XXVII EUCARPIA Ornamentals Symposium
From Nature to Culture: Breeding Ornamentals for Sustainability
Genoa (Italy), 2-5 July 2023

USING SELECTED HABITAT EUROPEAN DIRECTIVE SPECIES AS GARDEN PLANTS: CHALLENGES AND OPPORTUNITIES

LIFE SEED FORCE – SAVING PLANT DIVERSITY

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The Life+ SEEDFORCE project aims at improving the conservation status of 29 Annex II Habitat European Directive plant species, reported in bad conditions according to the 2013-2018 report on the trends of habitats and species according to art. 17 of the Directive. The project will identify and remove threats to the survival of these species in their native range, will assess their the genetic makeup, model their ecological niche and massively propagate them to bridge the isolation and re-establish gene flow between isolated population. To raise awareness of these species and to engage the public in their active conservation a selection of this species with ornamental and/or garden value will be tested for performance in suitable garden setting, including dry Mediterranean gardens [*Cytisus aeolicus* Guss., *Primula palinuri* Petagna, *Valeriana amazonum* (Fridl. & A.Raynal) Christenh. & Byng, *Dracocephalum austriacum* L., *Eryngium alpinum* L.] and wet boggy gardens [*Woodwardia radicans* (L.) Sm., *Adenophora liliifolia* (L.) A.DC., *Kosteletzkya pentacarpos* (L.) Ledeb.]. The project can therefore represent an example of a bridge linking the conservation of natural biodiversity and the production sector of ornamental plants.

Adenophora liliifolia (L.) Ledeb. ex A. DC. (Campanulaceae) Ann. II, IV (4068)
Actions (MUSE, UNIPD, UL-BF) in SACs: IT3120127 - Monti Tremalzo e Tombea, IT3230083 - Dolomiti Feltrine e Bellunesi, SI3000181 - Kum, SI3000263 - Kočevsko

Distribution: E Europe and Asia (ALP, CON, PAN in AT, CZ, DE, HR, HU, IT, PL, RO, SI, SK).
Habitat: Bright woodland edges on limestone. ***Threats***: discontinued haymaking, reforestation, fragmentation.
Conservation status (2018): Inadequate (U1-) in IT(ALP), (U1=) in SI(CON). ***IUCN status*** IT(2013): NT, EU(2011): LC.

*****Cytisus aeolicus*** Guss. (Fabaceae) Ann. II, IV (1546)
Actions (UNICT) in SACs: Isola di Vulcano - ITA030027, Isola di Alicudi - ITA030023

Distribution: endemic to the islands of Vulcano, Stromboli and Alicudi (Aeolian Archipelago, Sicily, Italy) (MED in IT).
Habitat: cliffs and scrub formations in the thermo-Mediterranean zone. ***Threats***: Fire, grazing, fragmentation.
Conservation status (2018): Inadequate (U1-) in IT(MED). ***IUCN status*** IT (2013): EN, EU (2011): CR

Kosteletzkya pentacarpos (L.) Ledeb. (Malvaceae) Ann. II, IV (1581)
Actions (UNIPD) in SACs: IT3250003 – Penisola del Cavallino: biotopi litoranei, IT4060015 – Bosco della Mesola, Bosco Panfilia, Bosco di Santa Giustina, Valle Falce, La Goara, IT4060005 – Sacca di Goro, Valle Dindona, Foce del Po di Volano

Distribution: SE Europe (CON, MED in ES, F, IT).
Habitat: irregular flooded coastal areas and along rivers. ***Threats***: land reclamation, drainage, invasion of alien species.
Conservation status (2018): Inadequate (U1-) in IT (ALP). ***IUCN status*** IT (2013): CR A2ac, EU (2011): VU.

Eryngium alpinum L. (Umbelliferae) Ann. II (1604)
Actions (UNIUD, UL-BF) in SACs: IT3320012 - Prealpi Giulie Settentrionali, SI3000119 - Porezen

Distribution: Alpine endemic on the whole alpine chain (ALP, CON in AT, FR, HR, IT, SI).
Habitat: wet meadows, wet ravines with low shrubs. ***Threats***: discontinued haymaking, reforestation, fragmentation
Conservation status (2018): Inadequate (U1+) in IT(ALP), (U1=) in SI(ALP). ***IUCN status*** IT(2013): EN B2ab(i,ii,iv,v), EU(2011): NT

Dracocephalum austriacum L. (Labiatae) Ann. II, IV (1689)
Actions (MUSE) in SACs: IT3120114 - Monte Zugna, IT3120116 - Monte Malachin

Distribution: Mountains of Central Europe and Caucasus (ALP, CON, MED, PAN in AT, CZ, ES, FR, HU, IT, RO, SK).
Habitat: Dry rocky grassland. ***Threats***: discontinued haymaking, reforestation, habitat fragmentation.
Conservation status (2018): Inadequate (U1=) in IT (ALP). ***IUCN status*** IT(2013): EN B2ab(iii), EU(2011): DD.

Centranthus amazonum Fridl. & A.Raynal (Caprifoliaceae) Ann. II, IV (6909)
Actions (UNICA) in SAC ITB022212 Supramonte di Oliena, Orgosolo e Urzulei - Su Sercone

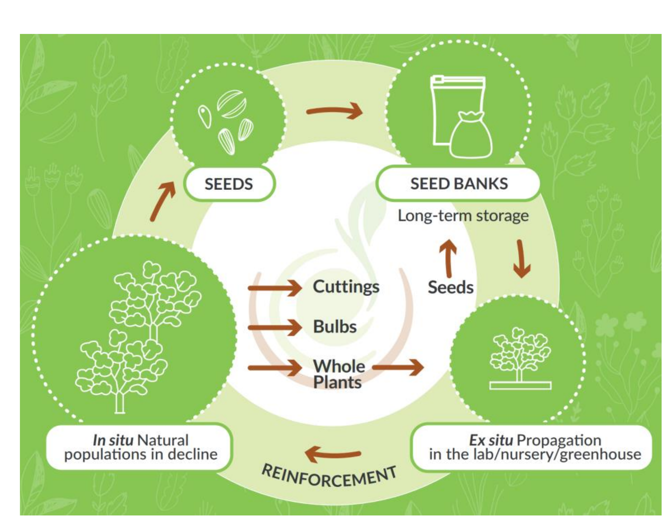
Distribution: Narrow endemic plant of Central-Eastern Sardinia (Italy). (MED in IT).
Habitat: It grows on limestone karst mountains at ca. 1300 m a.s.l.. ***Threats:*** small population size, grazing by goats, collectors.
Conservation status (2018): Bad U2(-) in IT(MED), ***IUCN status***: (2013): CR B1ab(i,ii,iii,iv,v) + B2ab(i,ii,iii,iv,v) + D1.

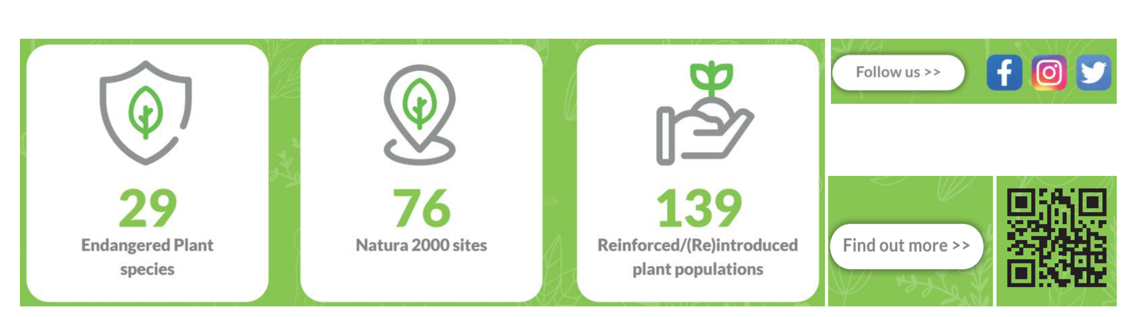
Primula palinuri Petagna (Primulaceae) Ann. II, IV (1628)
Action (BGR-DEB) in SACS: IT8050008 - Capo Palinuro, IT8050011 - Fascia interna di Costa degli Infreschi e della Masseta

Distribution: endemic to Southern Italy (Campania, Basilicata e Calabria) in 6 fragmented populations. (MED in IT)
Habitat: Limestone cliffs facing north. ***Threats***: grazing, anthropogenic disturbance, invasive alien species, fires.
Conservation status (2018): Inadequate (U1-) in IT (MED), ***IUCN status***: IT(2013): VU, B1ab(iii, v)+ B2ab(iii, v), EU(2011): VU.

Woodwardia radicans (L.) Sm. (Blechnaceae) Ann. II, IV (1426)
Actions (UNITUS) in SACs: IT8030008 Dorsale dei Monti Lattari, ITA030010 Fiume Fiumedinisi, Monte Scuderi, ITA030011 Dorsale Curcuraci, Antennamare

Distribution: boreal-subtropical, found in Macaronesia and in the Mediterranean (ATL, MAC, MED in ES, FR, GR, IT, PT)
Habitat: wet cliffs, undergrowth of gorges. ***Threats***: isolation, fragmentation and small population size; grazing.
Conservation status (2018): Inadequate (U1-) in IT (MED). ***IUCN status*** IT(2013): EN B2ab(i,ii,iii,iv), EU (2017): VU A2c.





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ROLE OF BOTANIC GARDENS FOR ORNAMENTAL PLANTS CONSERVATION TROUGH SUSTAINABLE MANAGEMENT: CASE STUDIES AT HANBURY BOTANIC GARDENS

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INTRODUCTION

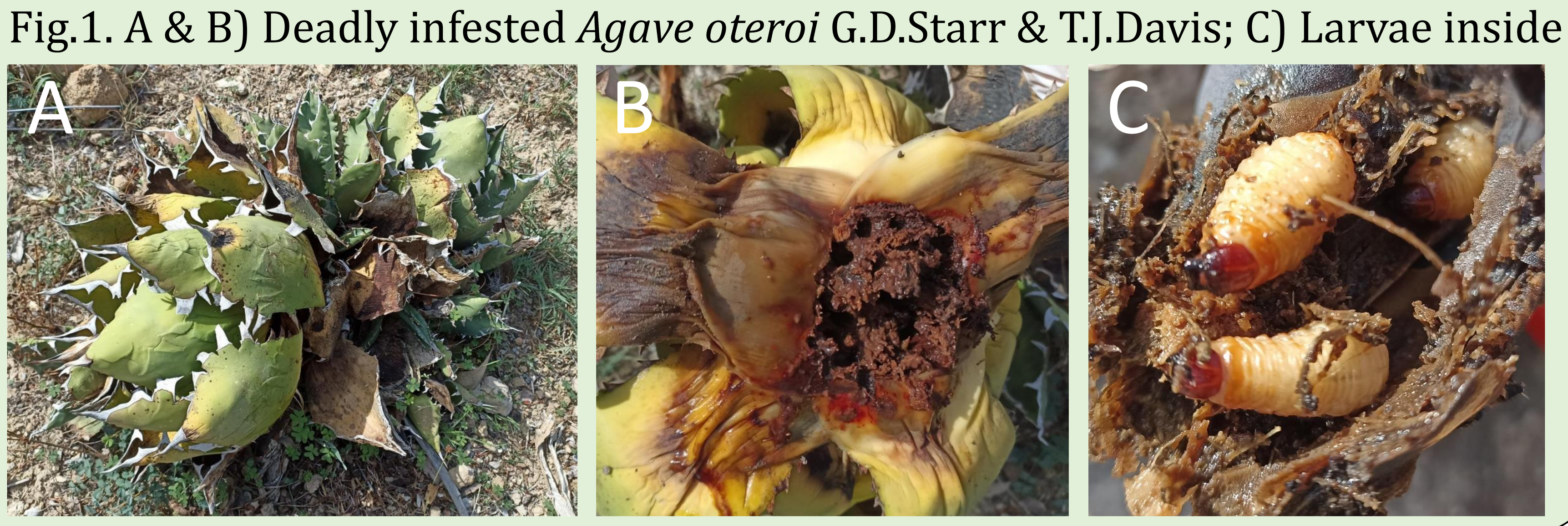
In recent years in botanic gardens there has been an increase in parasitic infestations on many plants collections as a result of both the introduction of several invasive alien species (IAS) and climate change. The IAS' management with sustainable methods becomes a priority. Hanbury Botanic Gardens (HBG) accommodate important ornamental plants collections, representing a scientific, historical, and biological diversity assets plus a significant genetic resource, that can be used as a basis for genetic improvement efforts. The following parasites now threaten the conservation of the plants, and several sustainable approaches are used to control the pests.

THE AGAVE WEEVIL

Scyphophorus acupunctatus Gyllenhal,1838 (Coleoptera: Dryophthoridae)

It is a species native to Central America, and it is considered the most important pest of agave worldwide. The damage to the host plants is caused by the feeding activity of larvae and adults, but the weevil is also a vector of microorganisms that break down the plant tissue. In HBG *S. acupunctatus* was discovered in 2018, since June 2021 its monitoring has begun and an IPM strategy has been used for its control. In 2022, 15 infested plants were eradicated, with a mean of 15.4 adult weevils and 25.93 larvae per plant; phytosanitary measures must be used in order to decrease weevil populations. The data monitoring revealed a drop in adult weevils after a month of the *Steinernema carpocapsae* based treatment.

Fig.1. A & B) Deadly infested *Agave oteroi* G.D.Starr & T.J.Davis; C) Larvae inside

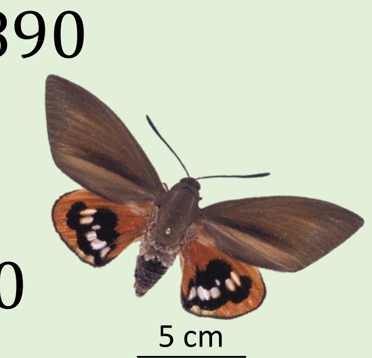


THE PALM PESTS

Rhynchophorus ferrugineus Olivier, 1890 (Coleoptera: Dryophthoridae)

and

Paysandisia archon Burmeister, 1880 (Lepidoptera: Castniidae)



Since 2014 the HBG's palm trees collection is threatened by the arrival of these alien species. Its larvae develop inside the plant and, depending on the intensity of the infestation, can lead to death. Over 40 *Phoenix canariensis* H.Wildpret plants were fatally attacked between 2015 and 2018. Since 2021, the HBG have developed a defense plan for both species. It involves repeated treatments of entomopathogenic organisms, such as *S. carpocapsae* and *Beauveria bassiana.* Plant mortality significantly decreased after these interventions.

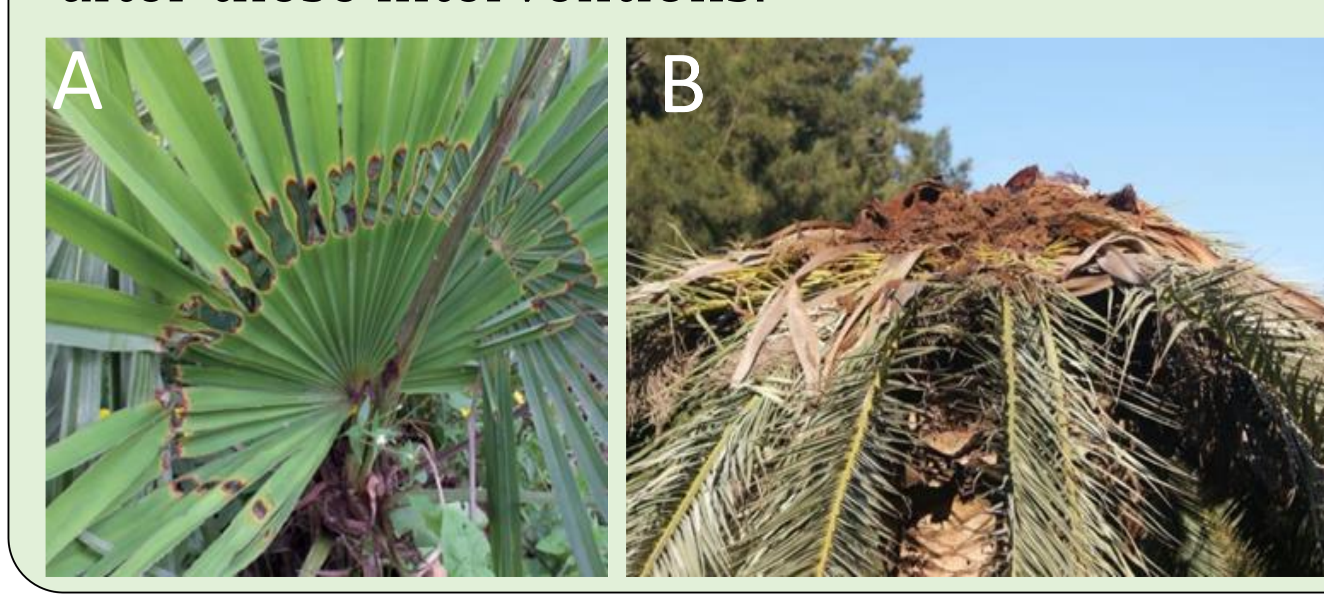


Fig.2. A) Typical *P. archon* damage on *Chamaerops humilis* L. leaf; B) *P. canariensis* stipe deadly infested by *R. ferrugineus*

THE CITRUS PESTS

Icerya purchasi Maskell, 1879 (Homoptera:Margarodidae)

Aonidiella aurantii Maskell, 1879 (Hemiptera:Diaspididae)

Unaspis yanonensis Kuwana, 1923 (Hemiptera:Diaspidinae)

Scale insects are major agricultural pests, their economic importance is connected to their ability to hide on all parts of the host plants. To keep these species under control *Rodolia cardinalis* and *Aphytis mellinus*-like antagonistic organisms are released into the citrus grove.

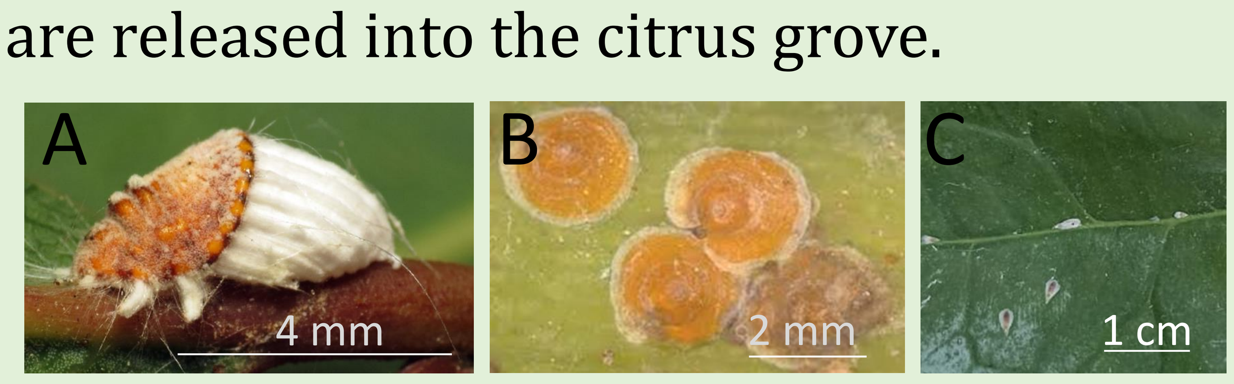


Fig.3. A) *I. purchasi;* B) *A. aurantii;* C) *U. yanonensis* on *Citrus aurantium* leaf

THE ALOE MITE

Aceria aloinis Keifer, 1941(Acari: Eriophyidae)

Many of aloe species are attacked by the eriophid mite. It causes important physiological and morphological alterations as tumor-like growths and is commonly referred to as aloe cancer. The biological control against this mite took place through the release of *Amblyseius swirskii* and *Neoseiulus californicus,* two predatory organisms.

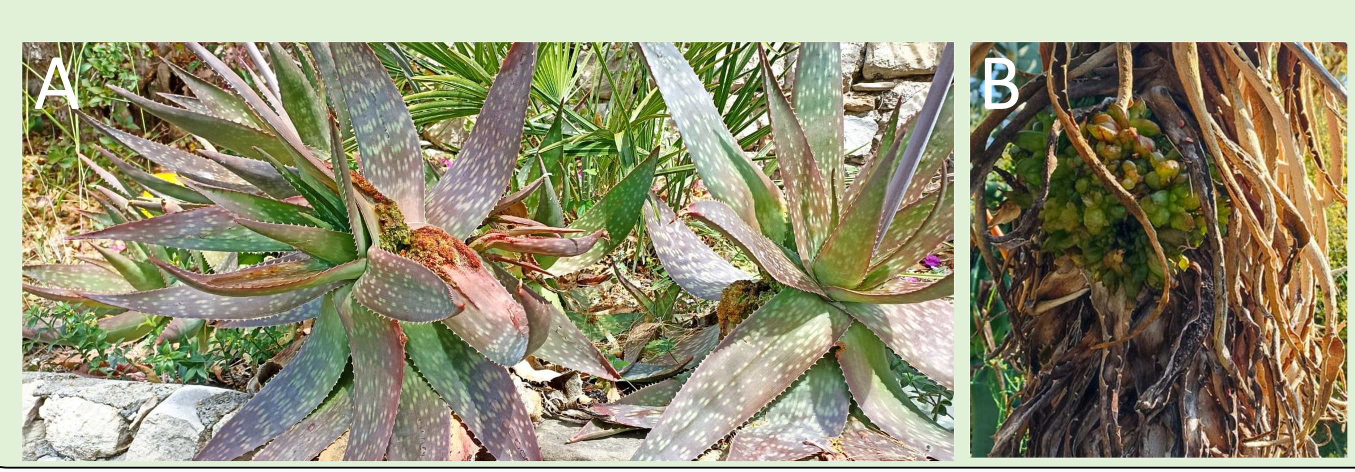


Fig.4. Aloe infested by *A. aloinis; A) Aloe* sp.*; B) Aloe arborescens*

CONCLUSION

The HBG's sustainable management practices have been successful in minimizing the harm caused by the various pests. Therefore, to reduce pollution and the loss of biodiversity brought on using chemical pesticides and to preserve ornamental plants, Botanical Gardens with their experience in sustainable control have a duty to share their management principles, potentially applicable both in urban greenery and in private gardens.

Succulent plant diversity as a boost for a sustainable Ligurian floriculture

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INTRODUCTION

Tissue-cultured plants of succulents (IRF, Sanremo)

Succulents are drought-tolerant plants increasingly recognized as a resource to mitigate the consequences of climate change. Thanks to their durability and flexibility, succulent plants offer many options for ornamental growers to provide low-maintenance plants that work well for green infrastructure, green roofs, and other eco-friendly projects. This added value offers new possibilities for ornamental growers to increase plant sales. Succulents have a centuries-old tradition in Liguria where the mild climate has been able to offer characteristics similar to the areas of origin of these plants. This has allowed the development of a significant production (approx. 20 million pots/year and 50 farms located in the Western area) characterized by many species addressed to a niche market. To maintain this production and to face the challenges related to competitiveness, it is mandatory to introduce new succulents with quantities which meet the market demands.

Plant tissue culture is a valuable mean that facilitates the propagation and shortens the time required to reach a commercial production of succulents and cacti. This aspect is particularly important in the case of unique, rare, or slow-growing plants. Moreover, the *in vitro* culture is useful to get healthy plants to be used as in vivo stock mother plants, and to perform an *in vitro* conservation of valuable genotypes or of endangered or threatened species.

In this work, we would like to present the work carried out at Regional Institute of Sanremo (IRF) which is addressed to *in vitro* cloning selected genotypes of several species.

MICROPROPAGATION FOR SUCCULENT PLANTS

In our work we use different plant tissues to initiate the *in vitro* culture (see table below). Interestingly, it is possible to propagate many species through axillary buds by removing the apical dominance.

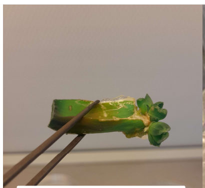
A surface sterilization of explants is carried out by a quick dip in 70% (v/v) ethanol, followed by a 20 min. treatment of 2% (v/v) NaOCl. Then explants are rinsed three times with sterile water (supplemented with 150 $mg\cdot l^{-1}$ ascorbic acid and 100 $mg\cdot l^{-1}$ citric acid to reduce browning).

Cultures are kept in a climate room (16 h light/8 h dark, 50-60 $\mu mol\cdot s^{-1}\cdot m^{-2}$ and 24$\pm$1°C) with regular subcultures every 8 weeks.

Our techniques allow to get a satisfactory initiation phase (50-100% of suitable explants according to the species) on **MS-based media** (Murashige & Skoog, 1962) supplemented with sucrose 3% (p/v) and gelled with 8 $g\cdot l^{-1}$ agar-agar (BV agar). Different **growth regulators** are used based on the species, and, generally speaking, low concentrations of kinetin-Kin or 6-Belzylaminopurine- BAP are added to the medium (see table below). We noticed that high cytokinin concentration enhances the hyperhydricity appearance in the micro-plantlets, hampering the subsequent micropropagation of many succulent plants.

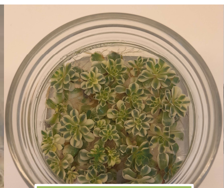
The table below shows data on multiplication rate.

Rooting can be carried out under *in vivo* conditions and no plant growth regulators are applied. After 2-week period the micro-plantlets placed on coco and peat substrate (70:30) are able to form a nice root system. ***Ex** vitro* plantlets showed a good survival rate (70-90%) after 4 weeks from the acclimatization and the subsequent *in vivo* growth was nice.



Regeneration on leaf explant of *Haworthia truncata* var. *maughani*

Regeneration on explant of *Tephrocactus geometricus*



Multiplication phase of *Echeveria* 'Compton Carousel'

Multiplication phase of *Crassula deceptor*

Hyperhydric shoots of *Crassula deceptor*

Multiplication phase of *Opuntia zebrina* f. reticulata

Rooted plants of *Agave pumila*

Acclimated plant of *Haworthia truncata* var. maughanii

Family	Genus	Species	Explant	Inoculation and multiplication medium	Method of micropropagation	Multiplication rate
Asphodelaceae	*Aloe*	*Aloe ibityensis*	shoot tip	MS + 2mg/L Kin+ 0.5mg/L IBA	axillary bud proliferation	5.6 ± 0.2
	Gasteria	*Gasteria batesiana*	shoot tip	MS + 0.25mg Kin+ 0.01mg/L IBA	axillary bud proliferation	6.2 ± 0.2
	Haworthia	*Haworthia truncata* var. maughani	shoot tip and leaf	MS + no growth regulators	axillary and adventitious bud proliferation from stem and leaf cutting (direct and indirect organogenesis)	8.4 ± 1
Asparagaceae	*Agave*	*Agave pumila*	shoot tip	MS + 1mg/L Kin+ 0.5mg/L IBA	axillary bud proliferation	3.5 ± 0.3
Asteraceae	*Senecio*	*Senecio saginata*	apical and nodal cutting	MS + 2mg/L BA+ 0.5mg/L IBA	axillary bud proliferation	8.8 ± 0.2
Cactaceae	*Mammillaria*	*Mammillaria formosa*	stem cutting	MS + 0.5mg/L BA+ 0.5mg/L IBA	axillary bud proliferation by areole activation (preexisting meristems)	3.9 ± 0.6
	Maihueniopsis (subfamily Opuntioideae)	*Maihueniopsis clavarioides*	new cladode (1-2 cm) or cladode segment with areole	MS + 0.5mg/L BA+ 0.5mg/L IBA	axillary bud proliferation by areole activation (preexisting meristems) and microcutting	3.3 ± 0.5
	Opuntia (subfamily Opuntioideae)	*Opuntia zebrina* f. reticulata	new cladode (1-2 cm) or cladode segment with areole	MS + 1mg/L BA+ 0.5mg/L IBA	axillary bud proliferation by areole activation (preexisting meristems) and microcutting	7.2 ± 0.2
	Tephrocactus (subfamily Opuntioideae)	*Tephrocactus geometricus*	new cladode (1-2 cm) or cladode segment with areole	MS + 1mg/L BA+ 0.5mg/L IBA	axillary bud proliferation by areole activation (preexisting meristems)	2 ± 0.1
Crassulaceae	*Crassula*	*Crassulla deceptor*	apical and nodal cutting, leaf	MS + no growth regulators	axillary bud proliferation and microcutting	7.6 ± 0.5
	Echeveria	*Echeveria* 'Compton Carousel'	apical and nodal cutting, leaf	MS + 0.25mg Kin+ 0.01mg/L IBA	axillary bud proliferation and microcutting	2.6 ± 0.1

Metabolite production from hairy root biomass in *Salvia* spp.

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XXVII EUCARPIA Ornamentals Symposium

crea Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

Introduction: Numerous plant species have been used to create hairy root (HR) cultures, which are caused by an infection with the bacterium *Agrobacterium rhizogenes*. HR cultures typically maintain a steady degree of biosynthetic ability while accumulating phytochemicals at quantities comparable to those of entire plants. HRs can be cultivated in industrial-scale bioreactors when they are adapted for liquid cultures, offering a practical, abundant, and sustainable supply of phytochemicals. Due to these properties, HR culture emerged as an appealing tool in the production of metabolites. The present examination aimed to summarize all previous research on the hairy roots of *Salvia* species (Table 1) and give the preliminary results on the ongoing work with the species: *S. oxyphora* and *S. karwinskii*. *Salvia* species transformed root cultures are rich in polyphenols, diterpenoids, and triterpenoids. These chemicals exhibit a range of biological properties, including the ability to activate the apoptotic process as well as antibacterial, cytotoxic, anticancer, and anti-inflammatory effects.

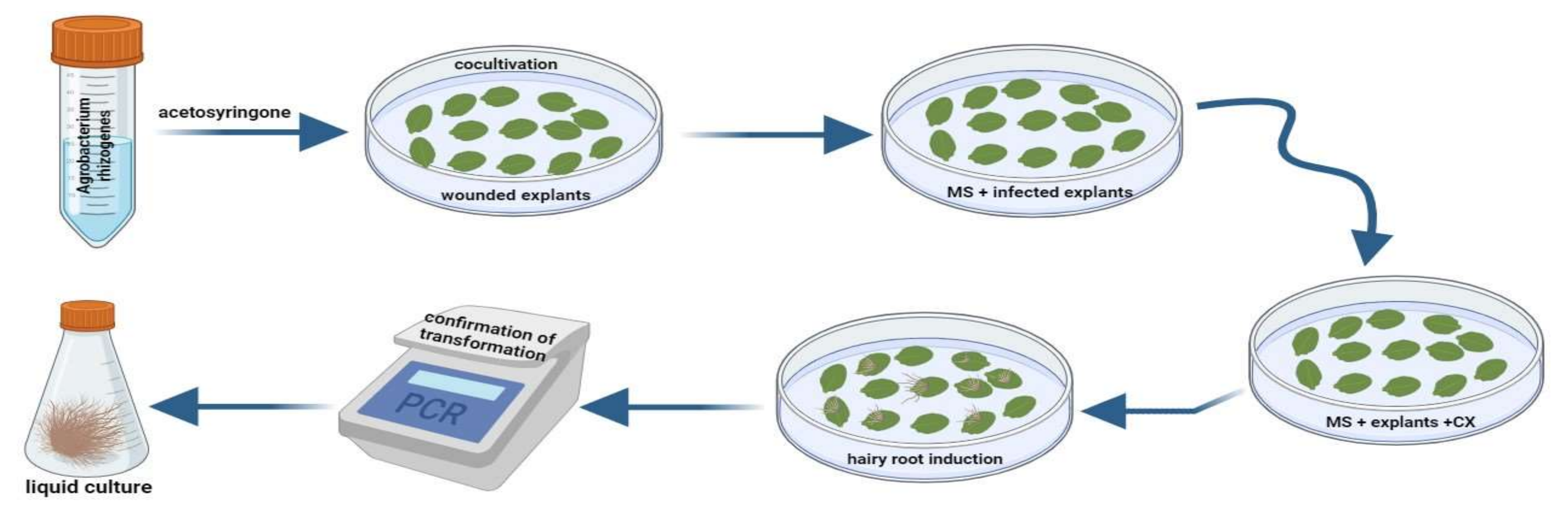

Fig. 1: Illustration of the transformation process

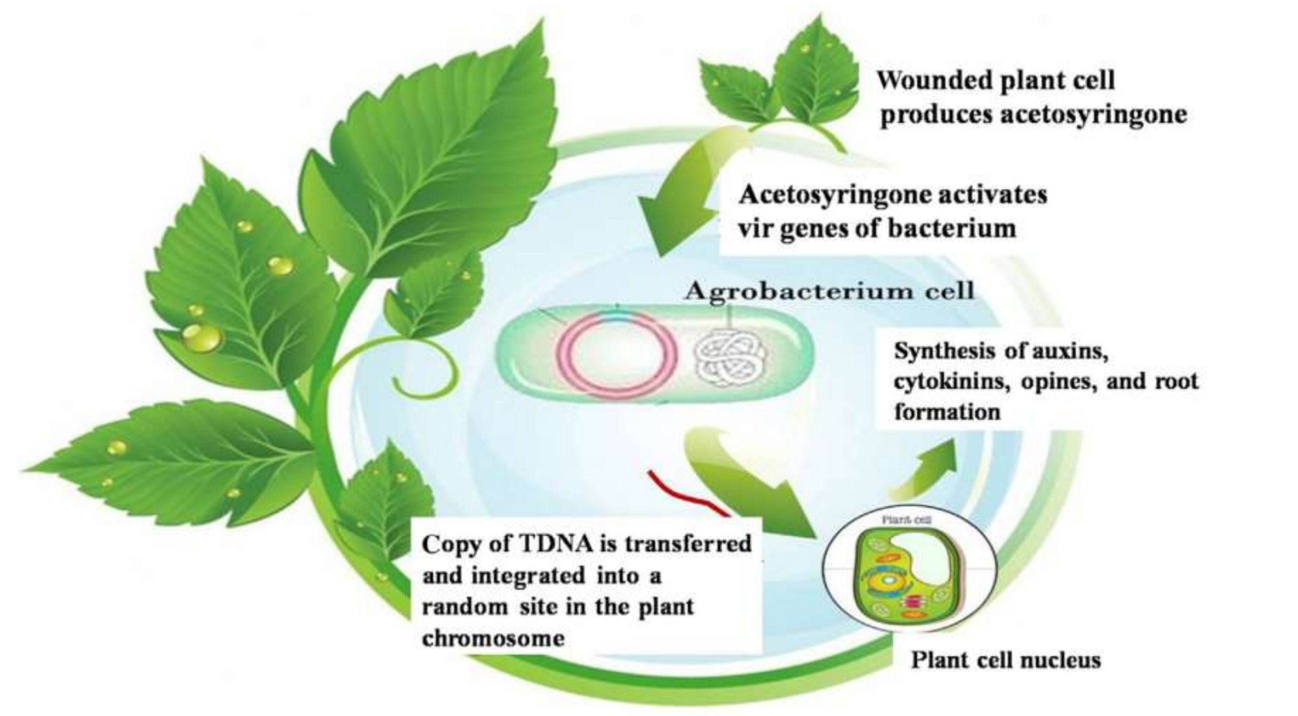

Fig. 2: Mechanism of T-DNA transfer by *Agrobacterium rhizogenes*

Table 1: Species *of Salvia* being investigated for HR cultures.

Species	First publication	Native place	*Agrobacterium rhizogenes* strain	Secondary metabolites	References
***S. miltiorrhiza* Bunge**	Enum. Pl. China Bor.: 50 (1833)	Central & S. China to Vietnam	ATCC 15834 LBA 9402, TR 105, R 1601, A 4 1027	Diterpenoids, Tashionone Polyphenolics	Hu & Alfermann, 1993, Wu & Shi, 2008
***S. Sclarea* L.**	Sp. Pl.: 27 (1753)	Medit. to Central Asia and W. Himalaya	ATCC 15834, LBA 9402	Abietane diterpenes, Sterols, Salvipisone, Aethiopinone	Rózalski et al., 2006, Vaccaro et al., 2019
***S. castanea* Diels.**	Notes Roy. Bot. Gard. Edinburgh 5: 233 (1912)	Central Himalaya to S. Central China	ATCC 15834	Tanshinones	Li et al., 2016, Yang et al., 2018
***S. officinalis* L.**	Sp. Pl.: 23 (1753)	SW. Germany to S. Europe	ATCC 15834, A4	Rosmarinic acid	Grzegorczyk et al., 2006
***S. wagneriana* Pol.**	Linnaea 41: 591 (1878)	SE. Mexico to Central America	ATCC 15834, NCPPB 1855	Rosmarinic acid	Ruffoni et al., 2016
***S. austriaca* Jacq.**	Fl. Austriac. 2: 8 (1774)	Central Europe to Romania	A4	Abietane diterpenes	Kuźma et al., 2017
***S. viridis* L.**	Sp. Pl.: 24 (1753)	Medit. to Turkmenistan	A4	Rosmarinic acid, Polyphenols	Grzegorczyk-Karolak et al., 2018, Karolak, 2020
***S. bulleyana* Diels**	Roy. Bot. Gard. Edinburgh 5: 233 (1912)	China	A4	Rosmarinic acid, Polyphenols	Wojciechowska et al., 2020
***S. przewalskii* Maxim**	Bull. Acad. Imp. Sci. Saint-Pétersbourg, sér. 3, 27: 526 (1882)	Tibet to Central China	ATCC 15834	Phenolic acid, Tashinones	Li et al., 2020
***S. corrugata* Vahl**	Enum. Pl. Obs. 1: 252 (1804)	S. Colombia to Peru	ATCC 15834, LBA 9402	Abietane Diterpenoids	Kenstop et al., 2021
***S. nemorosa* L.**	Sp. Pl., ed. 2.: 35 (1762)	Europe to W. Siberia and Afghanistan	ATCC 15834, A4, R1000, and GM1534	Rosmarinic acid	Khoshsokhan et al., 2022
***S. virgata* Jacq.**	Hort. Bot. Vindob. 1: 14 (1770)	SE. Europe to Central Asia	A4, ATCC 15834, R1000, GM1534, C58C1	Phenolic acids, Flavonoids	Dowom et al., 2022

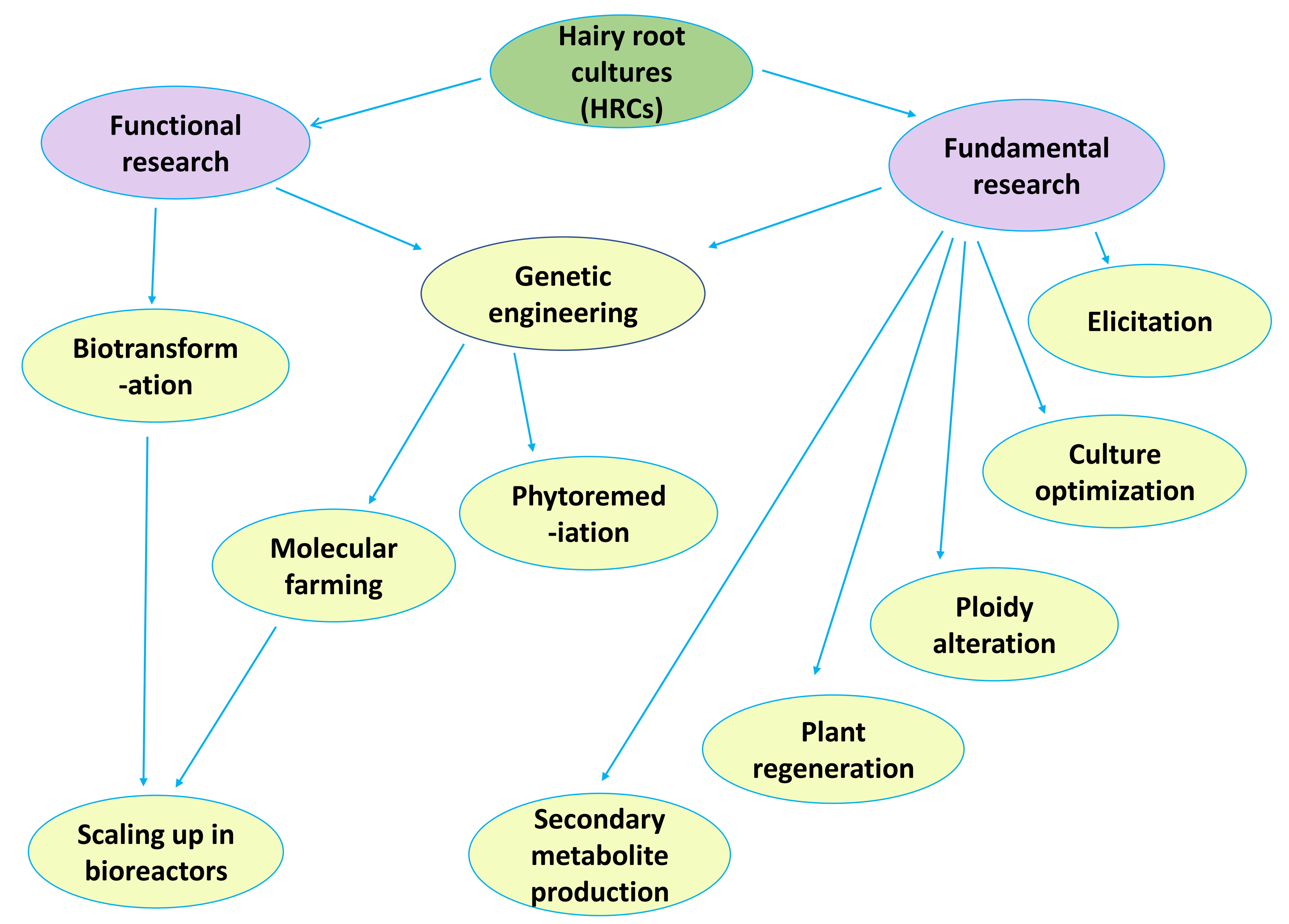

Fig. 3: Applications of HRCs

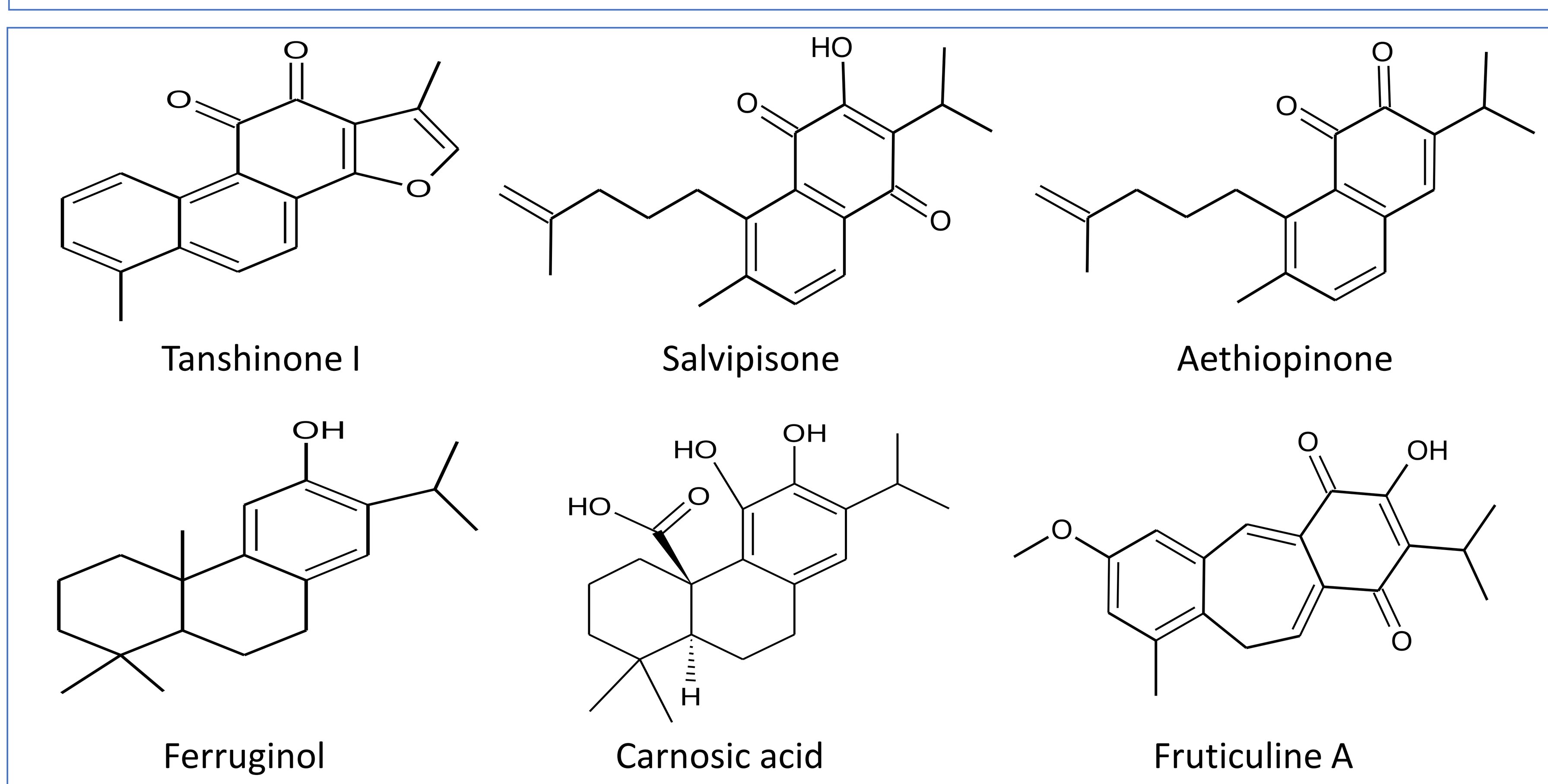

Fig. 4 : Chemical structure of selected metabolites

Ongoing research: In order to produce hairy roots, *in vitro* leaves of *S. oxyphora* and *S. karwinskii* were transformed using two strains of *Agrobacterium rhizogenes* (ATCC and LBA9402). When compared to the ATCC strain, the LBA 9402 strain grown on Yeast/Mannitol/Broth (YMB) medium supplemented with acetosyringone developed noticeably more roots on each explant. Producing biomass from hairy roots and further analysing secondary metabolite profiles are the next steps in our process.

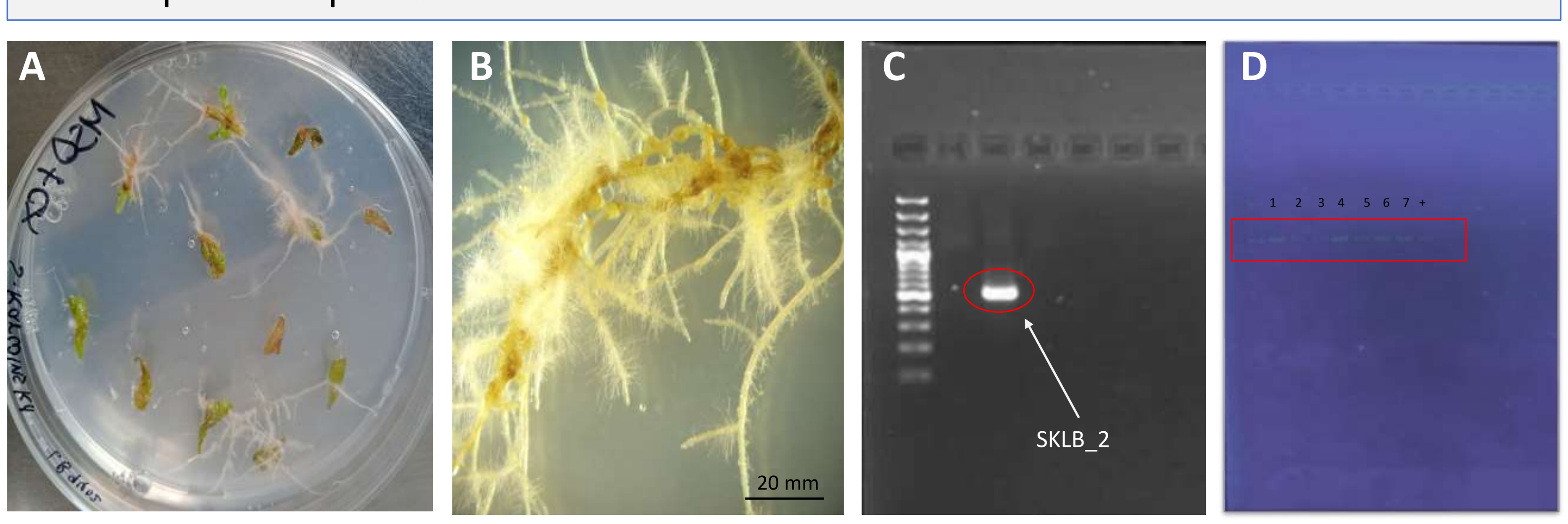

Fig. 5: A. Induced hairy roots B. Hairy roots as seen in microscopy C. PCR detection of *rol* C+ line of *S. karwinskii* D. PCR-*rol* C+ lines of *S. oxyphora* (1-7).

Conclusion and future perspectives:

Transformed root cultures of *Salvia* species are frequently a fascinating source of biologically active metabolites. *Salvia* is the largest genus among the Lamiaceae family composed of nearly 1000 species of herbs, shrubs, and perennial plants. So far, the production and augmentation of secondary metabolites using HR technology have been studied only in twelve species. The genetic modification of HR cultures is a particularly fascinating experimental paradigm for further study, including molecular analyses (such as the level of gene expression) and the search for novel pharmacologically active compounds. This study area can potentially find novel plant metabolites without compromising the entire plant.

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Morphological characterization of inflorescence and trunk in golden-rain trees (*Koelreuteria paniculata* Laxm.)

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Introduction

Golden-rain tree (*Koelreuteria paniculata* Laxm.), growing in Korea and China, has a high ornamental value due to its yellow flowers that bloom in summer season. Moreover, its tolerance to air pollution, salt, and dry soil makes it has a lot of potential both as a landscape tree and as a street tree in urban environments. Most researches about golden-rain tree have mainly focused on taxonomy, so there is a need for morphological research. This study was conducted to collect basic data on tree form and inflorescence characteristics of the golden-rain trees growing in six regions in Korea including Taean, Yeonggwang, Wando, Pohang, Andong and Jecheon.

Fig. 1. Golden-rain tree (*Koelreuteria paniculata* Laxm.)

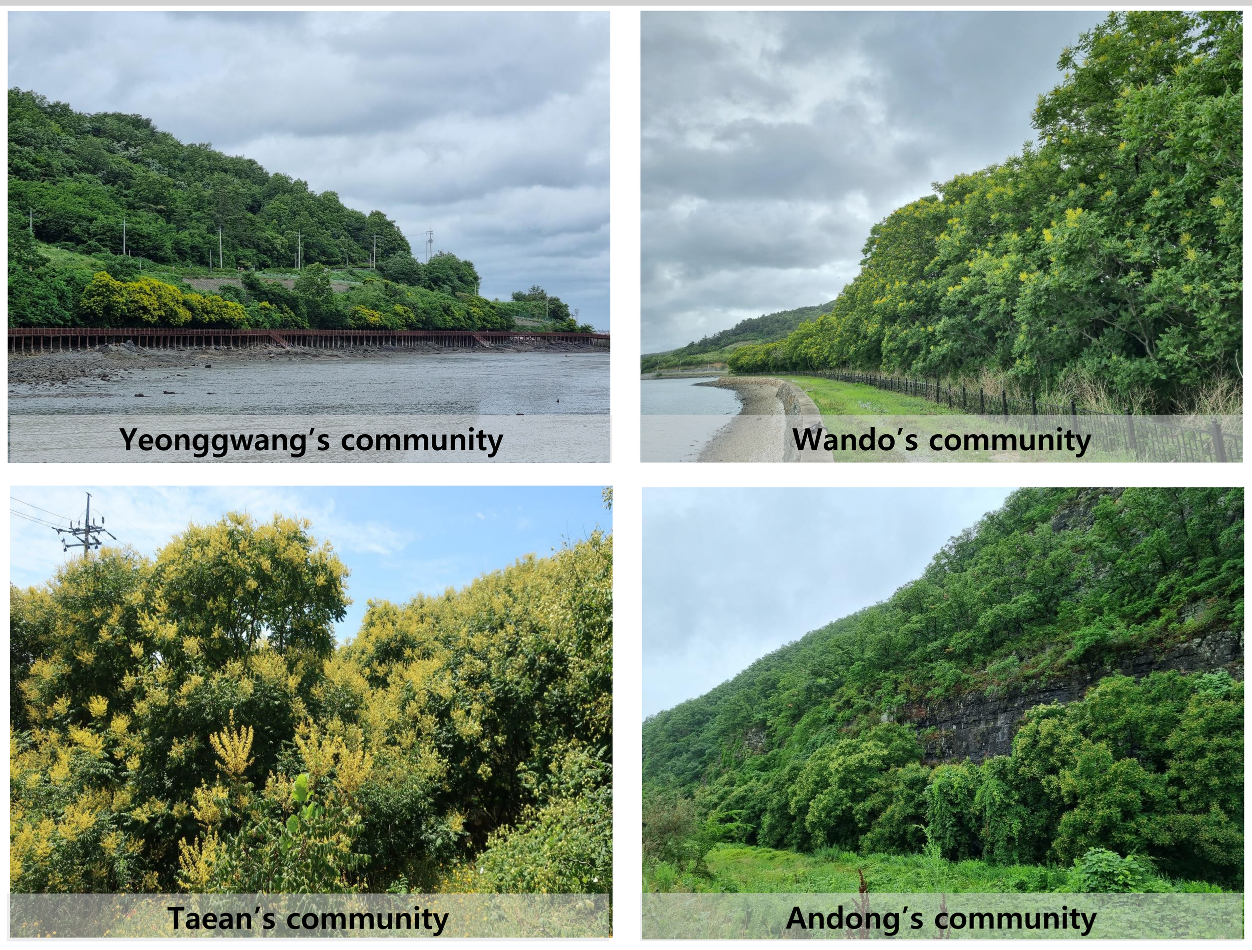

Fig. 2. The picture of community at Yeonggwang, Wando, Taean and Andong

Table. 1. Morphological characteristics of inflorescence in golden-rain trees in six regions of Korea

Region	Length of inflorescence (cm)	Width of inflorescence (cm)	The number of flowers per inflorescence (ea)	Clear bole length (m)
Yeonggwang	28.46±6.88a	24.57±5.60a	1223.16±734.54a	2.13±1.31a
Wando	20.85±9.36b	17.68±6.34bc	958.80±450.57ab	1.94±1.12a
Pohang	22.57±7.69b	23.35±5.90a	714.77±219.38bc	2.06±0.82a
Taean	27.99±6.95a	21.10±4.72ab	985.30±530.45ab	1.90±0.81a
Andong	19.95±10.88b	17.79±10.40b	555.93±387.74c	2.08±0.86a
Jecheon	21.69±4.38b	16.94±4.47c	728.93±189.10bc	2.12±0.84a

[z]Means within columns followed by different letters are significantly different by Duncan's multiple range test at $p\leq0.05$.

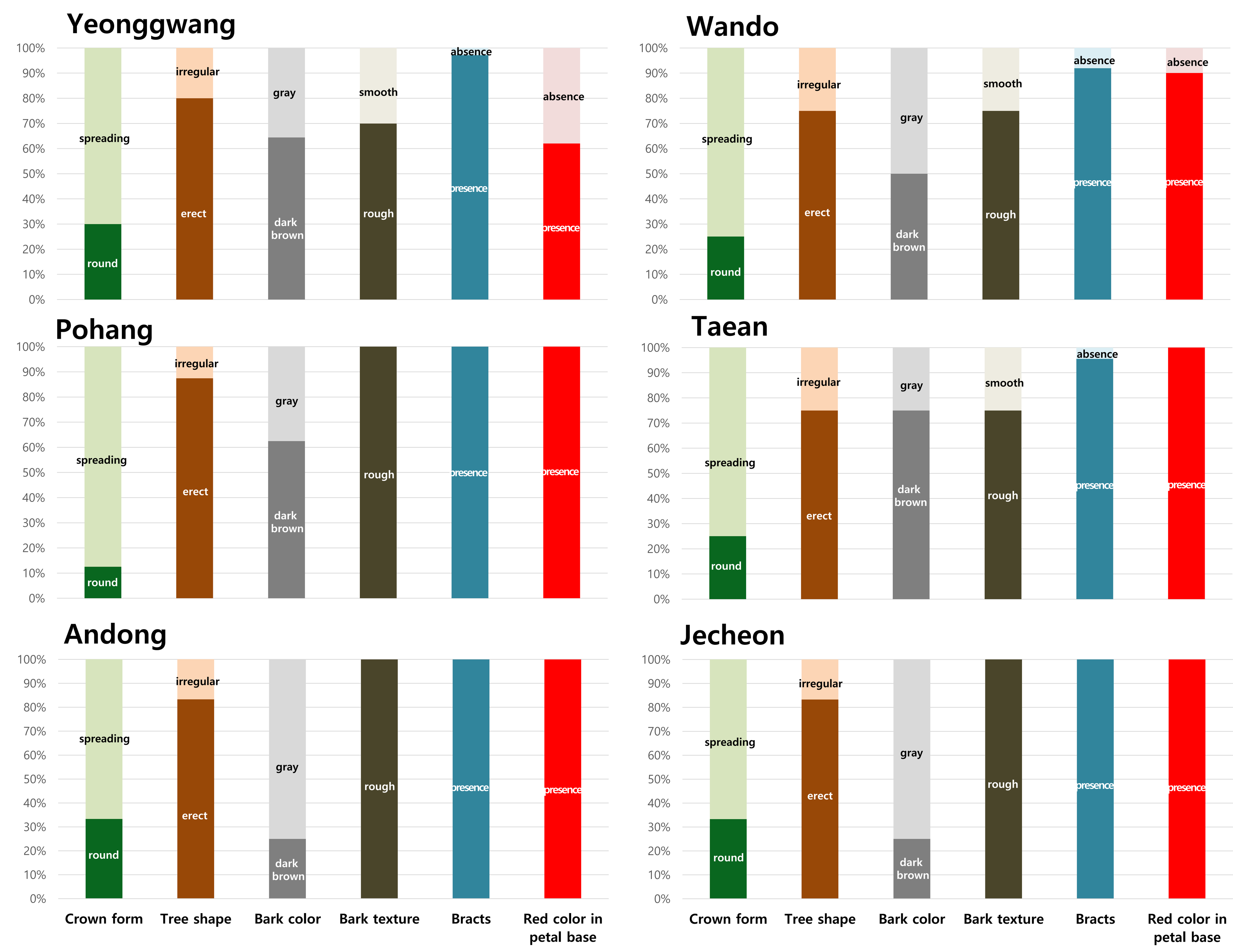

Fig. 3. Six characteristics of golden-rain trees based on collection region including Yeonggwang, Wando, Pohang, Taean, Andong, and Jecheon

Materials & Methods

- Plant name : Golden-rain tree (*Koelreuteria paniculata* Laxm.)
- Regions : Taean, Yeonggwang, Wando, Pohang, Andong and Jecheon in Korea
- The number of trees : Total 45 individuals
- Investigated characters : length of inflorescence (LI), width of inflorescence (WI), the number of flowers per inflorescence (NFI), clear bole length, presence bract and red color on petal base, crown form, bark color, bark texture, tree shape and stem straightness grade

Results

Superior individuals were selected by the number of inflorescences, however, there was no significant difference in the size of inflorescences. NFI is higher in the coastal regions, for example, Yeonggwang (1223.2±734.5), Wando (958.8±450.6), Taean (985.3±530.5), and Pohang (714.8±219.4) than it in other regions. The individuals selected in Andong had the smallest LI (20.0±10.9cm), WI (17.8±10.4cm) and NFI (555.93±87.7). Crown form accounted for 77.8% of spreading form and 22.2% of round form. Most of tree shape was erect form (82.2%) and most individuals of all regions have bracts (97.1%) and red color in petal base (86.5%). In most areas except Taean, main stems of trees were straight with a gentle curve, however, the individuals from Taean had seriously wavy stem and short clear-bole length.

Conclusion

Golden-rain tree that blooms in June to July and shows high tolerance to salt has a potential to develop as a landscape tree or street tree in urban area. National Institute of Forest Science selected this tree as one of the promising landscape trees and conducted a study on flower characteristics and tree form of individuals existed in six habitats of Korea. As a result, a total of 45 individuals were selected based in much flowering, early- or late-flowering, truck straightness, and so on.

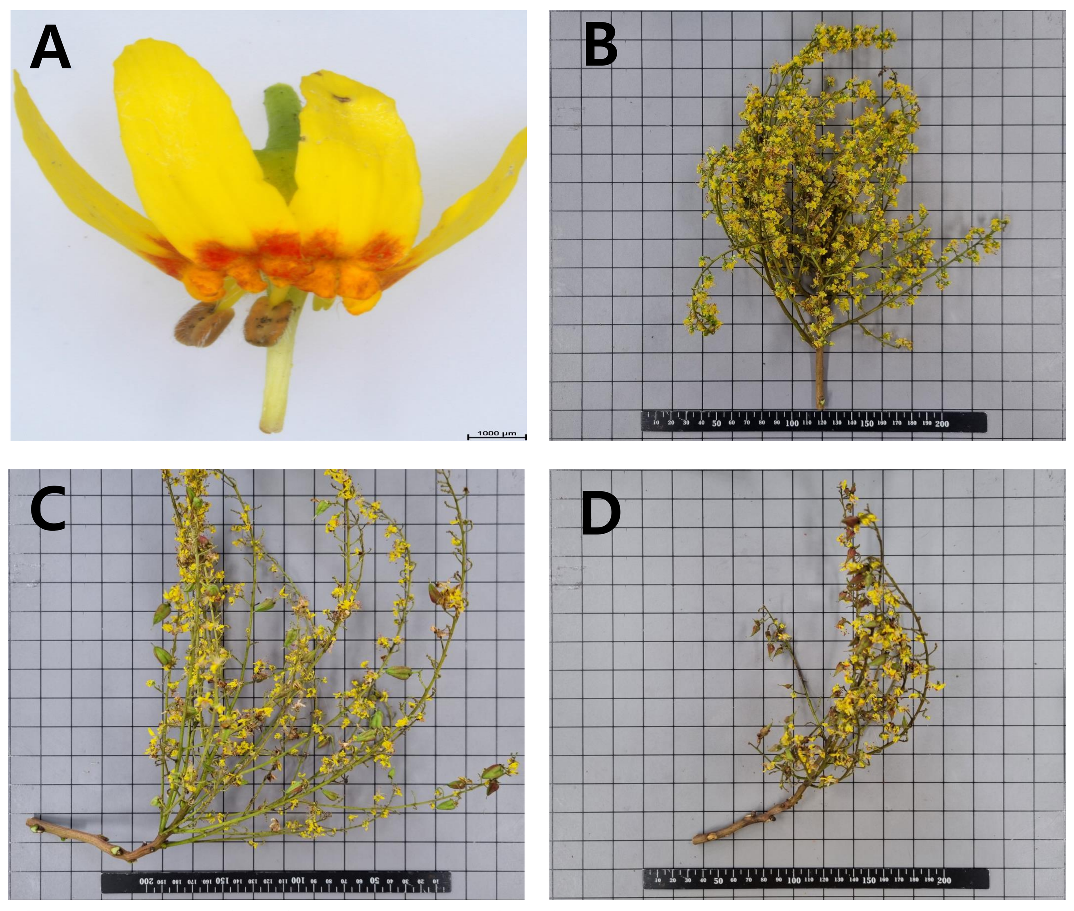

Fig. 4. The picture of a flower(A) and Inflorescences of golden-rain trees of three regions including Taean(B), Pohang(C) and Andong(D)

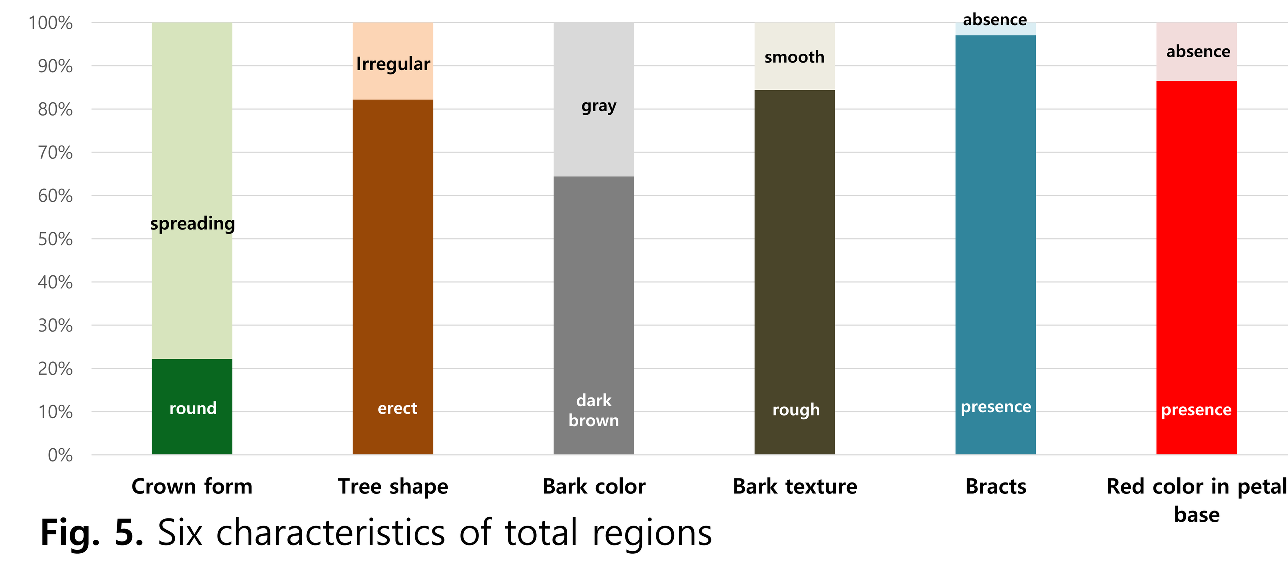

Fig. 5. Six characteristics of total regions

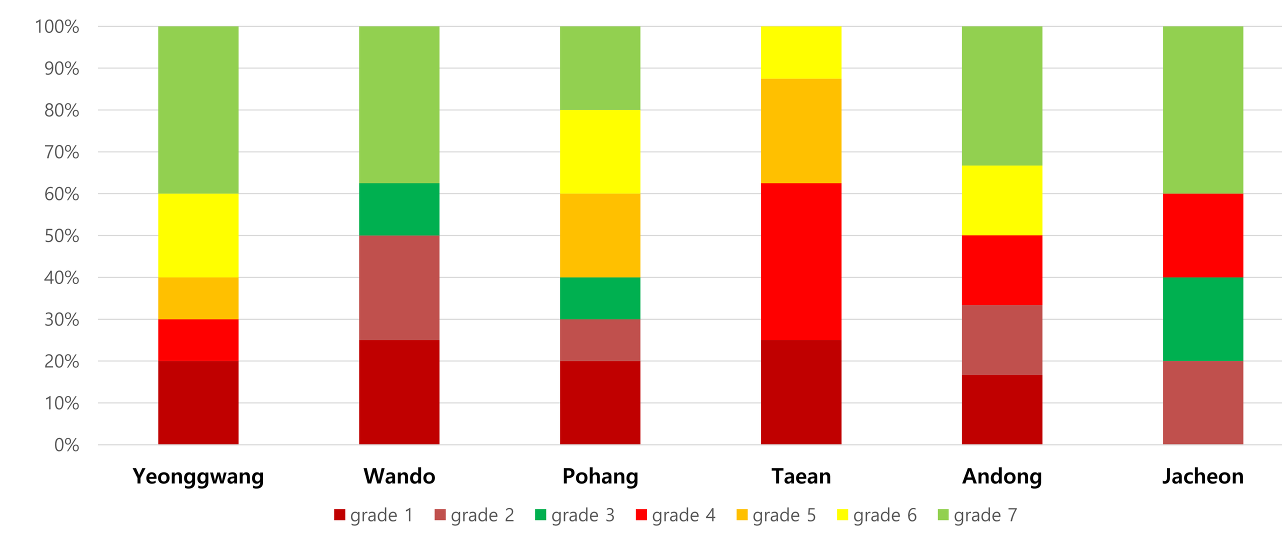

Fig. 6. Stem straightness grade in *Koelreuteria paniculata* Laxm. by region (7. straight; 1. very wavy)

Acknowledgment

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DAHLIA PARVIBRACTEATA FOR AGRICULTURE AND FLORICULTURE IN MEXICO

INTRODUCTION

The genus Dahlia is native to Mexico and there are 45 species dicovered so far, (Castro et al., 2019, Mejía et al., 2020) with herbaceous, shrubby and epiphytic growth patterns. It has been considered as medicinal plant, food source and ornamental plant for more than 600 years. It is so important that in 1963 the president Adolfo López Mateos held it as the symbol of floriculture and considered it the national flower of Mexico.

Various studies on the development of tuberous roots and flowers in Dahlia species have demonstrated the functional value and benefits of consuming it in different dishes, highlighting their fiber and inulin content, which have beneficial effects in reducing blood glucose levels and help in weight control in people with obesity (Mejía-Santoyo et al., 2020).

The ornamental value of this genus in the floriculture industry is evident, where the Dahlia is one of the most attractive flowers due to the diversity of shapes, sizes and colors of its flowers.

Dahlia parvibracteata plant growth

Vegetative stages of *Dahlia parvibracteata*
(image obtained from Ramírez Vázquez Jesús Alfredo)

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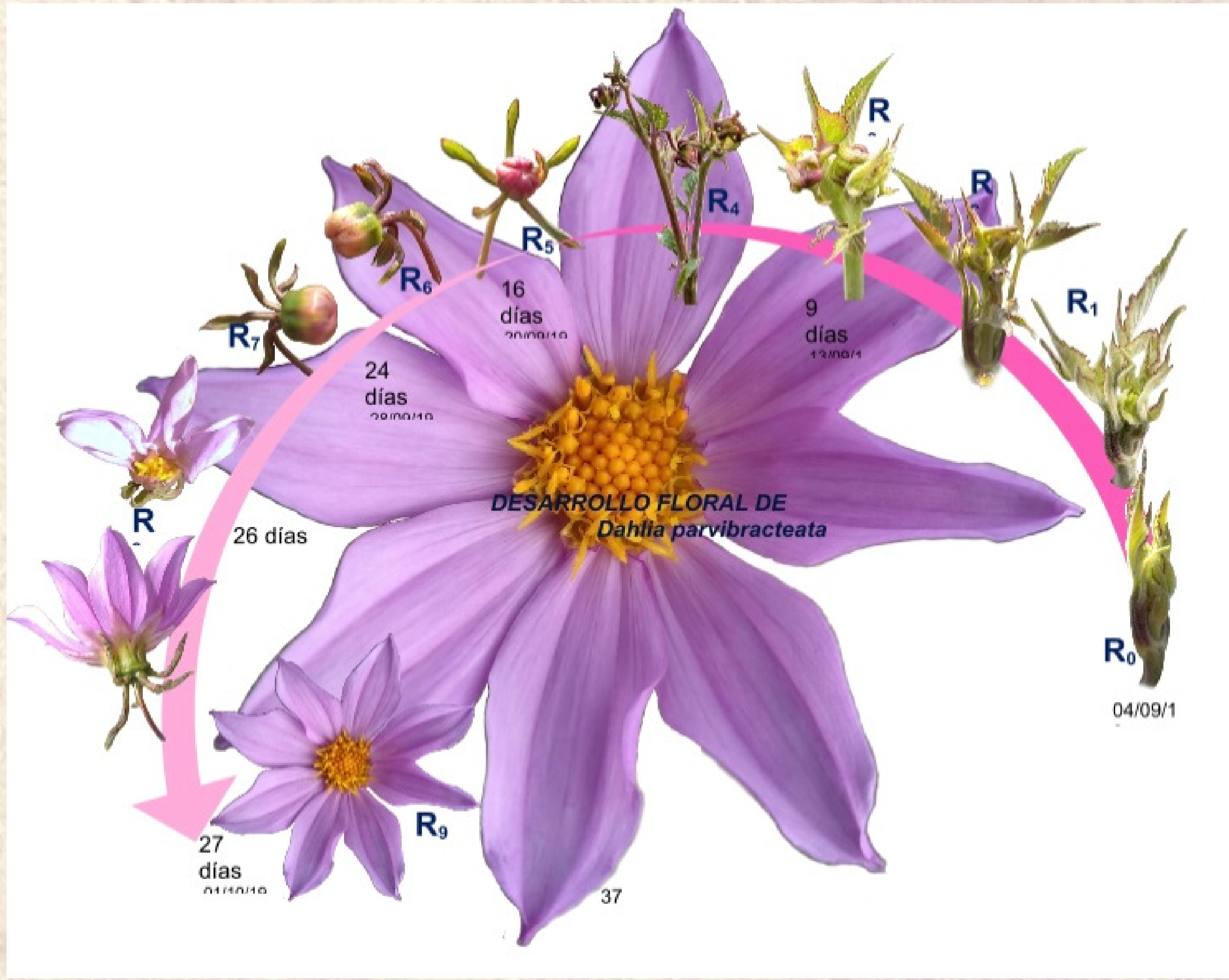

Reproductive development of *Dahlia parvibracteata*, image obtained from Ramírez Vázquez Jesús Alfredo

MATERIALS AND METHODS

Seeds from a wild population of *D. parvibracteata* were collected in a rocky area near Taxco, Guerrero at an altitude of 1800 meters above sea level

Developed seedlings were cultivated in natural conditions without irrigation during two cycles in Chapingo, State of Mexico

The stages of the life cycle from vegetative development to flowering were recorded (image obtained from Ramírez Vázquez Jesús Alfredo)

The tuberous roots were weighed and counted to determine their yield in fresh weight and sent to a laboratory to determine the percentage of inulin

Flower and buds of *Dahlia parvibracteata*

Flowering stage in *Dahlia parvibracteata*

Position of some stems and flowers in *Dahlia parvibracteata*

RESULTS

Cultivation

Seedlings 10 -12 cm tall with 2 to 4 true leaves were transplanted to soil conditions These seedlings developed on day 40 after sowing, 2 - 4 basal stems from the Crown, and presents single leaves After 65 days, the plants developed bipinnate leaves with conspicuous stipels and lateral branching as described by Saar and Sorensen (2000). After 81 days the plants reached their maximum development, with heights that varied from 60 to 150 cm. First flower buds reached the flowering stage after 105 days in early plants, while late plants flowered 120 days after sowing. Flowers developed long peduncles 40 to 65 cm in length, in groups of flowers that varied from 10 to 20 per stem, this characteristic is very useful to consider it as a cut flower. While in the plant as a whole it is abundant due to the number of flowers present on the stems, a characteristic useful for landscaping

Table 1. Tuberous roots characteristics of a sample of D. parvibracteata plants

plant	Number of tuberous roots	longest tuberous root length (cm)	Total weight tuberous roots (g)
1	23	13.5	402.0
2	16	11.5	338.6
3	28	9.7	224.0
4	21	9.0	164.5
5	16	10.2	148.2
6	14	8.2	204.1
27	17	9.0	151.5
8	21	9.8	276.0
9	16	7.0	107.0
10	16	5.5	118.5
11	9	5.5	118.43
12	16	5.5	178.0
13	8	8.0	117.0
14	8	6.5	125.2
15	7	6.7	81.8
16	8	4.7	89.2
17	7	7.1	79.4
18	8	4.6	94.5

CONCLUSIONS

Dahlia parvibracteata is a species with characteristics of interest for breeding programs for new varieties, particularly for its long flower peduncles and numerous flowers per stem, which makes it a good candidate for the cut flower market. Regarding the production of tuberous roots, it is shown that develops an average of 3.5 ton/ha in natural conditions (without irrigation), so under irrigation conditions this yield can be easily increased. Content of inulin useful to reduce blood glucose levels in people with diabetes is lower compared to most of the species studied, so more studies must be carried out to know the real performance potential under better culture conditions. Development of compact tuberous roots is an advantage for easy lifting, as they remain firm during soil removal and dont get damaged or split. Efforts continue to know more about this species in better cultivation conditions and initiating reeding programs for clonal varieties with useful characteristics for food and flower industry.

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