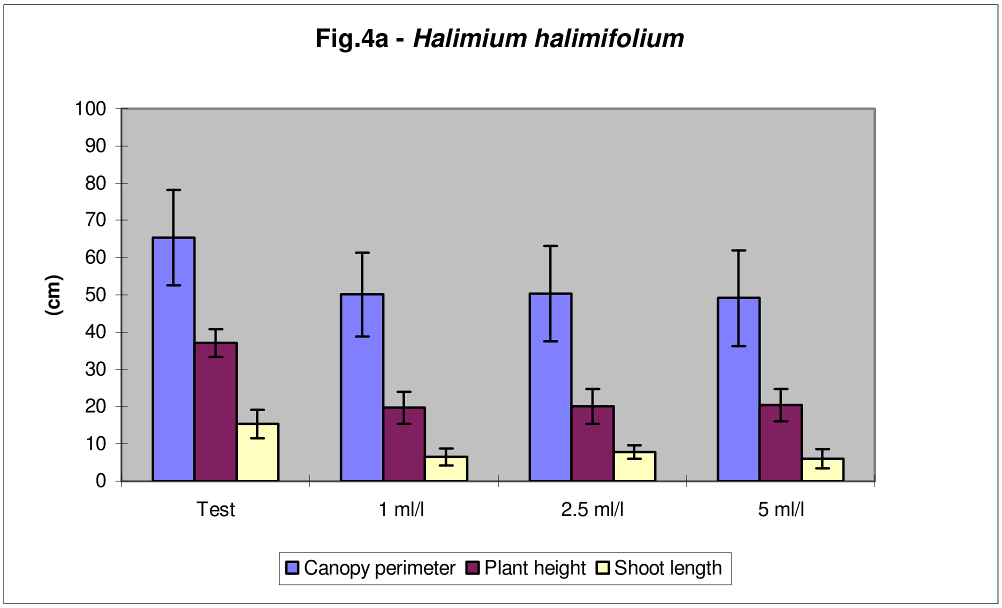


Fig.4a - Halimium halimifolium
(cm)
100
90
80
70
60
50
40
30
20
10
0
Test
1 ml/l
2.5 ml/l
5 ml/l
Canopy perimeter
Plant height
Shoot length

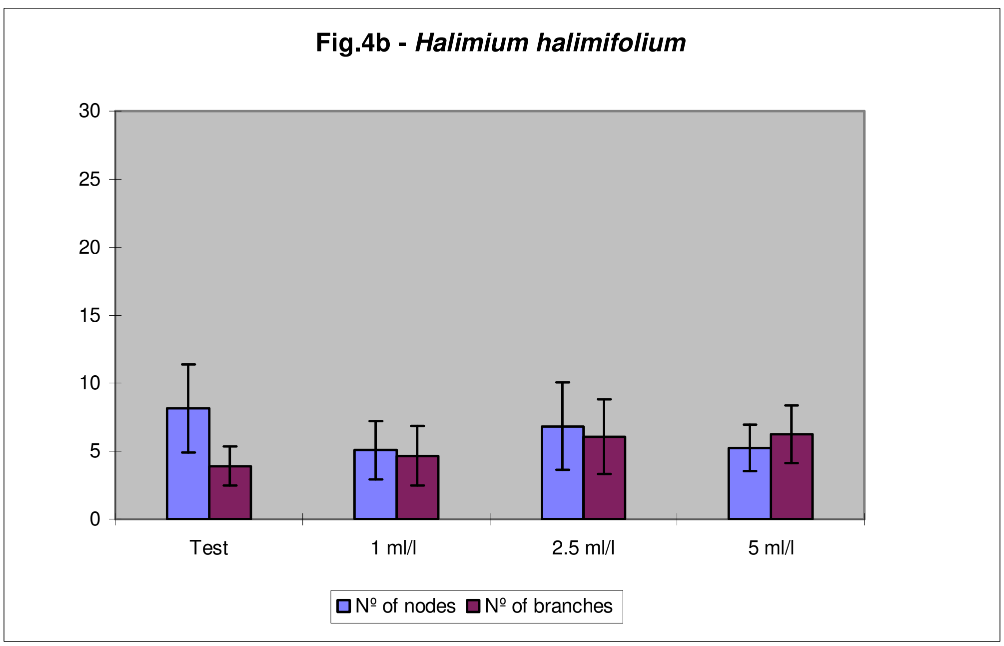


Fig.4b - Halimium halimifolium
30
25
20
15
10
5
0
Test
1 ml/l
2.5 ml/l
5 ml/l
Nº of nodes
Nº of branches

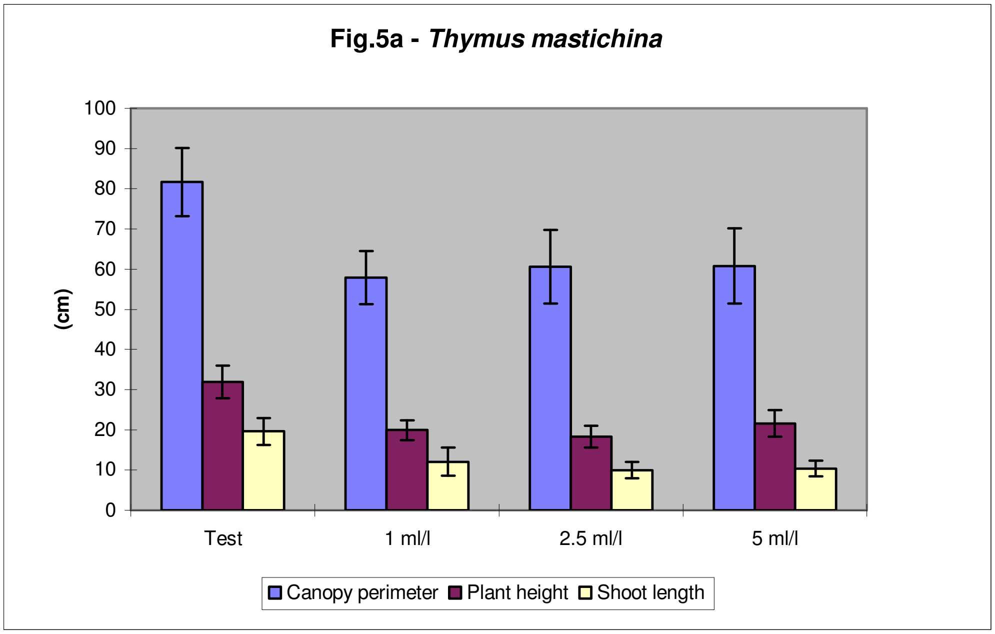


Fig.5a - *Thymus mastichina*
100
90
80
70
60
50
40
30
20
10
0
(cm)
Test
1 ml/l
2.5 ml/l
5 ml/l
Canopy perimeter
Plant height
Shoot length

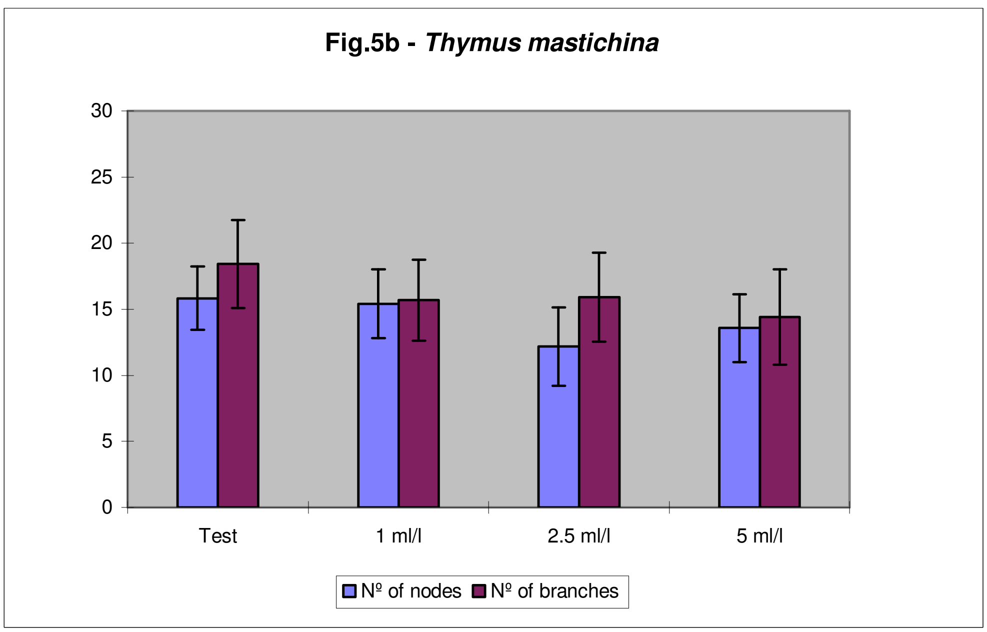


Fig.5b - *Thymus mastichina*
30
25
20
15
10
5
0
Test
1 ml/l
2.5 ml/l
5 ml/l
Nº of nodes
Nº of branches