LifeMedGreenRoof Project

Plant propagation technique

LIFE12ENV/MT/000732

LifeMedGreenRoof Project
MEETING ENVIRONMENTAL TARGETS

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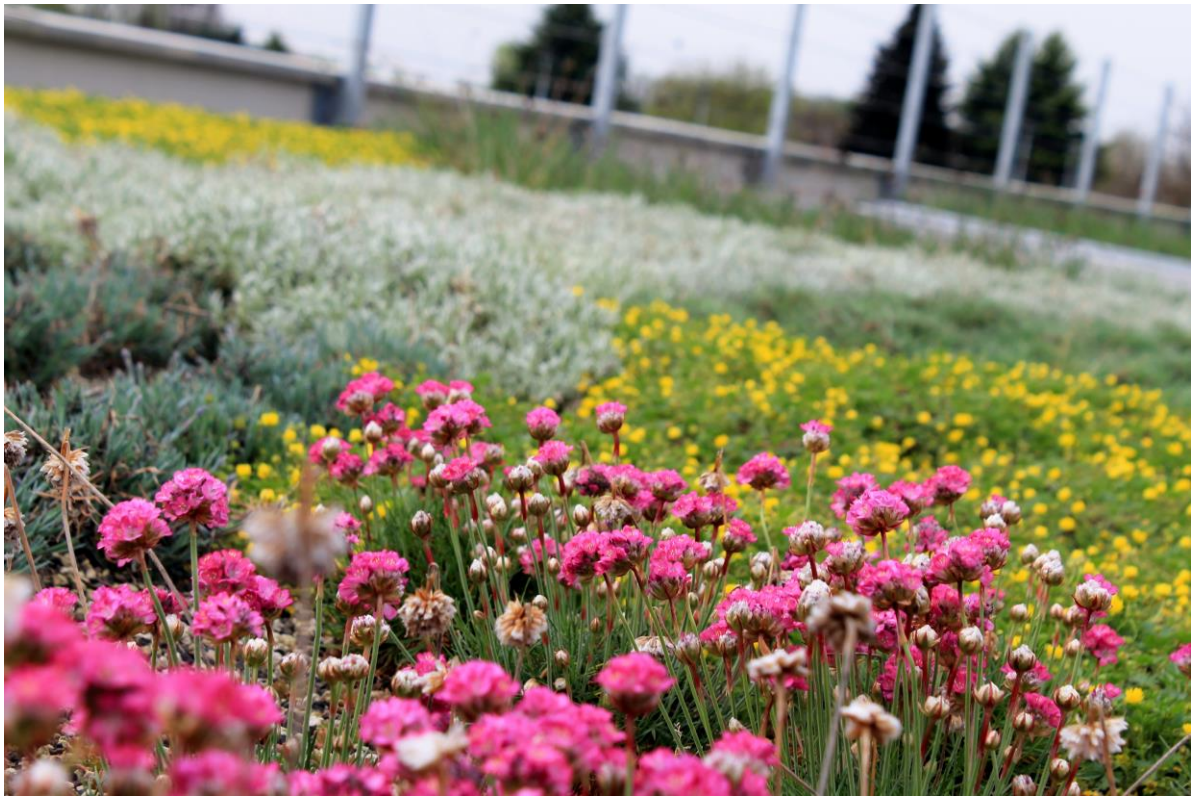

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LifeMedGreenRoof Project - Assessing the potential for propagating the selected plant species for the Green Roofs in Italy.

Executive Summary

The main goal of this action is to provide methods of propagation for the selected plant species for Italian green roofs. Efficient propagation methods vary depending on the species in question. Propagation could be either by seed, by cutting or by vegetative division; the latter might be the least efficient because of a low number of new divisions produced from the parent plant.

One of the main aims of the tests conducted was to evaluate the ability to directly propagate plants on a green roof similar to the technique used to establishing *Sedum* species and other succulents. Adopting such a method would overcome transplant stress to plants, reduce incompatibility between nursery and green roof substrates and can be said to be an easy way to fill in any bare patches during maintenance.

This action commenced with the selection of more than 40 green roof plant species propagated in a green roof simulator. 15 species were propagated through cuttings, 6 species were germinated from seed and 3 species where propagated by division.

The success in the propagation of plants through seeding and cuttings depended also on the season. The tests were performed according to best practices of nursery propagation. Plant growth rooting regulator (rooting hormone) was applied.

Sedum species proved the easiest and most successful to propagate although with adequate care and initial watering *Teucrium, Thymus, Helichrysum, Lavandula, Cerastium* and *Santolina* showed the ability to root directly in green roof conditions both in Autumn and Spring at a rate adequate to commercial standards.

1. Background information

This document forms part of the deliverables required of the LifeMedGreenRoof project, which is an EU funded project under the Life+ Programme, in an effort to encourage the widespread use of green roof technology throughout the Maltese territory and Italy. The scope of this document is to highlight issues pertaining to the cultivation of plants on a green roof when using native species. The benefits of green roofs are well documented and utilising native vegetation will render green roofs more efficient in mitigating urban related projects and ameliorate the quality of life of urban dwellers. Using native species will also render the roofs more sustainable when considering the benefits to biodiversity.

Indeed, green roofs were developed in the North of Europe, where generally water availability occurs all year round and weed dissemination is fairly contained thanks to low temperatures and other meteorological conditions. It's worth stressing that generally in the North of Europe people are more sensitive to environmental and climatic issues.

In the last years within the Mediterranean region people's awareness to these problems has, to some extent, increased, not only at political level but also amongst the public in general.

Since their reintroduction in the 1980s, green roof technology became more reliable leading to the development of different types of roof greening. Systems have become lighter and cheaper which could even be utilised on weak structures and requiring less maintenance.

With experience and research, the benefits of roof greening became more apparent. Initially green roofs were installed for their aesthetic appeal, insulation properties and the protection of roof membranes from the natural elements. Over the years, additional benefits became apparent. Green roofs are known to provide important environmental benefits such as storm water retention, summer cooling, improvement of urban biodiversity, economical, sociological and ecological advantages (Provenzano M.E., 2004). It is of no surprise that green roofs have become such an important addition to urban environments in practically all continents.

Today green roofs are considered an important element in the creation of sustainable urban settlements. Unlike grey infrastructure, green roofs provide a number of beneficial services which target both the owner, the community and the natural environment at different levels.

The propagation of green roof plants is an important aspect for the successful diffusion of green roofs within a territory. By commercially propagating green roof plants, prices become more competitive especially when cultivating native species. Native species are important to increase the intrinsic value of green roofs. Native vegetation an inherent connection with native fauna.

2. Introduction

To establish suitability of a plant species, many parameters may be collected, both in an empirically way, based on growth data, or in a more scientific way related to physiological parameters; the latter being less susceptible to environmental conditions of the test. Unfortunately, scientific data on the propagation of plants for green roofs is not available. The unusual weather conditions which were experienced in the years 2014 -2015 reduced the reliability of the field data. Spring and summer experienced numerous unusual rain events. In winter 2014, North Italy experienced very low temperatures. -18°C was recorded and is considered as a once in a decade event. On the other hand, the winter of 2015 was one of the warmest on record.

Although field trials were performed as originally planned, laboratory trials were also conducted.

The species that best suited green roofs were not only chosen by their ability to grow in a green roof environment but also on the ease by which plants could be commercially propagated. Traditionally, nursery plants are propagated in potting compost which facilitate their success. However, during the course of this action plants were tested for their ability to take roof directly in green roof substrates. Being able to root cuttings directly into green roof substrate would reduce plant stress during transplant. This is due to incompatibility which could arise between the nursery medium, in which the plant has been grown, and the green roof substrate. This would result in the mature death of plants and the reduction in vegetative cover on the green roof. Being able to propagate cuttings directly on the roof would have the added benefit of reducing the carbon footprint related to the transportation of nursery plants. On the other hand growing plants directly on a green roof using cuttings is limited to the seasonality.

Below are two tables, the first lists the species of plants tested in the green roof simulator whereas the second indicates methods of plant propagation for different species selected following their propagation success and their ornamental value.

Table 1 Plant list tested in green roof simulator

Ref	Scientific name	Common name
1.	*Ajuga reptans*	Blue bugle
2.	*Allium schoenoprasum*	Chives
3.	*Anthemis tinctoria*	Golden marguerite
4.	*Arabis caucasica*	Caucasian Rockcress
5.	*Armeria maritima*	Sea Pink
6.	*Buphtalmum salicifolium*	Ox-eye daisy
7.	*Campanula poscharskyana*	trailing bellflower
8.	*Cerastium bieberstenii*	Boreal chickweed
9.	*Ceratostigma plumbaginoides*	Plumbago
10	*Dianthus barbatus*	Sweet William
11.	*Dianthus carthusianorum*	Carthusian pink
12.	*Dianthus deltoides*	Maiden pink
13.	*Dianthus gratianopolitanus*	Cheddar pink
14.	*Dorychnum penthaphyllum*	Prostrate Canary clover
15.	*Drosanthemum floribundum*	purple carpet
16.	*Galium verum*	Lady's bedstraw
17.	*Geranium sanguineum*	Bloody crane's-bill
18.	*Globularia punctata*	Common Globe Flower
19.	*Helicrysum italicum*	Curry plant
20.	*Hieracium pilosella*	Mouse-ear hawkweed
21.	*Iberis sempervirens*	Perennial candytuft
22.	*Inula chritmoides*	Golden samphire
23.	*Lavandula angustifolia*	English lavender
24.	*Mesembrianthemum cooperi*	Trailing Iceplant
25.	*Origanum vulgaris*	Origanum
26.	*Petrorhagia saxifraga*	Tunic Flower
27.	*Phlomis fruticosa*	Jerusalem sage
28.	*Plantago serpentina*	Sea plantain
29.	*Potentilla neumanniana*	Alpine Cinquefoil
30.	*Rosmarino officinalis prostratus*	Creeping rosemary
31.	*Ruta graveolens*	Common rue
32.	*Santolina marchii*	Cotton lavander
33.	*Sedum acre*	Goldmoss stonecrop
34.	*Sedum album*	White Stonecrop.
35.	*Sedum palmeri*	Palmer's Sedum
36.	*Sternberja lutea*	Autumn daffodil
37.	*Teucrium chamaedris*	Wall germander
38.	*Thymus serpyllum*	Creeping thyme
39.	*Thymus vulgaris*	Common thyme
40.	*Westringia fruticosa*	Coastal Rosemary

Table 2 Plant list selected from data collection for their growth and ornamental value in green roof simulator

Ref	Scientific name	Common name	Main propagation methods
1.	*Allium schoenoprasum*	Chives	seeds, tuft division
2.	*Armeria maritima*	Sea Pink	tuft division
3.	*Cerastium bieberstenii*	Boreal chickweed	cutting, seeds
4.	*Ceratostigma plumbaginoides*	Plumbago	cutting
5.	*Dianthus carthusianorum*	Carthusian pink	seeds, tuft division
6.	*Dianthus deltoides*	Maiden pink	seeds
7.	*Dianthus gratianopolitanus*	Cheddar pink	tuft division seeds
8.	*Globularia punctata*	Common Globe Flower	seeds
9.	*Helicrysum italicum*	Curry plant	cuttings
10.	*Hieracium pilosella*	Mouse-ear hawkweed	cutting, running, seeds
11.	*Iberis sempervirens*	Perennial candytuft	cutting
12.	*Lavandula angustifolia*	English lavender	cutting
13.	*Origanum vulgaris*	Origanum	seeds cutting
14.	*Petrorhagia saxifraga*	Tunic Flower	seeds, cutting
15.	*Phlomis fruticosa*	Jerusalem sage	cutting
16.	*Plantago serpentina*	Sea plantain	seeds
17.	*Potentilla neumanniana*	Alpine Cinquefoil	tuft dividion, seeds
18.	*Rosmarino officinalis prostratus*	Creeping rosemary	cutting
19.	*Ruta graveolens*	Common rue	seeds, cutting
20.	*Santolina marchii*	Cotton lavander	cutting
22.	*Sedum acre*	Goldmoss stonecrop	cutting, seeds
23.	*Sedum album*	White Stonecrop.	cutting, seeds
24.	*Teucrium chamaedris*	Wall germander	cutting, seeds
25.	*Thymus serpyllum*	Creeping thyme	cutting, seeds
26.	*Thymus vulgaris*	Common thyme	cutting seeds

From the tests carried out it resulted that species in Tab. 2 are suitable for the use in extensive green roofs. These species can be grown in shallow substrates given that irrigation is provided during periods of very dry weather.

For a species to be appropriate for use on a green roof, it is imperative that it can be commercially propagated and that its propagation must be efficient, cheap and easy. Propagation therefore is an additional and essential variable in the selection of green roof species: even if stress-resistant and able to survive on a green roof, plants that do not propagate easily will not meet the requirements for mass use. The selected plants have to be easily propagated either by seed, cutting or division.

Since autumn 2014, 19 plant species have undergone rooting tests in a green roof medium. Tests were carried out both on site and in a greenhouse under controlled environment (Fig.1).

Figure 1 The two propagation environments, greenhouse on the left and on site in GR simulator on the right

3. Propagation trials

Of the 40 plant species tested in the green roof simulator, 26 species were selected for propagation tests (Table2). These species were classified according to their major propagation attitude, which is either by cutting or through seeding. Preliminary trials confirmed which species required the use of the plant growth regulator *indol butyric acid* (IBA) confirming existing literature.

Figure 2 New vegetative growth and root development in cuttings of Helichrysum (left) and Thymus (right).

For example, considering all the characteristics recorded (extent of new growth, number of main roots and their major length, vitality), treated cuttings with the plant rooting hormone IBA at 100 ppm concentration, outperformed the controls only in a few species. In species like *Helichrysum*, IBA effectiveness was confirmed through parameters such as plant height, length of roots and their number, more than the rooting percentage (Fig 2 on the left). The green roof medium (MT1) performed slightly better than the control which was a peat-based medium. This was also true for *Thymus* sp. Its susceptibility to IBA was not significant at the concentration and treatment time adopted at least in terms of root development (Fig 2 on the right).

On the other hand, *Iberis* performed poorly in terms of rooting with or without IBA treatment.

A. Cutting trials.

Green roof substrate MT1 (Malta 1) was used to investigate the rooting potential of a number of selected plant species. MT1 is a green roof substrate created my MAC S.r.l at the beginning of the LifeMedGreenRoof project for use in the Maltese green roof. Fifteen species were selected for this trial. Half of the cuttings were treated with plant growth regulator and the other half was not. Treatment was carried out according to the best practice reported in technical literature. When treated, cuttings were immersed for 5 seconds to 10 seconds (with the exception of *Phlomis*, which required 300 seconds) in a solution of the rooting plant growth regulator IBA at a concentration according to the species (Table. 3).

Table 3 Usual cutting treatments for propagating the employed species

Species	IBA (ppm)	Time cutting immersion (sec)	Reference
Cerastium biebersteinii	0	-	previous cutting trials during the progect LifeMedGreenRoofs
Ceratostigma plumbaginoides	1000	5	Mello E., Fisher P., Santos K., 2005: *"Perennial Propagation with Rooting Hormone Dips and Fertilizer in the Mist".* Internal Report for Young Plant Research Center Partners
Dianthus gratianopolitanus	550	10	Satendra Kumar, M.S.Verma, S.K.Lodhi and S.K.Tripathi, 2006: *"Effect of growth chemicals, type of cutting and season, root formation of carnation (Dianthus caryophyllus L.) cutting".* Internat. J. agric. Sci. Vol.2 No.2 : 596-598
Helichrysum italicum	0	-	previous cutting trials during the progect LifeMedGreenRoofs
Iberis sempervirens	500	10	previous cutting trials during the progect LifeMedGreenRoofs
Lavandula angustifolia	150	10	Dirr MA, Heuser CW (1987). *"The reference manual of woody plant propagation.From seed to Tissue Culture"* Varsity Press, Athens, 145-146 pp.
Mesembrianthemum cooperi	0	-	
Phlomis fruticosa	5000	300	Research Book n 34 April 2004: *"Progetto di sperimentazione regionale sul florovivaismo"*
Rosmarino officinalis prostratus	1000	10	Dirr MA, Heuser CW (1987). *"The reference manual of woody plant propagation.From seed to Tissue Culture"* Varsity Press, Athens, 193 pp.
Santolina marchii	500	10	previous cutting trials during the progect LifeMedGreenRoofs
Sedum acre	0	-	previous cutting trials during the progect LifeMedGreenRoofs
Sedum album	0	-	previous cutting trials during the progect LifeMedGreenRoofs
Teucrium chamaedris	1000	10	Dirr MA, Heuser CW, 1987: *"The reference manual of woody plant propagation.From seed to Tissue Culture".* Varsity Press, Athens, 208 pp.
Thymus serpyllum	500	10	Iapichino, G., Arnone, C., Bertolini, M. and Amico Roxas, U., 2006: *"Propagation of three Thymus species by stem cuttings".* Acta Hortic. 723, 411-414
Thymus vulgaris	500	10	Iapichino, G., Arnone, C., Bertolini, M. and Amico Roxas, U., 2006: *"Propagation of three Thymus species by stem cuttings".* Acta Hortic. 723, 411-414

The experimental unit was composed of 10 cuttings in a split plot design with 4 replications. Cuttings were put in an open air environment. Rooting was evaluated 90 days after.

Rooting in open air condition depended upon species and season as reported in the Tab 4 and in Fig 4. The seasonal conditions had a significant effect on the development of the cuttings. Development success depended on the species.

In both spring and autumn, Sedum *album* and *S. acre* achieved 100% rooting on site (in the green roof simulator), as expected. Only *Santolina* gave 100% rooting success in autumn and about 80% in spring. Rooting of *Cerastium* sp., *Thymus* sp, *Lavandula* sp and *Teucrium* sp was

poor or none at all in spring, while in autumn rooting was almost always successful.

In the case of *Mesambrianthemum* sp, rooting failed in both seasons. This may have been related to low temperature considering the requirements of the species. In spring or summer, rooting may prove more successful, this requires further testing.

Root length was longer in spring than in autumn in *Cerastium* and *Santolina,* despite the lower percentage of roots. The roots of all the other species elongated better in autumn.

Except for *Santolina*, root number was higher in autumn in all the species tested.

Species which have rooted in the spring have shown more growth than those which have rooted in autumn with the exception of *Lavandula* and *Thymus*.

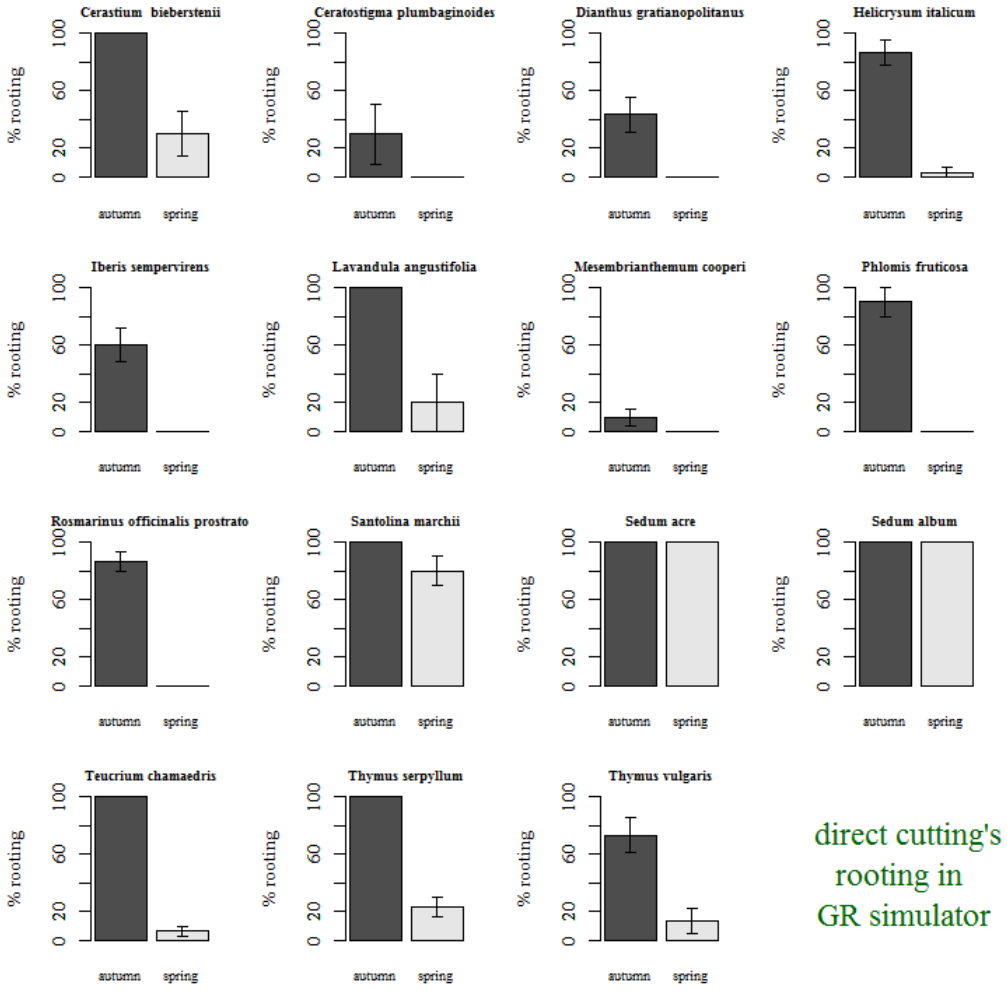

Figure 3 Percentage of rooted cuttings in spring and autumn

Table 4 Percentage rooted cuttings, root length, root number and height in spring and autumn

species	% rooting				root length (cm)				root number				height (cm)			
	autumn		Spring		autumn		Spring		autumn		Spring		autumn		Spring	
Cerastium bieberstenii	100.00	a	30.00	b	114.12	b	126.08	a	11.73	cd	6.58	bcd	158.33	a	202.50	a
Ceratostigma plumbaginoides	30.00	de	0.00	b	23.53	efg	0.00	F	2.92	fg	0.00	F	45.75	cde	107.67	bcd
Dianthus gratianopolitanus	43.33	cde	0.00	b	11.87	fg	0.00	f	2.62	fg	0.00	F	24.45	de	0.00	e
Helicrysum italicum	86.67	ab	3.33	b	62.97	cde	59.67	cd	10.02	de	5.75	de	71.97	bc	117.83	bc
Iberis sempervirens	60.00	bcd	0.00	b	22.33	efg	0.00	f	5.45	ef	0.00	F	17.78	de	0.00	e
Lavandula angustifolia	100.00	a	20.00	b	84.52	bcd	6.27	ef	8.38	de	0.13	F	33.52	cde	5.08	e
Mesembrianthemum cooperi	10.00	e	0.00	b	9.67	g	0.00	f	0.42	g	0.00	F	2.77	e	0.00	e
Phlomis fruticosa	90.00	ab	0.00	b	61.65	cde	0.00	f	7.73	de	0.00	F	47.73	cde	0.00	e
Rosmarinus officinalis	86.67	ab	0.00	b	54.60	cdef	0.00	f	5.68	ef	0.00	F	37.00	cde	0.00	e
Santolina marchii	100.00	a	80.00	a	40.72	defg	60.50	cd	8.57	de	28.60	A	27.60	cde	90.67	cd
Sedum acre	100.00	a	100.00	a	88.87	bc	67.83	bc	21.78	ab	8.45	B	49.75	cd	65.50	d
Sedum album	100.00	a	100.00	a	80.72	bcd	49.15	cde	20.72	bc	4.67	bcd	43.25	cde	63.17	d
Teucrium chamaedris	100.00	a	6.67	b	172.50	a	111.83	ab	30.08	a	12.85	bc	98.05	b	142.83	b
Thymus serpyllum	100.00	a	23.33	b	118.67	b	70.33	bc	10.32	de	5.20	cd	29.17	cde	74.33	cd
Thymus vulgaris	73.33	abc	13.33	b	32.85	efg	19.33	def	5.88	ef	0.73	ef	23.73	de	7.83	e

B. Seed trials.

To test the efficiency of seed germination, the green roof substrate Malta 1 was used. Green roof growing media are not suitable for seed germination because of the course particles they are made of. This characteristic is useful to avoid weeds however it can also decreases plant propagation of cultivated species. Tests were carried out in a controlled greenhouse environment as well as on site. Seeding was carried out both in the spring and autumn seasons. The experimental unit account for 50 seeds per lot. A complete randomized block design was imposed to autumn and springtime trials with 4 replications.

The greenhouse germination shows potential even if excessive wetting caused seedlings to decay, especially with *Origanum*. This was observed both in spring and autumn. *Allium* sp and *Dianthus carthusianorum* showed this pattern mainly in autumn.

In autumn, *Dianthus, Ruta* and *Origanum* germination was more successful in the green roof simulators than in the greenhouse, while seeds of *Teucrium*, *Plantago* and *Allium* germinated better indoors. *Allium* seeds did not germinate outdoors and outdoor poor germination occurred in *Plantago* whose germination increased from 10 to 50% in March (Fig. 5) for autumn seeding. The seeds of this species has a complex type of dormancy: repeated cycling of drought and wet condition are needed to break the dormancy. Seedlings of species seeded outdoors in autumn and which eventually germinated suffered problems in winter.

In spring the percentage germination of plants grown indoors reached the potential of each species. On the other hand, in the green roof simulator germination reached only 5%, achieving 25% only in *Dianthus carthusianorum*. *Allium* germinated outdoors was unsuccessful even in spring (Fig. 5).

Another factor which is crucial in plant establishment is the mortality, or the survival rate of seedlings. The mortality rate of spring sown species in the simulator after about 40-100 day from germination is a key factor to consider: in the autumn seedling death is caused by the winter low temperatures, in springtime it is caused by the summer drought.

Therefore, not all the species tested can spread naturally on the green roof. Experience shows that *Potentilla neumanniana* can spread all around the green roof by seeds. This is also relevant to *Thymus* sp. even if at an inferior rate.

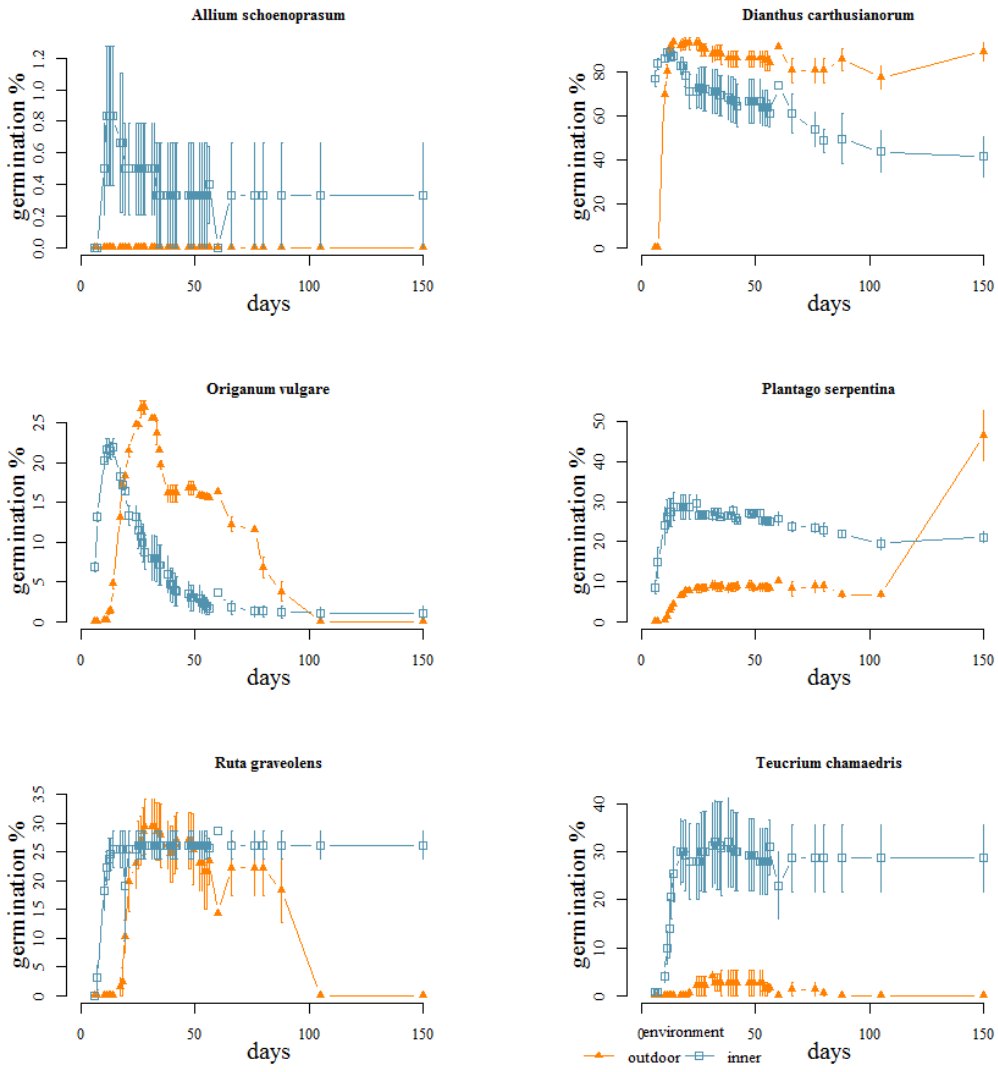

Figure 4 Autumn germination percentage

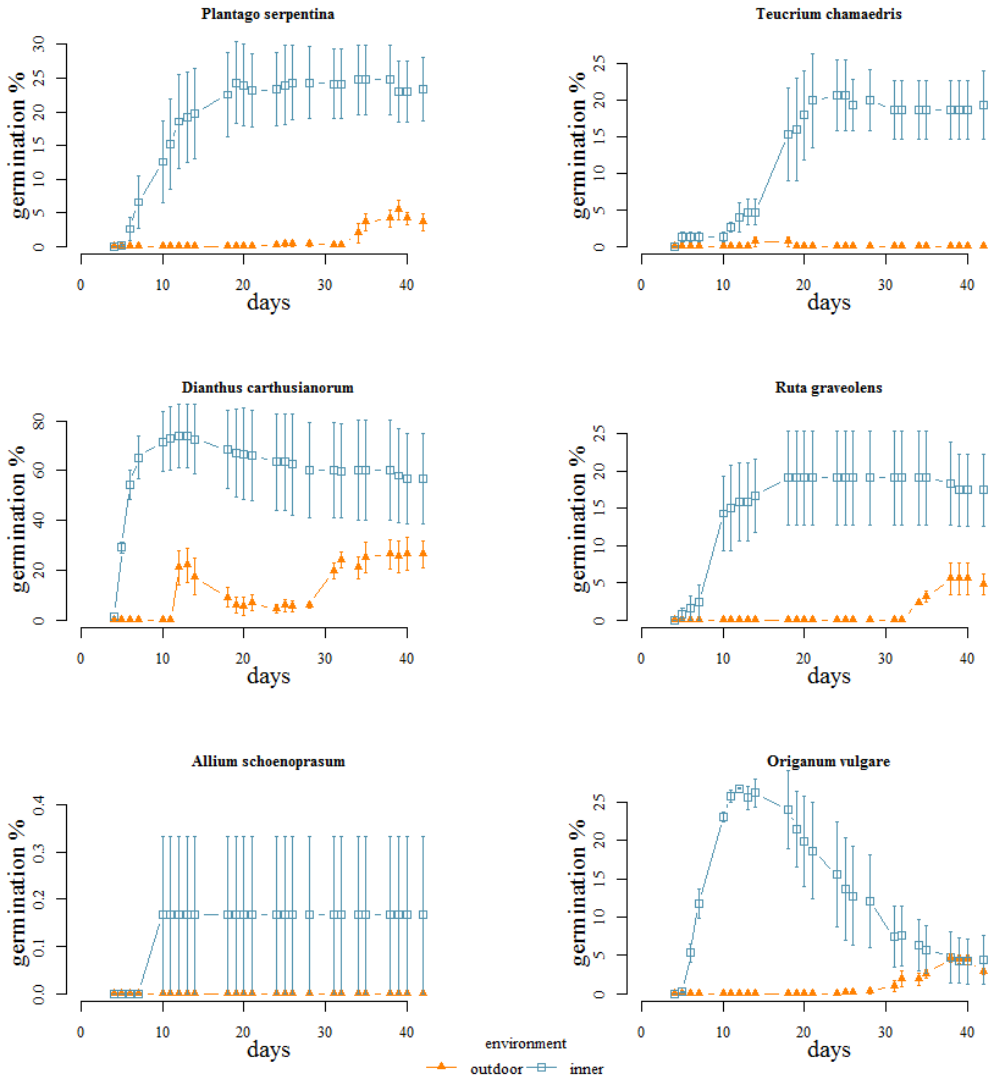

Figure 5 Spring germination percentage

C Division trials.

Propagation by division is not the preferred way to multiply plant stock because of the need of a high number of parent plant maintenance, poor multiplication rates compared to seeds and cuttings. Nevertheless, it is a solution for species which do not perform well by cuttings.

Trials by division were evaluated by studying the vitality of the shoots of a plant 60 days after it has been repotted from a 7cm to an 18 cm diameter pot. Species selected were those unsuitable for propagation by cutting. *Petrorhagia saxifraga* gave the poorest results with only 30% success. This is not considered high enough for commercial production (tab. 5). The best performance was given by *Campanula* and *Potentilla* respectively.

Table 5 Percent rooting in tuft division

Species	pot Ø cm	Rooted plants %	
Armeria maritima	9	72%	± 0.02
Campanula poscharskyana	9	97%	± 0.01
Ceratostigma plumaginoides	18	83%	± 0.01
Petrorhagia saxifraga	7	30%	± 0.28
Potentilla neumanniana	9	90%	± 0.01

4. Conclusion

Green roof substrates are not ideal for seed germination due to large size of the particles from which they are composed. Erratic weather conditions also account for poor germination and plantlet survival.

The selected species are known to be suitable for commercial propagation, but only a few can be propagated in a green roof environment. Species such as *Cerastium, Helycrysum, Iberis, Lavandula, Phlomis, Rosmarinum*, *Santolina, Sedum* species, *Teucrium, Thymus* spp. can be successfully propagated in autumn whereas only *Santolina* and *Sedum* species gave satisfactory results in spring. The issues related to mortality for plant cuttings include cold spells in autumn and drought in summer.

According to the experiments conducted, direct propagation is achievable depends upon the species. The use of irrigation and protection, may enhance performance, but financial returns might not be adequate. Direct seeding can be used to fill in patches of bare substrate in between existing vegetation during maintenance tasks. The poor seed germination in a green roof substrate confirms the suitability of green roof substrates in suppressing weeds growth and dispersal by seed. Plant division may be utilized when other methods are not suitable for the species as in the case of *Armeria* and *Potentilla.* These may successfully reach high division rates.

Table 6 Detailed propagation methods and results achieved per species

SPECIES AND REFERENCE TREATMENTS					LIFE PROJECT		FINAL INFORMATION	
Ref	**Scientific name**	**Common name**	**Propagation**	**Reference treatment**	**Treatments done in the project**	**Survival rate on GR**	**Efficiency of direct GR propagation**	
							Springtime	**Autumn**
1	*Allium schoenoprasum*	Chives	cuttings		-			
			seed	seed in Spring or Autumn, germination 60%	Seed in Spring or Autumn	low	none	none
			tuft division					
2	*Armeria maritima*	Sea Pink	cuttings	-	-			
			seed	seed after chilling, 40 to 70 % germination in 15-60 days				
			tuft division	divide rootball	divide rootball	high		high
3	*Cerastium biebersteinii*	Boreal chickweed	cuttings	in Spring and Autumn no PGR treatment	in Spring and Autumn	high	medium low	high
			seed	early in Spring				
			tuft division					
4	*Ceratostigma plumbaginoides*	Plumbago	cuttings	herbaceous or softwood cuttings , 0.1% IBA in May June 60% rooting	0.1% IBA, 5"dip	medium	no	medium low
			seed	-				
			tuft division	root cutting in early Spring 90% rooting	in Autumn division of new root offSpring	high		high
5	*Dianthus carthusianorum*	Carthusian pink	cuttings		_			
			seed	seed in Autumn and Springtime	seed in Autumn and Springtime	high	medium low	high

			tuft division		slow number of daughter plant	high		
6	*Dianthus deltoides*	Maiden pink	cuttings					
			seed	seed in February				
			tuft division					
7	*Dianthus gratianopolitanus*	Cheddar pink	cuttings	single shoot and root in a month, 0.05% IBA	single shoot and root in a month	medium	no	medium
			seed		-			
			tuft division	divided in a few clumps				
8	*Globularia punctata*	Common Globe Flower	cuttings		-			
			seed	chilled seeds germinate in 3-4 weeks	seed in Springtime or Autumn, slow growing	medium	medium	medium
			tuft division	2 to 3 rosettes can be sometime divided per plant	vegetative division	high	very low	very low
9	*Helichrysum italicum*	Curry plant	cuttings	semi herbaceous half ripe wood catting in June root in 3-4 week	no PGR required for rooting even if root number is risen by 0.1% IBA	depending from season	low	high
			seed	seed in early Spring germinated in 90% rate	-			
			tuft division	-	-			
10	*Hieracium pilosella*	Mouse-ear hawkweed	cuttings					
			seed	Seed all year around	Seed in early Spring or Autumn		low	
			tuft division	Running e secondary rosettes can be separate easily		high	low	low

11	*Iberis sempervirens*	Perennial candytuft	cuttings	soft root cutting in Spring, half ripe in Summer. 0.05% IBA, 10" dip, or 0.1-0.3% IBA in talc powder	0.05% IBA, 10" dip	medium low	no	medium
			seed	-				
			tuft division	-				
12	*Lavandula angustifolia*	English lavender	cuttings	tip cuttings in Spring, Summer and Autumn, best with hormone 80-90%	0.015% IBA, 10" dip	depending from season	low	high
			seed	no pretreatments, high germination rate (90%), slow growing seedlings				
			tuft division					
13	*Origanum vulgaris*	Origanum	cuttings					
			seed	high germination	seed in Autumn and Springtime	medium-low	medium-low	medium-low
			tuft division					
14	*Petrorhagia saxifraga*	Tunic Flower	cuttings					
			seed					
			tuft division		tuft division	slow number of daughter plant		low
15	*Phlomis fruticosa*	Jerusalem sage	cuttings	50-70% rooting of cutting taken from early autmn to Springtime after 300" dip in 0.5% IBA	cutting taken from early autmn to Springtime after 300" dip in 0.5% IBA	high	no	high
			seed					
			tuft division					
16		Sea plantain	cuttings					

	Plantago serpentina		seed	Spring or Autumn	Seed in Spring and Autumn	low	low	high
			tuft division					
17	*Potentilla neumanniana*	Alpine Cinquefoil	cuttings					
			seed	Seed	Spead easily and high germination	high	high	high
			tuft division	Division all year around	Till 20 daughter fron one plant, best lateSummer to earlyu Autumn	high	medium	medium
18	*Rosmarino officinalis prostratus*	Creeping rosemary	cuttings	early Spring cutting >90% rooted	0.1% IBA, 10"dip, in Spring and Autumn	high rooting in Autumn, absent in Spring	none	high
			seed					
			tuft division					
19	*Ruta graveolens*	Common rue	cuttings	tip cuttings in early Autumn				
			seed	seed in Autumn/Spring	seed in Spring and Autumn	high	low	medium
			tuft division					
20	*Santolina marchii*	Cotton lavander	cuttings	in mid Summer to early Autumn, lateral shoot tip cutting. Softwood treated with 0.3% IBA in talc powder, hardwood with 0.8%	0.05% IBA, 10" dip, in Spring and Autumn	high	high	high
			seed	-				
			tuft division	-				

22	*Sedum acre*	Goldmoss stonecrop	cuttings	from leaves , plant fragments and branches, almost 100% rooting	cutting without IBA	high	high	high
			seed					
			tuft division					
23	*Sedum album*	White Stonecrop.	cuttings	from leaves , plant fragments and branches, almost 100% rooting	cutting without IBA	high	high	high
			seed					
			tuft division					
24	*Teucrium chamaedris*	Wall germander	cuttings	0.1 to0.3% IBA gives 60% and more rooting	0.1% IBA, 10"dip, in Spring and Autumn	high	high	low
			seed	seed germination >60%, no dormancy breaking treatment	seed in Spring and Autumn	germination <10% in Autumn, almost absent in Spring	high	high
			tuft division					
25	*Thymus serpyllum*	Creeping thyme	cuttings	High rooted cutting from herbaceous in Spring or half ripe wood shoot tip in mid Summer to early Autumn, 0.05% IBA for 10" dip gives 70-100% rooting	Spring and Autumn cutting (0.05% IBA 10" dip)	high	medium low	high
			seed	seed easily germinate	seeds can been spread in early Autumn or Springtime, but	high	medium	medium

					germination is erratic			
			tuft division	division in Spring, each stakes with a root				
26	*Thymus vulgaris*	Common thyme	cuttings	High rooted cutting from herbaceous in Spring or half ripe wood shoot tip in mid Summer to early Autumn; 0.05% IBA, 10" dip improves rooting	Spring and Autumn cutting (0.05% IBA 10" dip)	medium	medium low	high
			seed	seed easily germinate				
			tuft division	division in Spring, each stakes with a root				

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