Charles University
Department of Botany, Faculty of Science

Study programme: Evolutionary biology

Bc. Alžběta Poštulková

The role of the *FAR5* gene in alpine adaptation of *Arabidopsis arenosa*

Úloha genu *FAR5* v horské adaptaci *Arabidopsis arenosa*

Diploma thesis

Supervisor: Mgr. Magdalena Bohutínská, Ph.D.

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Declaration

I declare that I prepared the final thesis independently and that I have properly acknowledged and cited all the information sources and literature used. This work, or a substantial part of it, has not been submitted for the award of another or the same academic degree.

In Prague, 30. 4. 2024

Alžběta Poštulková

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Abstract

The repeated adaptation presents a unique opportunity to study the mechanisms of evolution in natural replicates. Repeated adaptation of *Arabidopsis arenosa,* a wild relative of the model organism *Arabidopsis thaliana*, to the alpine environment was previously studied. Genomic analysis by selection scans revealed a set of candidate alleles. Here, I present a functional follow-up study of a candidate alpine-adaptive allele of *FAR5*. Specifically, I asked: What are the characteristics of the alpine (*A*) allele compared to the foothill (*F*) allele? Is there any phenotypic effect of the two different alleles of *FAR5*? What are the environmental factors shaping the distribution of the alpine allele of *FAR5* among the populations of *A. arenosa*?

I first demonstrated that natural variation in *FAR5* played a role in adaptation to the alpine environment: I identified four SNPs that were positively selected in the alpine populations across all five high altitude colonizations of *A. arenosa*. Three of these SNPs are coding and are linked together, forming a distinct alpine allele of the FAR5 protein. Using a unique crossing design based on a natural standing variation of the two identified *FAR5* alleles, I prepared carriers of the non-native alleles on the genomic background of foothill and alpine populations. I then conducted a transplant experiment into the alpine environment of Austrian Alps and examined the phenotypic effect of the two alleles. Due to the reported function of *FAR5* in wax biosynthesis in *A. thaliana*, I used a GC-MS-based metabolite profiling. My results show a clear phenotypic effect of the candidate alpine-adaptive allele. The substrate specificity of the FAR5 enzyme is shifted from foothill 18C to alpine 16C, resulting in an increased production of a shorter primary fatty alcohol (C16:0-OH) in plants carrying the alpine allele of *FAR5*. This finding experimentally supports *FAR5* as an important player in producing the alpine-adaptive phenotype and brings question about what the function of such metabolomic change is. Thus, I performed a genotype-environment association to unravel which environmental factors might be responsible for the *FAR5* natural variation. I identified an association of the alpine allele of *FAR5* with higher spring precipitation, lower solar radiation in the vegetative season and lower minimum winter temperature. The genome wide association study (GWAS) revealed eight genes significantly associated with similar environmental factors as *FAR5*. Some of these genes are involved in the regulation of seed germination. In connection with the putative effect of the change in substrate specificity on the production of suberin, and *FAR5*'s expression in seed coat, I propose a hypothesis about its adaptive involvement in regulating seed germination. Other factors would also suggest a possible role in pathogen or drought resistance. I suggest that a follow-up targeted study is needed to assess the exact impact of the alpine allele of *FAR5*.

Overall, this study contributes to the understanding of repeated adaptation to the alpine environment through the characterization and functional validation of a candidate alpine-adaptive allele. Unravelling the mechanisms behind such adaptation to dramatic environmental shifts, such as those between lowland and alpine populations, advances our understanding of adaptation. This understanding could be beneficial, for example, in the context of climate change.

Keywords: repeated evolution, alpine adaptation, *Arabidopsis arenosa, FAR5*, functional genetics, genotype-environment association

Abstrakt

Opakovaná adaptace představuje jedinečnou příležitost ke studiu mechanismů evoluce v rámci přirozeného experimentu s několika opakováními. Již dříve byla studována opakovaná adaptace *Arabidopsis arenosa*, divokého příbuzného modelového organismu *Arabidopsis thaliana*, na vysokohorské prostředí. Genomická analýza pomocí selekčních skenů odhalila sadu kandidátních alel. Zde uvádím navazující funkční studii kandidátní horské adaptivní alely *FAR5*. Mé konkrétní otázky byly: Jaké jsou vlastnosti horské (*A*) alely ve srovnání s nížinnou (*F*) alelou? Existuje nějaký fenotypový projev těchto dvou různých alel *FAR5*? Jaké faktory prostředí utvářejí distribuci horské alely *FAR5* mezi populacemi *A. arenosa*?

Nejprve ukazuji, že přirozená variabilita genu *FAR5* hrála roli v adaptaci na vysokohorské prostředí: identifikovala jsem čtyři SNP, které byly pozitivně selektovány v horských populacích při všech pěti vysokohorských kolonizacích *A. arenosa*. Tři z těchto SNP jsou kódující a jsou spolu svázány, čímž tvoří jasně odlišitelnou horskou alelu proteinu FAR5. Pomocí unikátního křížení založeného na přirozené dostupné variabilitě (standing variation) dvou identifikovaných alel *FAR5* jsem připravila jedince nesoucí nepůvodní alely na genomovém pozadí nížinných a horských populací. Poté jsem provedla transplantační experiment do vysokohorského prostředí rakouských Alp a zkoumala jsem fenotypový projev těchto dvou alel. Vzhledem k uváděné funkci FAR5 v biosyntéze vosku u *A. thaliana* jsem využila profilování metabolitů pomocí GC-MS. Mé výsledky ukazují jasný fenotypový efekt kandidátní horské adaptivní alely. Substrátová specifita enzymu FAR5 je posunuta z nížinné 18C na horskou 16C, což vede ke zvýšené produkci kratšího primárního mastného alkoholu (C16:0-OH) v rostlinách nesoucích horskou alelu *FAR5*. Tyto výsledky experimentálně podporují *FAR5* v roli důležitého hráče při produkci horského adaptivního fenotypu a přináší otázku, jaká je funkce takové metabolomické změny. Provedla jsem tedy asociaci genotypu s podmínkami prostředí, abych odhalila, které faktory prostředí mohou být zodpovědné za přirozenou variabilitu *FAR5*. Pozorovala jsem asociaci horské alely *FAR5* s vyššími jarními srážkami, nižším slunečním zářením ve vegetačním období a nižší minimální zimní teplotou. Celogenomová asociační studie (GWAS) odhalila osm genů významně spojených s podobnými faktory prostředí jako *FAR5*. Některé z těchto genů se podílejí na regulaci klíčení semen. V souvislosti s možným vlivem změny substrátové specificity na produkci suberinu a s expresí *FAR5* v obalu semen navrhuji hypotézu o jeho adaptivním vlivu v regulaci klíčení semen. Další faktory také naznačují možnou roli v odolnosti vůči patogenům nebo suchu. K posouzení přesného dopadu horské alely *FAR5* je třeba navazující důkladná studie zaměřená na tuto problematiku.

Celkově tato studie přispívá k pochopení opakované adaptace na vysokohorské prostředí prostřednictvím charakterizace a funkční validace kandidátní alely horské adaptace. Odhalení mechanismů zodpovědných za adaptaci na takovéto dramatické změny v podmínkách prostředí, jaké vidíme mezi nížinnými a vysokohorskými populacemi, posouvá naše chápání adaptace. Toto pochopení by mohlo být dále přínosné například v souvislosti se změnou klimatu.

Klíčová slova: opakovaná adaptace, horská adaptace, *Arabidopsis arenosa*, *FAR5,* funkční genetika, asociace genotypu a podmínek prostředí (GEA)

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Introduction

They say variety is a spice of life. From an evolutionary point of view, variation is the very basic aspect of surviving. It enables organisms to react to changes in their environment. Different variants of a phenotypic trait or different genetic variants (alleles further) can be advantageous under different conditions (Blanquart et al., 2013). The more variable a population is, the better it can adapt to environmental changes (Bomblies and Peichel, 2022). The process of filtering alleles in every generation is called natural selection. It is through this process that species become adapted to their environment. Famous example involves three-spined sticklebacks adapting to the freshwater environment via alleles of *Eda* locus available already in the ancestral marine populations (Colosimo et al., 2005).

Repeated adaptation at multiple levels

In the world around us we can encounter organisms that are strikingly similar without being related. Such organisms are often found in similar environments. That suggests that there are some optimal solutions to problems posed by particular conditions and that the organisms can independently find the optimum. Repeated independent evolution of a particular beneficial trait is called repeated adaptation (Cerca, 2023). Some authors distinguish the modes of repeated adaptation based on relatedness between the organisms as convergent and parallel adaptations (Losos, 2011). But for this distinction we need to know details about the relatedness between the organisms and/or the molecular sources of the repeatedly adaptive mutations. Due to these difficulties, it was suggested to denote all such cases as convergent adaptation in the 2008 (Arendt and Reznick, 2008). But throughout my thesis I will use the term 'repeated adaptation' which was more recently proposed as a neutral alternative (Cerca, 2023).

The two main perspectives on the study of the repeated evolution are from the point of view of the phenotype or the genome. Repeated phenotypic evolution refers to the independent emergence of similar traits or characteristics in different lineages of organisms, driven by similar selection pressures. The repeated phenotypic evolution can be exemplified by two plant families *Euphorbiaceae* and *Cactaceae*. Both form succulent forms in the reaction to arid environment and in consequence a layman could easily confuse them because of their phenotypic similarity (Wood et al., 2005). Another famous example is the evolution of a wing in bats and birds in which a same organ was formed through different anatomical changes (Alexander, 2015). In the end the structures serve the same function, to fly.

However, I will focus on examining the repeated evolution from the genomic perspective. Repeated adaptation at the genomic level involves the independent positive selection acting on similar genetic changes in different populations or species, leading to repeated genomic signatures. Such repeated genomic evolution can manifest itself at various levels: the level of molecular pathway, gene or allele. At the molecular level, we see organisms using the same molecular pathways (e.g. adaptation to an extreme abiotic stress in Arctic *Brassicaceae* (Birkeland et al., 2020), same genes (e.g. pelvic reduction via *Pitx1* in vertebrates (Shapiro et al., 2006) or even the same variants (e.g. selection of same SNPs in alpine environment (Bohutínská et al., 2021b) to achieve the repeated adaptation. Here, I focus on repeated use of genes (referred to as 'gene reuse' hereafter) and alleles.

Gene reuse in evolution

Gene reuse is a surprisingly frequent phenomenon (Conte et al., 2012) whose importance in evolutionary biology is recently rising thanks to the development of sequencing and genomic analysis methods. It can emerge essentially in three ways (Lee and Coop, 2019). Firstly, the organisms can repeatedly positively select the variation inherited from their shared ancestors. Secondly, the positively selected variants that we observe as reused are a result of a single mutational event and subsequent spread via gene flow. And finally, the same mutation can originate and subsequently become positively selected independently in multiple lineages (Fraser and Whiting, 2020). Repeatability at the gene level provides insight into the factors influencing the diversity of genetic pathways to adaptation (Yeaman et al., 2018). The fact that a gene has been used repeatedly in the past to solve a particular problem increases the chance that it will be used to solve the same problem in the future.

Alpine environment: 'natural laboratory' for studying repeated adaptation

The alpine environment represents a natural experiment of adaptation of organisms to a relatively steep gradient of conditions. The character of this experiment encompassing replicates across different latitudes and climatic regions (represented as different mountain ranges) attracted scientists for a long time. The island-like alpine environment provides an opportunity for studying the repeated adaptation to similar selective pressures.

Alpine flora thrives amidst the challenging climatic conditions of the alpine zone

Defining the conditions of the alpine environment in global terms is challenging because of the variability of various alpine environments. Main factor introducing variability in the definition of the alpine environment is latitude. Indeed, the extratropical and tropical mountain ranges differ in many aspects, one of them being seasonality (Körner, 2022). My study however is limited to the area of Central Europe which simplifies the situation, because across Europe the alpine climate was shown to be similar (Körner et al., 2003).

The climate trends in the temperate zone mountains are long studied and well described. Air temperature is reduced in higher altitudes (Ceppi et al., 2012). The gradient of temperature between foothill and alpine environment is particularly prominent during the growing season (more than during winter) and drives the adaptation of plant traits to cold temperatures (Körner, 2022). Opposite trend is observed in precipitation, where values, but also their fluctuation, increase with increasing altitude (Flohn, 1974). Another important environmental factor is solar radiation. No significant elevational changes of solar radiation were reported in European mountains (Tranquillini, 1960). But under certain sky conditions alpine plants can experience short term extremes, not occurring in foothills. That happens when there is a gap in a thin layer of clouds in the direction of midday radiation, so the plants have to cope not just with the direct radiation but also diffuse radiation from the clouds surrounding the gap. This can be further enhanced by reflectance

from snow (Körner, 2022). The atmospheric pressure decreases with altitude, consequently so does partial pressure of CO_2 (Körner, 2022) which could be of importance for the efficiency of photosynthesis (Singh and Kumar, 1935). The reduced partial pressure of CO_2 can be partially compensated by increased molecular diffusivity (Gale, 1972) however other factors such as the plant's mechanism of CO_2 uptake or air temperature are relevant.

In general, the climate measured by the weather station is not necessarily the climate that alpine plants are experiencing. The specific regional aspects of the environment are extremely relevant from the point of view of a single plant. The topographical properties of the habitat, slope inclination, exposure to sun and wind, and landscape fragmentation by relief can significantly alter the environmental conditions (Körner, 2023). Moreover, the plants themselves can influence the conditions in their favor. By modifying their stature, height above ground, leaf arrangements or the density of the canopy they can buffer the harsh conditions that we experience during our trips to mountains (Körner, 2022). For instance, cushion plants increase the leaf temperature thanks to their compact stature (Salisbury and Spomer, 1964). Overall, the interplay between climate and topography creates in places a very challenging environment for plant survival, nevertheless some plants are able to overcome those challenges.

Arabidopsis arenosa: a model for studying alpine adaptation

The habitats of *Arabidopsis arenosa*, a wild relative of the famous model organism *Arabidopsis thaliana*, span different altitudes which makes it an interesting candidate for studying the alpine adaptation (Knotek et al., 2020; Kolář et al., 2016).

A case of repeated alpine adaptation in *Arabidopsis arenosa* was described by Knotek et al, 2020. They demonstrated that five different lineages of *Arabidopsis arenosa* repeatedly colonized the alpine environment of Alps and Carpathians, representing four to five independent instances of alpine adaptation (Knotek et al., 2020; Wos et al., 2022). After colonization of the alpine environment, *A. arenosa* repeatedly formed a distinct alpine ecotype. To name a few differences between these ecotypes, the alpine plants are shorter and have thicker leaves, bigger and more colourful flowers.

The occurrences of morphologically distinct populations of *A. arenosa* have been reported from four different mountain regions across Europe: Eastern Alps (Melzer, 1960), Eastern (Pachschwöll and Pachschwöll, 2019), Western (Měsíček, J. and Goliášová, K., 2002) and Southern Carpathians (Bartok et al., 2016). In Western Carpathians, both diploid and tetraploid lineages occur (Wos et al., 2019) and are kept separate in the literature about the alpine adaptation of *A. arenosa*. Hereafter, I refer to the five alpine lineages: Niedere Tauern and surrounding foothills of the Eastern Alps (referred to as NT), Rodna Mts. and adjacent regions of Eastern Carpathians (RD), Făgăraş Mts. in Southern Carpathians (FG), Vysoké Tatry Mts. and adjacent foothill diploid populations in Western Carpathians (VT, diploid), Západné Tatry Mts. and adjacent foothill tetraploid populations in Western Carpathians (ZT, tetraploid) as described in (Knotek et al., 2020).

To unravel the processes at the genetic level of adaptation, the genome resequencing and following searches for signatures of positive selection are often taken. Using genome resequencing, a follow up study further found a set of genes showing signatures of repeated selection associated with the alpine environment (Bohutínská et al., 2021b). It found that lineages significantly often reuse these genes and reported a clear pattern: more closely related lineages reused more genes

during alpine adaptation, likely because they share more variation which selection can act on. However, which genes are the most frequently reused among these lineages, what is their role in the alpine environment, and why they repeatedly became targets of natural selection, remained largely unknown.

FAR5: know your candidate gene

In my thesis, I focus on the *FAR5* gene, referred to as fatty acid reductase 5 (TAIR database, Berardini et al., 2015)) or fatty acyl-CoA reductase 5 (Domergue et al., 2010). Here I decided to use the name 'fatty acyl-CoA reductase 5' as it better fits the described function of the enzyme.

The family of fatty acyl-CoA reductases (FAR) plays a role in the formation of primary fatty alcohols which are fundamental compounds in suberized tissues (Delude et al., 2016). They catalyze the reduction of fatty acyl-CoA to a primary fatty alcohol during a NADPH-dependent reaction. *FAR5* in particular usually reduces C18:0-CoA to octadecanol (C18:0-OH) via an aldehyde intermediate (Domergue et al., 2010). The FAR enzymes have two main domains: Rossmann-fold domain at the N terminus and FAR_C domain at the C terminus (Rowland and Domergue, 2012). The Rossmann-fold domain is responsible for binding of NAD(P)H and is common in intermediate short-chain dehydrogenase/reductase proteins (Kavanagh et al., 2008). The FAR_C domain carries the fatty acyl-CoA reductase activity (Rowland and Domergue, 2012).

It was shown that amino acid changes at the positions 355 and 377 alter the substrate specificity of FAR5, resulting in a shift in chain length of substrate and thus the product to 16-carbon chains (Chacón et al., 2013). Therefore, the region between the two functional domains was recognised as being responsible for stability and specificity of the enzyme (Chacón et al., 2013). Throughout my thesis, I use the term 'allele' both to denote a gene variant, but also to refer to the corresponding sequence of amino acids.

In *A. thaliana*, the expression of *FAR5* was reported in roots, wounded leaves and seed coat (Domergue et al., 2010) and also in mature leaves and flowers (Mergner et al., 2020).

As stated above, FAR5 is involved in suberin biosynthesis. Suberin is a plant biopolymer deposited in the cell walls of certain tissues such as root endodermis, root and tuber peridermis and seed coat (Franke and Schreiber, 2007; Vishwanath et al., 2015). It is a complex heteropolymer composed of polyaliphatic and polyphenolic domain. The polyphenolic domain is anchored in the primary cell wall and mainly consists of polymerized hydroxycinnamates and monolignols (Bernards et al., 1995; Kolattukudy, 2001). The polyaliphatic domain is located between the cell wall and plasma membrane (Woolfson et al., 2022) and is made up from ω-hydroxy fatty acids, α,ω-dicarboxylic acids, midchain oxygenated fatty acids, unsubstituted fatty acids and primary fatty alcohols (Kolattukudy, 2001; Pollard et al., 2008).

Non-covalently linked root waxes, including besides other compounds also primary fatty alcohols, were reported in association with suberin (Schreiber et al., 2005). They are considered to importantly influence the water diffusion across suberized cell walls (Schreiber, 2010). Suberin and its associated waxes play an important role as a barrier in plant-environment interfaces controlling the movement of water and solutes (Franke and Schreiber, 2007). Suberization was also recognized as essential for wound-healing in plants (Dean and Kolattukudy, 1976). Together with its role in water management it makes suberin, and thus possibly FAR5, interesting for the study of environmental adaptation.

Objectives and thesis summary

In my thesis I first demonstrated that multiple genes show signals of selection in all five alpine lineages of *Arabidopsis arenosa*. I found one of the strongest signals in the gene *FAR5*, which affects the biosynthesis of suberin in *A. thaliana*. I focused on the *FAR5* gene further, asking: Which mutations characterize foothill and alpine alleles of *FAR5*? What is the phenotypic consequence of the alpine allele? Which environmental factors may have triggered the selection acting on the alpine allele? Answering these questions may improve our understanding of the process of repeated adaptation on a gene level.

Summary

Using the fact that the *FAR5* alleles occur at low frequencies in their non-native environment, I was able to apply a unique crossing design resulting in homozygous rare carriers of the contrasting (alpine and foothill) *FAR5* alleles. Seeds from these crosses were germinated and because they are not artificially modified organisms, I was able to set a transplant experiment in Innsbruck. I planted a set of seedlings in the alpine environment. The set comprised case (alpine plants with foothill allele and foothill plants with alpine allele) and control plants (alpine plants with alpine allele and foothill plants with foothill allele). Based on literature in *A. thaliana* I focused my search for candidate alpine-environment related phenotypes at the level of production of metabolites.

My results from the transplant experiment suggest that there is a phenotypic difference between different alleles of *FAR5* affecting the substrate specificity of the enzyme and the proportions of primary fatty alcohols in the plant tissues. This well corresponds to the proposed function of FAR5 in production of primary fatty alcohols (Domergue et al., 2010). These results of my functional investigation support the strategy of identifying candidate alleles, which in my case effectively revealed *FAR5* alleles contributing to altered alpine phenotype of *A. arenosa*. However, while my findings underscore *FAR5* not only as a candidate gene for alpine adaptation but also as a determinant of plant phenotype in alpine environments, numerous questions remain unanswered, including the specific functional and fitness effects of alpine alleles.

In the final part of my thesis, I shed light on these questions by demonstrating the correlation between the frequency of *FAR5* alleles within my *A. arenosa* dataset and a set of environmental factors, employing a pRDA analysis. The best explanatory variables suggest influences from early season precipitation, solar radiation in the vegetative season and minimum winter temperature.

The adaptation of organisms to a changing environment presents an ideal opportunity for studying the mechanisms of evolution. Specifically, local adaptation to the alpine environment enables us to study the reaction of an organism to a relatively steep gradient of conditions. By understanding the processes of adaptation of an organism to challenging environments, we may be able to predict certain aspects of adaptive evolution: a knowledge which can be widely applied, for example to weaken the consequences of climate change.

Methods

Genomic and transcriptomic datasets

I used a genomic dataset that includes genomes from a total of 73 previously sequenced alpine and foothill populations of *A. arenosa* (Bohutínská et al., 2021b; Konečná et al., 2021; Marburger et al., 2019; Monnahan et al., 2019; Novikova et al., 2016; Preite et al., 2019), mapped to the reference genome of *A. lyrata* (Hu et al., 2011) following the mapping procedure published in (Monnahan et al., 2019). On this data I performed Picmin and AFD-based selection scan (see below).

I annotated each SNP in the genome wide dataset and assigned it to a gene using SnpEff 4.3 (Cingolani et al., 2012) and following *A. lyrata version 2* genome annotation (Rawat et al., 2015). Annotated variants were extracted from vcf format to table using SnpSift, part of SnpEff 4.3, with flags "CHROM POS REF ALT AC AN 'ANN[*].HGVS_P'" and these tables were used as the basis for the subsequent analysis of positive selection.

I also used PacBio HiFi read assemblies from two alpine (lineage VT and FG) and eight foothill individuals of *A. arenosa* (unpublished data kindly provided by Filip Kolář) to assess the relationships between the differentiated candidate SNPs. Specifically, to examine the linkage between the SNPs and check for possible structural variants between alpine and foothill individuals, using BLAST analysis followed by visualization in Geneious. Moreover, these data were used for designing primers and restriction sites (see below).

Furthermore, analysis of *FAR5* gene expression was conducted on data from Wos et al., 2021 where the plants were grown under both the alpine- and foothill-like conditions. The dataset encompassed RNA-Seq data previously generated for a subset of the four alpine and four foothill studied populations (Wos et al., 2021). The edgeR package was used to test for consistent differential gene expression between foothill and alpine individuals, irrespective of their growth conditions (Robinson et al., 2010). Briefly, library sizes (i.e., read counts) were scaled and normalised, dispersion estimated and the 'glmFit' function used to test for gene expression differences between alpine and foothill individuals, with treatment as covariate.

PicMin and AFD-based selection scan

I applied PicMin over 500 bp windows, which is just below the average LD decay of *A. arenosa* (~600 bp, (Bohutínská et al., 2021b)) to test for evidence of repeated genetic differentiation among the foothill/alpine population pairs. PicMin uses order statistics to test whether population genetic summary statistics (in this case Fst (Hudson et al., 1992)) for orthologous genomic regions in different lineages exhibit a common shift towards extreme values in multiple lineages. That indicates the repeated operation of positive selection. PicMin was applied on windows that had data for all five lineages. A genome-wide false discovery rate correction was then performed with a significance threshold of $q < 0.01$. In cases of outlier signal spanning adjacent windows, the window with the lowest q-value and highest Fst was retained.

For the selection scans, the allele frequency difference (AFD), was used as the measure of genetic differentiation (Berner, 2019). The selection scan was performed using the NatGenVarViewer R script (github.com/mbohutinska/NatGenVarViewer). Briefly, genes were

scanned for outlier single nucleotide polymorphisms (SNPs) differentiated between foothill and alpine individuals. with the outlier AFD cut-off set at AFD = 0.6. The identification of candidate genes was facilitated by outcrossing in both alpine and foothill populations and following high nucleotide diversity that aids candidate gene detection in *A. arenosa* (Yant and Bomblies, 2017).

AlphaFold

To visualize the changes between the A and F variant of FAR5 I used AlphaFold v2.0 (Jumper et al., 2021). I used the protein sequence of *A. lyrata*. For highlighting the relevant structures, I gave different colors to different functional domains as described in (Chacón et al., 2013). Blue was used for the Rossmann-fold domain, green for the FAR_C domain and gray for the part of protein with SNPs affecting the specificity and stability of the enzyme. Furthermore, I also highlighted the molecular surface of the residues in *A. lyrata* at the positions corresponding to the candidate SNPs.

Cultivation of plants

For the experimental part, I used two different alpine lineages of *A. arenosa,* one diploid VT and one tetraploid ZT, as replicates. I selected 4 populations (2 pairs of alpine and foothill) from our seed collection, based on their genotype frequencies of the three differentiated coding FAR5 SNPs (selecting the purest alpine and foothill populations, which segregate FAR5 SNPs). For alpine populations I used seeds from TKO (ZT lineage, 1783 masl) and ZEP (VT lineage, 1625 masl) and for foothill populations HRA and SUB (further details regarding these populations see Suppl. Table 1). I germinated the seeds in the walk-in chamber provided by PSI under controlled conditions (23/18 ˚C, 16/8 h day/night, light intensity 150 µE). I vernalized the seedlings for 4 weeks (6 ˚C, 8/16 h day/night, light intensity 150 µE). After vernalization I transferred them to conditions (20/15 ˚C, 16/8 h day/night, light intensity 150 µE) for maturing and subsequent crossing.

Crossing design

To generate individuals with contrasting combinations of genomic background and *FAR5* allele, I genotyped the plants for the presence of alpine and foothill alleles, using restriction fragment length polymorphism in the *FAR5* locus (method CAPS, see below). I first aimed to identify rare heterozygous carriers of the contrasting allele. I then reciprocally crossed these heterozygotes within the population (aiming at three pairs of reciprocal crosses within each population), resulting in a F1 generation equally segregating the alpine and foothill allele (1AA:2AF:1AA in diploids, more complex pattern of genotypes in tetraploids, with most common being 1AAAA:8AAAF:18AAFF:8AFFF:1FFFF) (Fig. 5A). I did another round of crossing to generate *FAR5*-homozygous (or, in case of tetraploids, nearly homozygous) F2 generation which were transplanted to an alpine environment (see below).

I managed to successfully apply this design on three of the four populations originally selected for the experiment. The alpine population from the VT lineage did not show sufficient frequency of the foothill allele, therefore I only used the results from the two populations from the ZT lineage (foothill HRA and alpine TKO) and the foothill population (SUB) from the VT lineage in the subsequent analysis.

DNA extraction, CAPS

I extracted DNA as described in Supplementary Method 1. DNA samples were stored at 5 °C in the TE buffer for further use. Before PCR I diluted the sample to 10 ng/µl.

For assessing the allele in an individual, I used CAPS (cleaved amplified polymorphic sequences), a method where PCR-amplified DNA fragments are digested by a restriction enzyme. The restriction fragment length polymorphisms are then visualized on an electrophoretic gel (Konieczny and Ausubel, 1993). Specifically, the primers for amplification were designed in Geneious Prime 2021.2.2 software. The PCR mixture contained 10 ng of plant genomic DNA, 5 pmol of the F primer (TCATGTTGACAGATACCAGTGGA), 5 pmol of the R primer (CCTGGAGAGGTAGTTTGTAACGT), 2 µl of MyTaq reaction buffer (containing dNTPs, $MgCl_2$ and enhancers) and 0.5 U of Taq polymerase in a total volume of 10 µl. PCR was performed by Eppendorf Vapo.protect Mastercycler Pro for 1 min at 95 ˚C, 30 cycles of 15 s at 95 ˚C, 15 s at 60 ˚C and 10 s at 72 ˚C, followed by 5 min at 72 ˚C and finally had been held at 10 ˚C. The resulting fragment had 283 bp.

For digestion of the alpine allele, I used the DdeI restriction enzyme (Howard et al., 1986). This enzyme was designed in Geneious Prime 2021.2.2 software using alpine and foothill sequence of *FAR5* assembled from our long-read resequencing dataset. The enzyme was designed to cut at the position 377 that is in the middle position among my differentiated SNPs and also is the most foothill-alpine differentiated SNP. The reaction mixture for enzyme digestion contained 2 µl of the PCR product, 6.7 µl of ddH_2O, 0.3 µl of the restriction enzyme (1000 U/ml) and 1 µl of 10× enzyme buffer, which was incubated at 37 °C for 15 min, 65 ˚C for 30 min and held at 10 ˚C in the end. The products were visualized by 1.8% agarose gel electrophoresis run at 120 V for 30 min. The *F* allele had length of 283 bp and the *A* allele was cleaved into two fragments of 69 bp and 214 bp. The agarose gel electrophoresis results were photographed using the GelDoc Go imaging system. I manually scored each genotype, using band intensities to distinguish the different classes of heterozygotes (allele dosage) in tetraploids (Gebhardt, 2007).

Transplant experiment, leaf wounding

Four weeks after germination, F2 seedlings were transplanted into pots and burrowed in sand in the Alpengarten Patscherkofel (1960 m a.s.l.). After two months I wounded the leaves by applying pressure by the tweezers for a few seconds (Sözen et al., 2020). I then left the lesion to heal and harvested the leaves after 5 days. At this time point there is expected to be the highest expression of *FAR5* in *A. thaliana* (Domergue et al., 2010) and also my test runs determined it as the best time to observe the effect of the wounding (Suppl. Fig. 1).

Sampling, GC-MS-based metabolite profiling

For root sampling, plants were removed from the pots, roots were carefully cleaned in water and briefly dried them with paper towels. Afterwards, a 5 cm root segment was collected 1 cm below the incipience of the leaf rosette and placed in liquid nitrogen (- 196 °C). Both control and wounded leaves were sampled after 5 days of the wounding treatment, cut and immediately frozen in liquid

nitrogen. All the samples were freeze-dried with Zirbus VaCo 2 for three days and then stored at -80 °C.

The preparation of samples for GC-MS followed a slightly modified version of the non-extraction method for global-acyl-chain profiling previously described in (Delude et al., 2017), during which the samples are directly depolymerized by acidic transmethylation. For the method, ca. 3 mg DW of root material and 5 to 6 mg DW of leaf material were used. The aliquots of freeze-dried material and quality controls were extracted at 85 ˚C for 3h in 1 mL of 5% (v/v) sulfuric acid in methanol containing heptadecanoic acid (C17:0), pentadecanol (C15:0- OH) and C15-hydroxypentadecanoic acid (ω-OH-C15:0) as internal standards. After adding 1 mL of 2.5 % (w/v) NaCl and 2.2 mL of methyl tert-buthyl ether (MTBE) and centrifugation I collected the upper phase. 1mL of 100 mM Tris base pH 8.0 containing 0.09% (w/v) NaCl were added to the MTBE phase before proceeding with another centrifugation. The upper phase was collected again, and MTBE evaporated under a gentle stream of nitrogen prior to derivatizing the samples using 100 µL of 99% BSTFA (N,O-Bis(trimethylsilyl)-trifluoroacetamide) with 1% TMCS at 110 ˚C. Finally, after evaporating the solvent, I dissolved the products in 500 µL of heptane:toluene (1:1, v/v).

Metabolites were separated on a 30 m BPX70 column with 0.25 mm ID and 0.25 µm film thickness from SGE (Melbourne, Australia) using a Trace 1300 gas chromatograph coupled to a TSQ 8000 triple quadrupole mass spectrometer from Thermo Scientific (Massachusetts, USA) with a Topaz 4.0 mm ID Single Taper Inlet Liner w/Wool from RESTEK (Bad Homburg, Germany). A 1 µl aliquot of the sample was injected in splitless mode for GC-MS analysis. The temperature of the injector was held at 250 °C. The column oven temperature was held at 50 °C for 1 min and then increased from 50 °C to 200 °C at a rate of 25 °C per min, followed by a 1 min hold, and then was ramped up again at a rate of 10 °C per min to a final temperature of 320 °C, which was held for 8 min. The total run time was 28 min. High purity helium was used as the carrier gas at a flow of 1.5 ml per min. A mix of alkanes with 10 to 36 carbons was injected in the middle of the sequence for retention indices calibration.

Compound spectra were extracted from the raw data files using the “Automated Mass-spectral Deconvolution and Identification System” (AMDIS) and compared against a custom-built mass spectral library and the commercial library of the National Institute for Standards and Technologies (NIST) using the MS Search software (v2.4). Compounds identification were based on both spectral and retention index match. Afterwards, I used Xcalibur software (v4.5, Thermo Scientific) to determine peak areas for compound-specific fragments for relative quantification of identified compounds in the biological samples.

The final data I used for wounded leaves is in Suppl. Table 5 and for roots in Suppl. Table 6.

Statistical analysis

For metabolite profiling data I used Wilcoxon rank sum test to compute pairwise comparisons in the relative abundance of the compounds between different genotypes. I used Kruskal-Wallis rank sum test to test if there are significant overall differences between the groups. This statistical analysis was performed using the stats package in R version 4.1.2 (R Core Team, 2021). All main data handling was conducted with this software. In the analysis of environmental data, I used the function ggpairs from R package GGally (Schloerke et al., 2021) to compute and plot Pearson correlation coefficient. For creating the illustrational maps I used features from R packages: giscoR,

elevator, sf, terra and raster (Hernangómez, 2024; Hijmans, 2023a, 2023b; Hollister et al., 2023; Pebesma, 2018).

Genotype-environment association

I used redundancy analysis (RDA, implemented in R package vegan (Oksanen et al., 2022)) to identify the relationship between the frequency of *A* allele of *FAR5* and environmental variation. RDA is a powerful tool based on multivariate regression which enables us to model linear relationships between genomic data and environmental variables. More precisely, I used a derived method called partial redundancy analysis (pRDA) that allows us to look separately at the explained variability for different explanatory variables and to account for the correlations between the variables. I followed a similar course of actions as described in (Capblancq and Forester, 2021). For this analysis I standardized all the variables, i.e. subtracted the mean and divided by the standard deviation. To account for the correlation between the environmental variables, I used the ordi2step function from the vegan package in R. The method starts with an empty model and subsequently compares the current model with the global model (all variables) after adding other environmental variables one by one. Once the model cannot get better than the global model, the p-value reaches the threshold or the adjusted R^2 decreases, the method stops. After each round the method removes the effect of the best explanatory variable and thus all the variables that strongly correlate with it. As a consequence, one can find the second best explanatory variable without the effect of the first best. Genomic data were from the dataset mentioned above. Values of 103 environmental variables for all populations were extracted from the WorldClim database with a resolution of 2.5 min (Fick and Hijmans, 2017). For the final analysis I used monthly data for minimum temperature (tmin), maximum temperature (tmax), wind speed (wind), solar radiation (srad), precipitation (prec) and water vapor pressure (vapr). I also used specific value for each population corresponding to the most important vegetative month based on our field data for six variables mentioned above and average temperature (tavg). My full RDA model comprised 79 environmental variables.

For conducting GWAS I followed (Capblancq and Forester, 2021). I assessed to which extent allele frequency at each SNP corresponds to the set of environmental conditions shaping the FAR5 alllele frequencies across all populations of *A. arenosa.* Specifically, I used the following model: *RDA_env <- rda(AllFreq ~ prec_May + srad_vegMonth + tmin_Feb + Condition(PC1 + PC2), Variables)*. Where AllFreq are population allele frequencies calculated across all non-synonymous SNPs found in all 73 populations in my genomic dataset (see above). For assessing the neutral genetic structure (PC1 and PC2) I used 10 000 SNPs randomly chosen from all the synonymous SNPs. I selected all SNPs with p-value lower than 1×10^{-50} for further interpretation.

Results

Four *FAR5* SNPs show robust and repeated selection signals in alpine adaptation

To identify genes showing signatures of selection associated with alpine environment, I used a collection of previously published genomes of *A. arenosa* and selected 299 individuals of all five lineages where colonization of the alpine environment has been described (73 VT, 75 ZT, 89 NT, 40 FG and 22 RD, Fig. 1A). This involved 87 alpine and 212 foothill individuals.

To detect genes showing signatures of repeated positive selection I applied PicMin, a method that can test for repeated genetic differentiation, using the results of genome scans (Booker et al., 2023). To do so, I compared genetic differentiation between each of the five alpine populations and their foothill counterparts from the same mountain range (Fig. 1A) by calculating Fst in 500 bp genomic regions. Using PicMin, I next identified 285 significantly differentiated windows (q-value < 0.05) and 100 of these overlapping with 30 genes were found to be differentiated in all 5 lineages, likely contributing to an aspect of presumably highly polygenic alpine adaptation (Suppl. Table 2).

At the minimum q-value of 0.0097 (given the number of windows and replicates), I identified 79 windows showing signatures of repeated selection and 41 of these windows in all five lineages. These 41 windows overlapped with 13 genes, 6 of which have well described protein functions in *A. thaliana*. Specifically, these are photoreceptor phytochrome B involved in germination, myrosinase TGG1 producing compounds toxic to herbivores, RPM1 conferring a resistance to certain pathogens, a transporter ACD11, LAZ5 responding to pathogens and fatty acyl-CoA reductase FAR5 involved in formation of suberin (TAIR database, (Domergue et al., 2010)). The *FAR5* gene showed a particularly strong signal of repeated differentiation at SNP level (Fig. 1D) and therefore I studied it further.

Calculation of allele frequency difference (AFD) between a set of all alpine and all foothill populations in my dataset revealed that four SNPs drove the strong differentiation pattern in the *FAR5* window (Fig. 1D). These involve three amino acid changes, all located outside of the two conserved FAR5 domains (Fig. 1CE), and one intron variant. The most alpine-differentiated SNP is located at position 377 (Val377Leu, AFD = 0.68), a site demonstrated to alter FAR5 substrate specificity in *A. thaliana* (Chacón et al., 2013), which was therefore my primary center of interest for the downstream analyses. The other two amino acid changes involved Ala384Ser, located in a region possibly affecting FAR5 stability, and Cys329Gly (Fig. 1CE).

To better understand the genetic variability in the *FAR5* locus, I next used PacBio HiFi read assemblies from two alpine (lineage VT and FG) and eight foothill individuals of *A. arenosa*. All three alpine-characteristic amino acids were linked together, making either fully alpine allele (329Gly - 377Leu - 384Ser; *A* allele hereafter), or fully foothill allele (329Cys - 377Val - 384Ala; *F* allele hereafter, Fig. 1D). The coding SNPs were not linked to any structural variant in the *FAR5* coding region, suggesting that these SNPs alone primarily underlie foothill-alpine protein differences (Suppl. Fig. 2).

The comparison of the 10 *A. arenosa FAR5* assemblies to the *A. thaliana* and *A. lyrata FAR5* reference sequences revealed that for the position 329 the change to glycine is likely a reversal into

an ancestral state. The ancestry at the position 377 is more ambivalent; however, the change to leucine is in concordance with the *A. lyrata* state (Fig. 1E). The apparent evolutionary novelty of the third coding SNP, together with the fact that the substituted amino acids (Ala384Ser) have different chemical properties, and position in the region known to be involved in FAR5 stability, makes it an additional candidate SNP of interest. I further found that while coding *FAR5* regions are conserved (average pairwise alignment identity, PAI = 98.5 %), introns are considerably more variable (PAI = 91.4 %). In accordance with this observation, I found that three small deletions are linked to the alpine-characteristic SNP in the intron 8 (Suppl. Fig. 3).

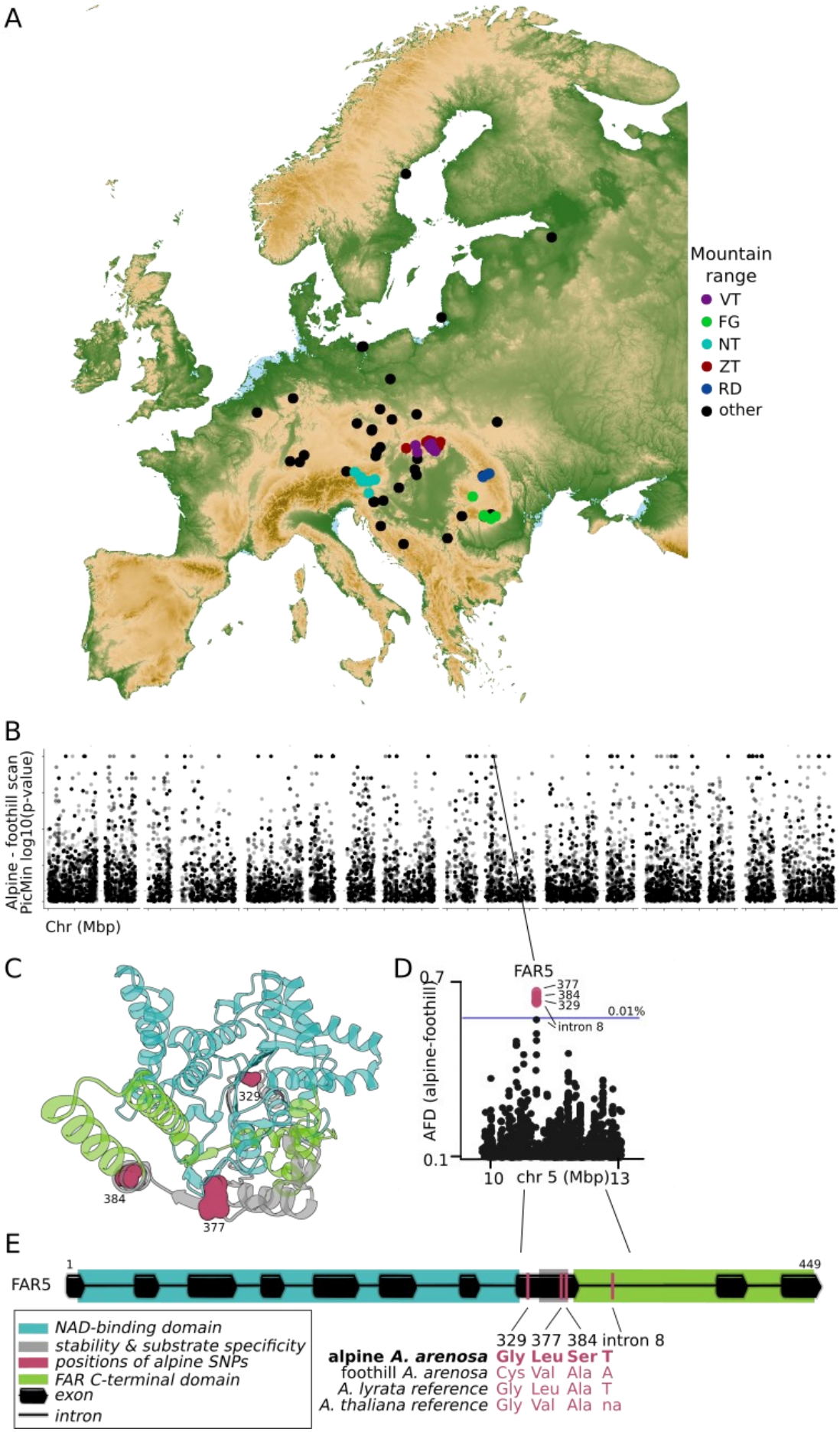

Fig. 1: Signals of positive selection acting on FAR5 in A. arenosa. A: the genomic dataset of 73 populations of A. arenosa, alpine and foothill populations from the five alpine lineages are marked by colored dots, other populations are black; B: Manhattan plot

depicting the results of Picmin across eight chromosomes of A. arenosa, FAR5 overlaps with one of the peaks showing the strongest signal of repeat positive selection; C: AlphaFold-visualized protein structure of FAR5. Highlighted are functional domains and the molecular surface of the three coding candidate SNPs; D: zoom-in into the FAR5 region on the chromosome 5 showing high allele frequency difference (AFD) for three coding and one intron SNP; E: gene model of the FAR5 gene and phylogenetic comparison of SNPs with the closest relatives. Candidate SNPs highlighted by vertical red lines, functional domains by colorful boxes.

Using AlphaFold protein structure predicted for FAR5 from *A. lyrata*, I found that the molecular surface of the (alpine) leucine residue at position 377 is predicted to extend towards the NAD-binding domain of FAR5 (Fig. 1C). This may suggest that the alpine FAR5 allele evolved to alter substrate specificity of FAR5, and in consequence the composition of fatty alcohols in alpine plants.

To assess if the SNPs and deletions in the intron 8 could have an impact on FAR5 protein through its retention, I mapped 96 available leaf transcriptomes of *A. arenosa* on a foothill *FAR5* gene assembly from the VT lineage. I have not detected any sign of intron 8 retention, but I noticed slight differences in transcription around intron/exon boundaries, which could make *A. arenosa*'s FAR5 protein few amino acids different compared to the one in *A. lyrata*. Finally, I found slightly higher levels of FAR5 leaf transcription in alpine compared to foothill individuals, which could make an effect of FAR5 allele in alpine populations more pronounced (Fig. 2).

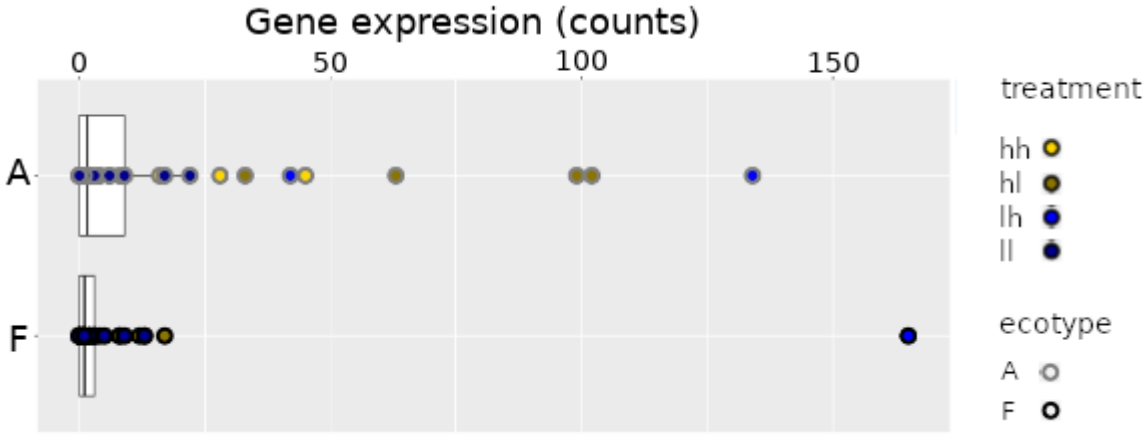

Fig. 2: The degree of leaf FAR5 expression in alpine and foothill individuals. Blue and yellow highlight different treatments under which the plants were grown.

To understand the evolution of the three candidate coding SNPs from a broader phylogenetic perspective, I explored FAR5 sequences across 25 million years of evolution of *Brassicaceae*. To do so, I gathered FAR5 protein sequences from 30 unique species from the *Brassicaceae* family, aligned them and explored how much my candidate positions vary across evolution, how unique are the alpine amino acids and how unique is the biochemical impact of the foothill-alpine change.

The position 329 was not highly conserved throughout the *Brassicaceae* family (PAI = 54.3 %) with glycine as the most abundant amino acid at this position (Fig. 3). I do not observe any change to cysteine in the 30 sequences which makes the protein corresponding to the *F* allele exceptional. Nevertheless, I noticed changes to other hydrophilic amino acids - serine and asparagine. Further, the position 377 does not show a pattern of strong conservation either (PAI = 55.2 %). The foothill version of 377Val is prevalent in the family. The *A* allele variant 377Leu corresponds to *A. lyrata* and to three other species - *Capsella rubella, Capsella grandiflora* and *Camelina sativa*. Lastly, the serine at position 384 is different from all the other sequences in my *Arabidopsis* dataset. In general, this position seems rather conserved throughout *Brassicaceae* (pairwise alignment identity at position 384 = 80.7 %), with alanine being the most prevalent amino acid. I observed three instances of amino acid change at this position, one of them being a change to serine in *Eutrema salsugineum*. The other two changes were to threonine in *Lepidium sativum* and to glycine in

Camelina sativa. Overall, biochemically most relevant are the amino acid changes at positions 329 and 384 which also show a certain uniqueness across the *Brassicaceae* family.

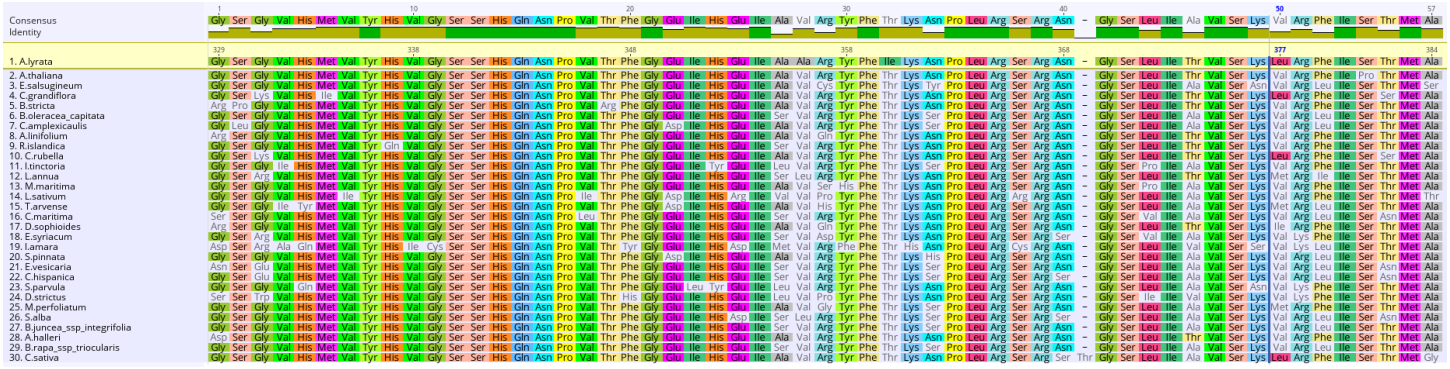

Fig. 3: Protein sequence alignment of 30 Brassicaceae sequences of FAR5, shown are protein positions 329-384 according to A. lyrata, encompassing all three candidate coding SNPs (positions 329, 377 and 384).

Alpine and foothill alleles of FAR5 mediate distinct metabolic phenotypes

The alpine adaptation is deeply intertwined with the environmental conditions. Because of the possibility that *FAR5* alleles are both transcriptionally and functionally manifested in an environment-dependent manner, I decided to determine the effect of carrying *A* or *F FAR5* allele in natural alpine conditions. Hence, I conducted a transplant experiment into an alpine environment, using alpine and foothill individuals, crossed to be homozygous for either *A* or *F FAR5* allele. To prepare such plants, I implemented a crossing design utilizing the natural variation of *A. arenosa* (Fig. 5A). In 78 % of foothill and alpine populations, rare non-native alleles occur (AF of *A* allele across all foothill populations = 0.24, AF of *F* allele across all A populations = 0.15, Fig. 10A). I thus performed a large-scale genotyping of alpine and foothill populations from VT and ZT regions and identified heterozygous plants carrying these rare contrasting variants. I crossed those within populations, genotyped the resulting F1 families and crossed the individuals carrying the non-native allele, resulting in a set of rare allele-homozygous lines (foothill plants homozygous for the *A* allele and likewise for plants originally from the alpine population) and control plants (foothill plants homozygous for the *F* allele and vice versa; Fig. 5A). Such natural variability-based crossing design allowed me to test the effect of both alleles on their native genome background (as compared to for example transforming the *F* and *A* alleles into model species *A. thaliana*) and also enabled me to transplant them to the actual alpine environment, which would not be possible with genetically modified plants.

Metabolite profiling suggests shift in the FAR5 substrate specificity

The positions of candidate SNPs within FAR5 stability and substrate specificity-related domain offer two hypotheses regarding their specific functional impacts: (1) they affect FAR5 substrate specificity and in consequence the relative abundance of the products or (2) they affect FAR5 stability and in consequence the accumulation of FAR5 products. Together with the proposed

function of FAR5 enzyme in suberin biosynthesis, this led me to focus my inquiry about the phenotypic effect of the allele on the production of metabolites, especially on 16- and 18-carbon chain metabolites. I presumed the *F* allele to produce the octadecanol (C18:0-OH) and the *A* allele to produce hexadecanol (C16:0-OH) based on their sequence similarity to *A. thaliana* variants from Chacón et al., 2013 (Fig. 5D). Based on the expression patterns of FAR5 in *A. thaliana* (Domergue et al., 2010; Klepikova et al., 2016; Mergner et al., 2020), I primarily focused on the composition of wax layers of roots and wounded leaves.

To see if any differences in the GC-MS (gas chromatography-mass spectrometry, see Methods) quantification of these metabolites were not given just by different overall metabolic activity of the two alleles, or if there are not genetic variants linked to FAR5 allele which would affect the overall spectrum of metabolites, and in consequence biasing my analysis of FAR5-dependent metabolite changes, I started by analyzing a set of neutral metabolites (metabolites except for hexadecanol, octadecanol and their related compounds). I analyzed this set of neutral metabolites across my 46 experimental individuals and asked if there are any signals of clustering by the allele. PCA of all neutral metabolites from wounded leaves does not show any significant effect of the *FAR5* alleles (Fig. 5B). The metabolites do not cluster neither by the allele nor by their original ecotype. Bearing this in mind, I continued by analysis of the relevant compounds according to my hypothesis about *FAR5* function.

Comparison of individual compounds between individuals carrying *A* and *F* allele has shown that the individuals with *A* allele produced proportionally more hexadecanol (C16:0-OH) than octadecanol (C18:0-OH) compared to the individuals with *F* allele, independent of their alpine and foothill origin ($p < 0.001$, N = 61, Kruskal-Wallis rank sum test; Fig. 4 left). This pattern is consistent across all three populations in my experiment and in both my measured tissues. In roots the pattern is more prominent and the proportional production of hexadecanol is significantly higher in all compared populations (p = 0.004/0.01/2.027e-05, N = 11/22/28 for VT, ZTA and ZTF, respectively, Fig. 5C).

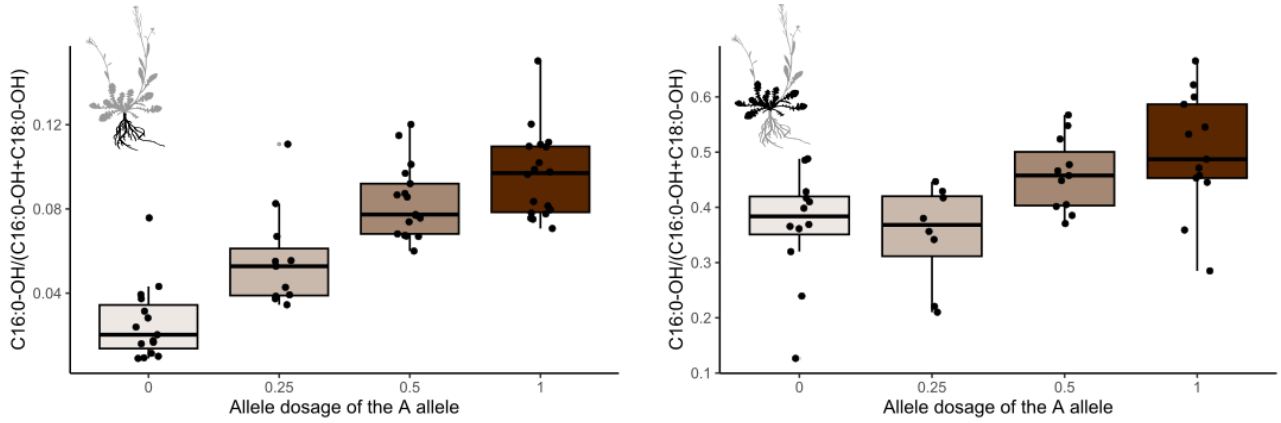

Fig. 4: Proportion of hexadecanol (C16:0-OH/C16:0-OH+C18:0-OH) in roots (left) and wounded leaves (right) in relation to the dosage of the A allele of FAR5 across all samples. The browner the box is, the more A alleles the individuals possessed. 0 – the individual had a genotype of FF or FFFF, 0.25 – AFFF genotype, 0.5 – AF or AAFF genotype, 1 – AA or AAAA genotype.

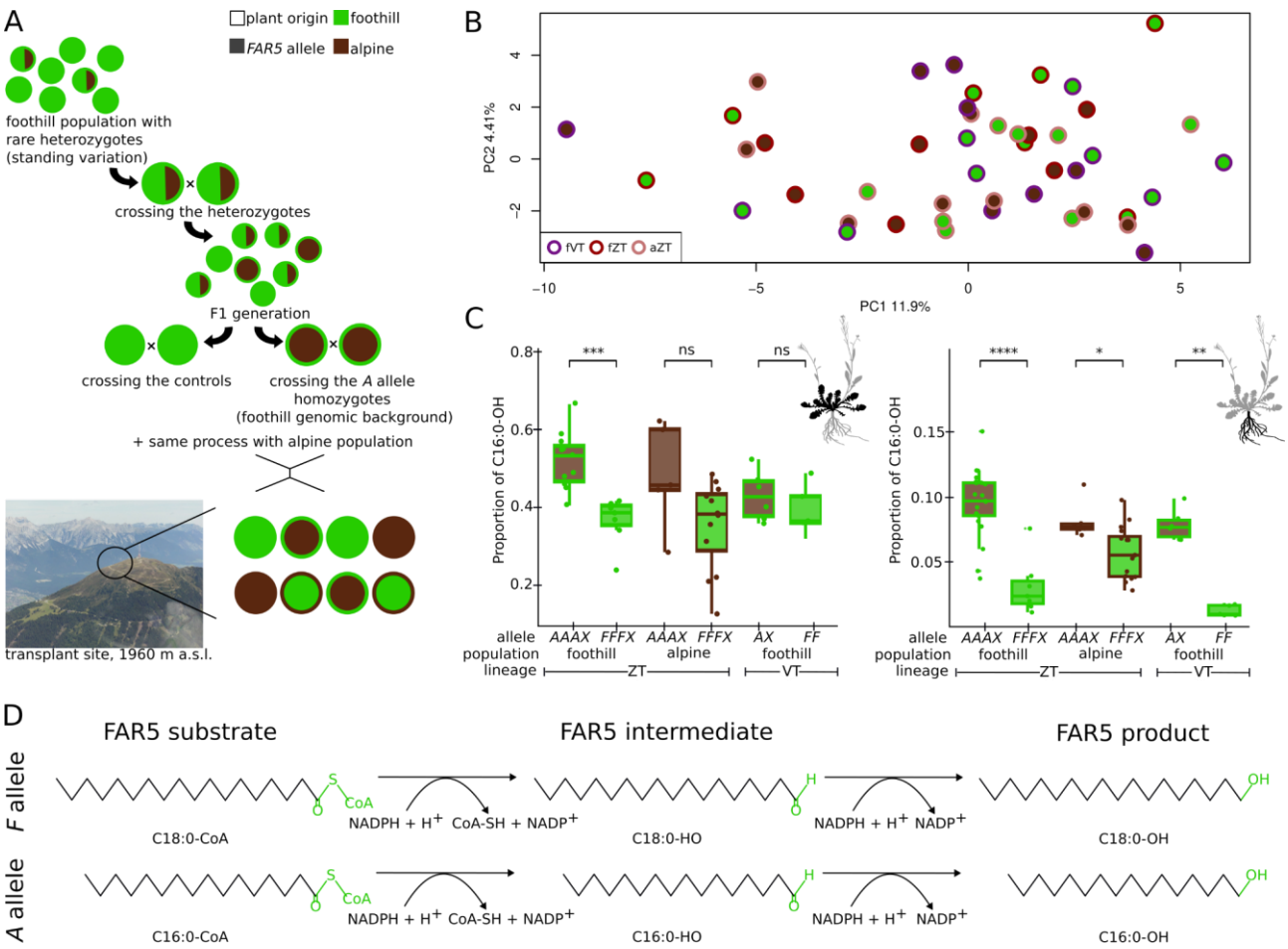

Fig. 5: Metabolomic characterisation of the FAR5 alleles in the natural alpine environment; A: design of crossing the FAR5 genotypes for transplant experiment and the resulting combinations of genotypes; B: PCA of 'neutral' metabolites (see text for details) from the wounded leaves across all individuals in my metabolomic analysis; C: proportion of hexadecanol (C16:0-OH/C16:0-OH+C18:0-OH) in wounded leaves and roots, X allele can be either A or F due to imperfect crossing; D: my hypothetical model of phenotypic effect of FAR5 A allele. Color legend for all figures: green = foothill, brown = alpine, outline = original ecotype, fill = FAR5 allele.

For wounded leaves I firstly tested if leaf wounding had any effect on the production of C16:0-OH and C18:0-OH in my populations of *A. arenosa*. Indeed, the inquiry of the metabolites revealed a significant difference in the relative abundance of hexa- and octadecanol between the unwounded control leaf and a leaf harvested five days after wounding across all the samples ($p < 0.001$ in both cases, N = 46, Wilcoxon rank sum test, Fig. 6).

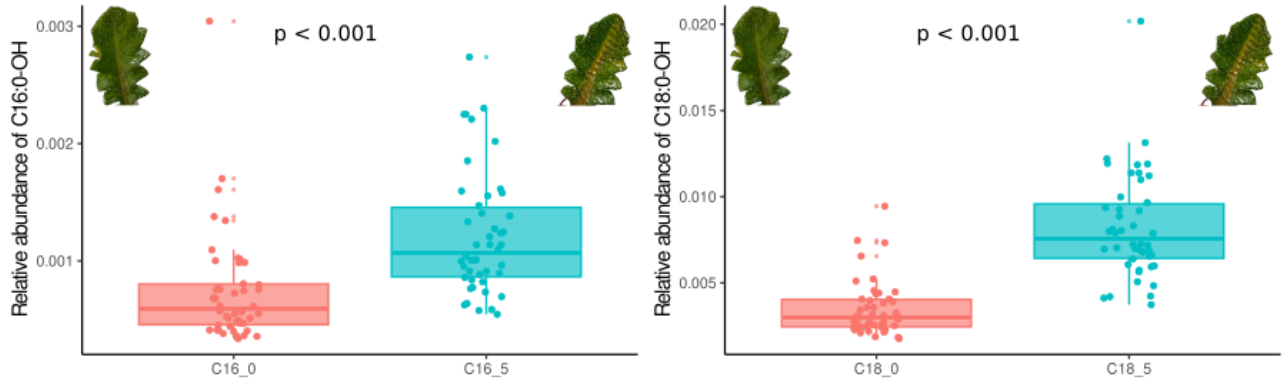

Fig. 6: Relative abundance of hexadecanol (left) and octadecanol (right) in the unwounded control leaves (red) and in the leaves 5 days after wounding (blue).

Specifically, I observed the increase in the production of both fatty alcohols in the wounded leaves. I thus asked if the degree of induction is allele-dependent. I expected the plants with *A* allele to have a higher increase in the production of hexadecanol than plants with the *F* allele and plants with the *F* allele were expected to increase production of octadecanol more than plants with the *A* allele. Indeed, the comparison of the differences in relative abundances of hexadecanol and octadecanol show that the induction of production of C16:0-OH by wounding is higher in the plants with *A* allele, and induction of production of C18:0-OH by wounding is higher in the plants with the *F* allele (Fig. 7).

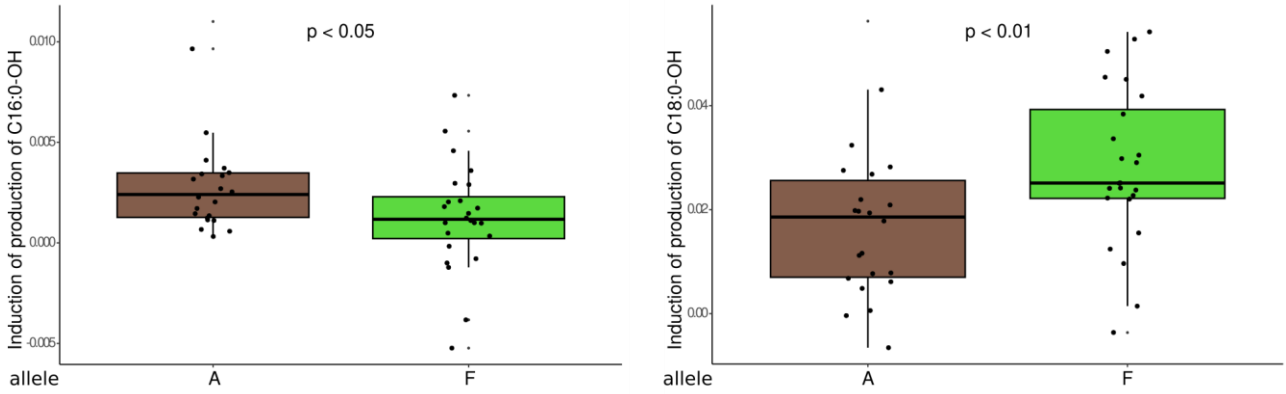

Fig. 7: Induction of hexadecanol (left) and octadecanol (right) production (difference between unwounded and wounded leaf amounts) based on allele; green=foothill, brown=alpine

Because the unwounded control leaves varied in the relative abundance of both fatty alcohols, for the final analysis, I standardized the wounded samples by their unwounded controls. This allowed me to test the effect of the allele on the fraction of metabolites induced by wounding, which is directly linked to *FAR5* expression. When comparing the proportion of hexadecanol across all my populations, I found that plants carrying the *A* allele produced more hexadecanol (p=0.002, N=44, Kruskal-Wallis rank sum test, Fig. 4 right), independent of their foothill or alpine origin. That is consistent with the pattern observed in roots. In wounded leaves, I found significant increase in the C16:0-OH proportion in the foothill population from ZT lineage (p-value = 0.0003, N=18) and similar but nonsignificant increase in the other two lineages (p = 0.4/0.1, N = 11/17 for VT and ZTA, Fig. 5C).

Other evaluated fatty alcohols with different chain lengths did not show consistent and strongly significant differences between the alleles neither in roots nor in the wounded leaves (Suppl. Fig. 4-9). All in all, these results suggest that the changes between the *F* allele and the *A* allele alter the substrate specificity from 18C to 16C of the FAR5 protein.

The stability of FAR5 is not affected by the candidate SNPs

Two main characteristics of an enzyme are its specificity and its stability. After finding out that the specificity of FAR5 is shifted if the *A* allele is present, I next tested if there is any allele-dependent effect on FAR5 stability. As enzyme stability correlates with its efficiency, I compared the sum of the two products of FAR5, octadecanol and hexadecanol (corresponding to the overall efficiency of FAR5, independent of its specificity (Kunka et al., 2023)). There were not any consistent differences between individuals carrying the *A* and *F* allele in the sum of products. There were two significant, yet opposite, differences in the sum of the two products between my test groups: an increase in individuals with *A* allele in ZTF population (p=0.027) and decrease in the individuals with the *A* allele in ZTA population (p=0.0024) both in root samples. The rest of the comparisons

were not significant (p>0.05). Therefore, I conclude that amino acid changes in the *A* allele of FAR5 affect the substrate specificity, while the stability of the protein is not affected (Fig. 8).

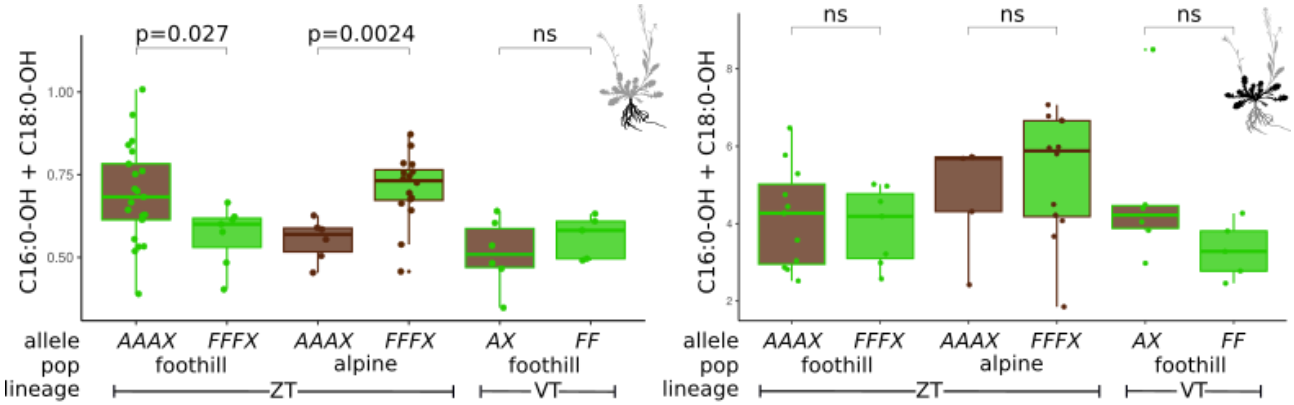

Fig. 8: The sum of relative abundance of hexadecanol and octadecanol, which I use as a proxy of FAR5 stability, for the samples from roots (left) and wounded leaves (right); ns: non-significant result (p-value > 0.05), X allele can be either A or F due to imperfect crossing; box outline=ecotype, fill=allele, green=foothill, brown=alpine

Environmental drivers of *FAR5* variation

My next aim was to gain insight into the possible functional consequences of the identified *FAR5* alleles and metabolomic phenotypes. For this, I assessed which environmental factors may have shaped the distribution of the *FAR5 A* allele among populations of *A. arenosa*. To do so, I used partial redundancy analysis (pRDA). RDA is a powerful tool based on multivariate regression which allows to model linear relationships between genomic data and environmental variables. More precisely, I used a derived method called partial redundancy analysis (pRDA) that enabled me to separately assess the explained variability for different environmental variables and to account for the correlations between the variables (for details see Methods).

My dataset comprised geographic data from 73 populations across the distribution range of *A. arenosa* (Fig. 1A) and 71 climatic variables extracted for these coordinates from the WorldClim database. I further included data for all climatic variables during the most critical month of the growing season for each population, based on our field observations, which I further denote as 'vegetative month' variables (Suppl. Table 3). My final set encompassed 79 climatic variables, seven of which were selected by pRDA as significant for explaining the variation in the frequency of the *FAR5 A* allele (Table 1). Out of these, the best correlated explanatory variables suggest an association of the genetic variance of *FAR5* alleles with early season precipitation, irradiation during vegetative season or winter temperatures (Fig. 9).

*Table 1: Explanatory variables significant based on pRDA; ** p<0.01 *p<0.05.*

Variable	Cummulative R2 adjusted	F-value	p-value	correlation
prec_May	0.275927587	28.438	0.002**	0.535
srad_vegMonth	0.3413852	8.0565	0.006**	-0.499
prec_Oct	0.4605063	16.456	0.002**	0.211
tmin_Feb	0.5019368	6.7396	0.004**	-0.472
tmin_Dec	0.5727211	12.265	0.002**	-0.457
srad_Apr	0.6329272	11.989	0.004**	0.116
prec_Jul	0.6552639	5.2764	0.026*	

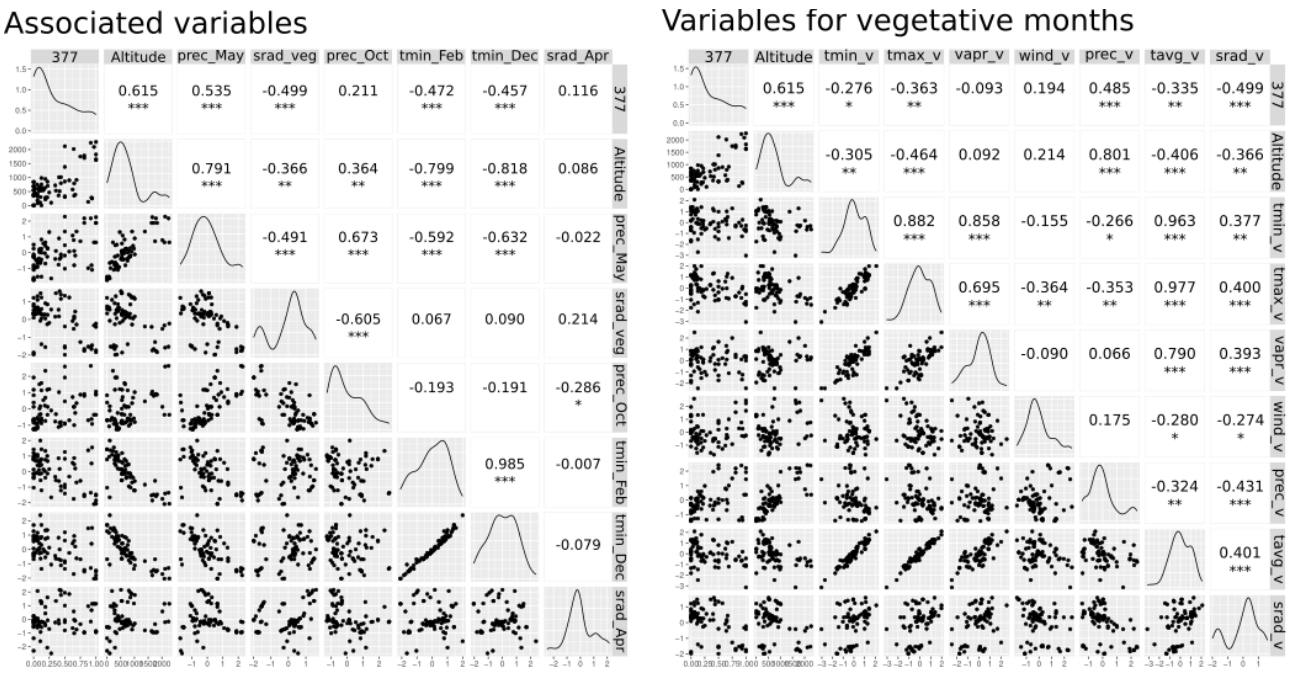

Fig. 9: Correlation of the A allele frequency (approximated as allele frequency at position 377) with selected environmental variables, across all 73 populations. Correlation of the best of associated variables (left) and variables for the vegetative month (right).

To examine the relationship between the best associated environmental variables and the frequency of the *A* allele, I compared their values between the populations from my dataset with almost fixed *A* allele ($AF_A > 0.9$, N = 10) and populations with fixed *F* allele ($AF_A = 0$, N = 12). I observe a significantly higher amount of precipitation in the populations with a high proportion of the *A* allele (Fig. 10BC). In the amount of solar radiation in the vegetative season and the minimum winter temperature I observe a negative correlation (Fig. 10C) and thus lower values in the populations with high proportion of the *A* allele (Fig. 10B). The relationship between the amount of precipitation in May and the frequency of the *A* allele is noticeable from the climate map (Fig. 10A), where the populations with higher proportions of the *A* allele are located mainly in the regions with higher amounts of precipitation.

To test which genes show allele frequency correspondence with the same environmental conditions as *FAR5*, and may have therefore co-evolve under a similar selective regime, I applied RDA-based GWAS. For the model I selected three climatic variables that were best associated with the frequency of the *A* allele of *FAR5* (based on the pRDA and correlation) – prec_May, srad_vegMonth and tmin_Feb. I also accounted for the neutral genetic structure using the population scores along the first two axes of genetic PCA. I found 19 loci associated with similar environmental conditions as FAR5, which may have therefore evolved under similar selective forces. These 19 SNPs are annotated to 9 genes. Specifically, I detected a single SNP of a protein from the family CAMTA (calmodulin-binding transcription activators), 4 SNPs from a translation regulatory factor MRF2, 3 SNPs from FAR5, an arginine/serine-rich splicing factor RSP35, a transporter ABCG40 associated with ABA transport and resistance to lead, a vacuolar phosphate transporter VPT1 securing phosphate homeostasis, 3 SNPs from CFTR transporter, DOG1 controlling seed dormancy and mRNA binding CRS1 / YhbY (CRM) domain-containing protein (Suppl. Table 4). From all the SNPs, only the SNP from CAMTA and one SNP from MRF2 had stronger association with the environmental predictors than FAR5. The SNPs from FAR5 were associated as follows: strongest association was with Leu377Val (based on its variability, the predictors were chosen), then Gly329Cys and lastly Ala384Ser.

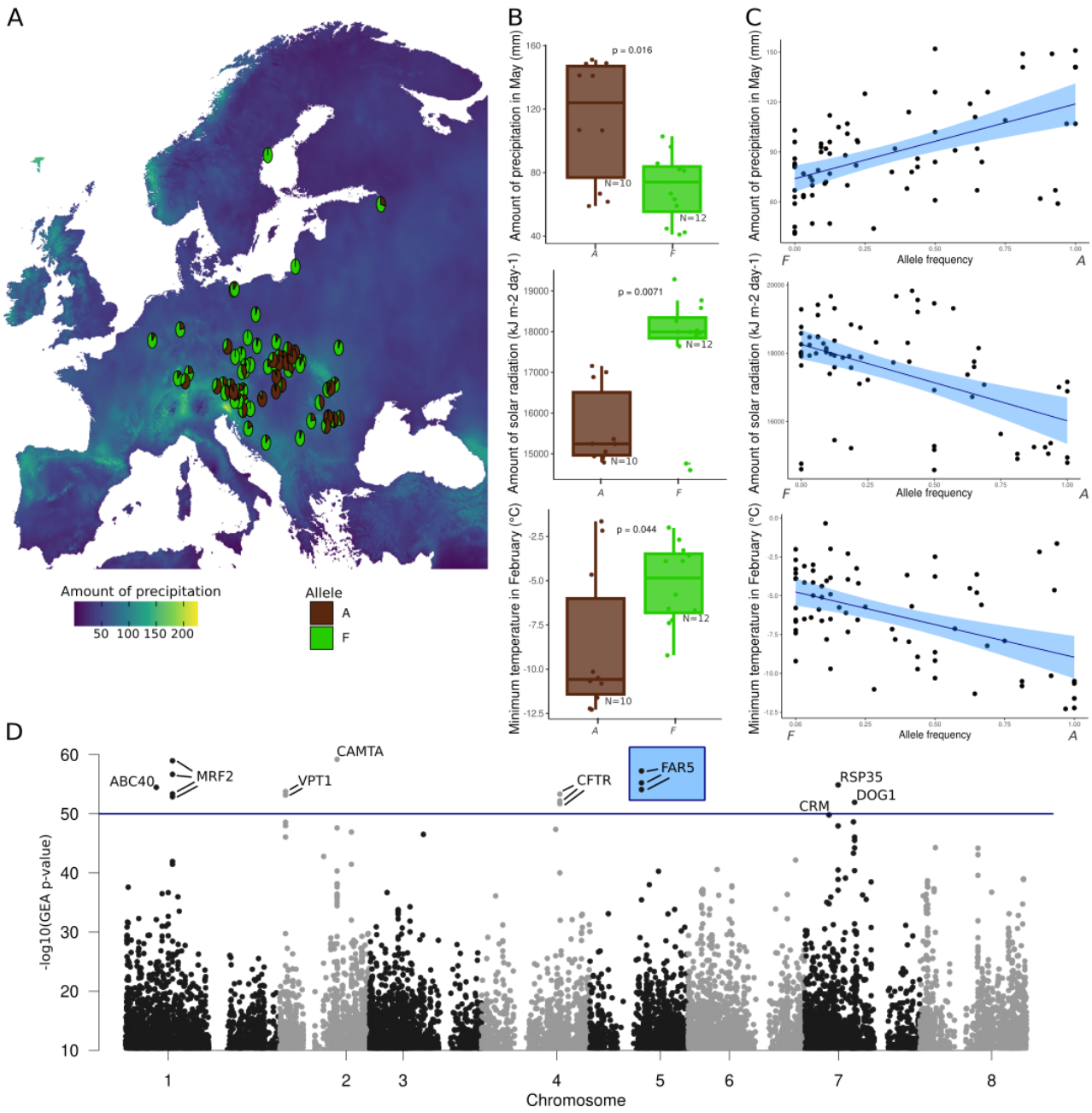

Fig. 10: Environmental drivers of FAR5 variation; A) frequency of the A and F- allele across the set of 73 populations of A. arenosa, projected on the map of spring precipitation (climatic variable prec_May); B) Differences in three climatic variables (prec_May, srad_vegMonth, tmin_Feb) between populations with nearly fixed A alleles (AFA > 0.9, N = 10) and populations with fixed F alleles (AFA = 0, N = 12).; C) correlation of A allele frequency with the three climatic variables (prec_May, srad_vegMonth, tmin_Feb); D) Manhattan plot of the association between genome-wide nonsynonymous variation of A. arenosa and the climatic variables important for the FAR5 A-allele distribution (prec_May, srad_vegMonth, tmin_Feb), blue line indicates the strongest outlier SNPs, rectangle marks FAR5 SNPs.

I further tested which environmental factors drive the frequency of the *A* allele across foothill populations in my dataset of *A. arenosa*. The motivation was to understand which environmental variables support the standing variation in the foothill populations and isolate the effect of climate on the frequency of the *A* allele from the effect of the alpine environment itself. The change in climate between foothill and alpine populations is prominent with strong correlations of environmental variables. Furthermore, the alpine populations are almost fixed for the *A* allele which could confuse the interpretation of the causative environmental variables because a change in the variable would be correlated with the increase in the *A* allele frequency.

From the pRDA analysis on this foothill subset, two variables resulted as significant: maximum temperature in May and water vapor pressure in vegetative season (both $p<0.05$, R^2 adjusted=0.10746/0.16982). In the correlation matrix maximum temperature in May is significant (- 0.352) in contrast to water vapor pressure in vegetative season (0.243) (Fig. 11 left). From the correlation with the variables from the vegetative season, I infer a slight significance of solar radiation on the frequency of *A* allele in foothill populations (Fig. 11 right).

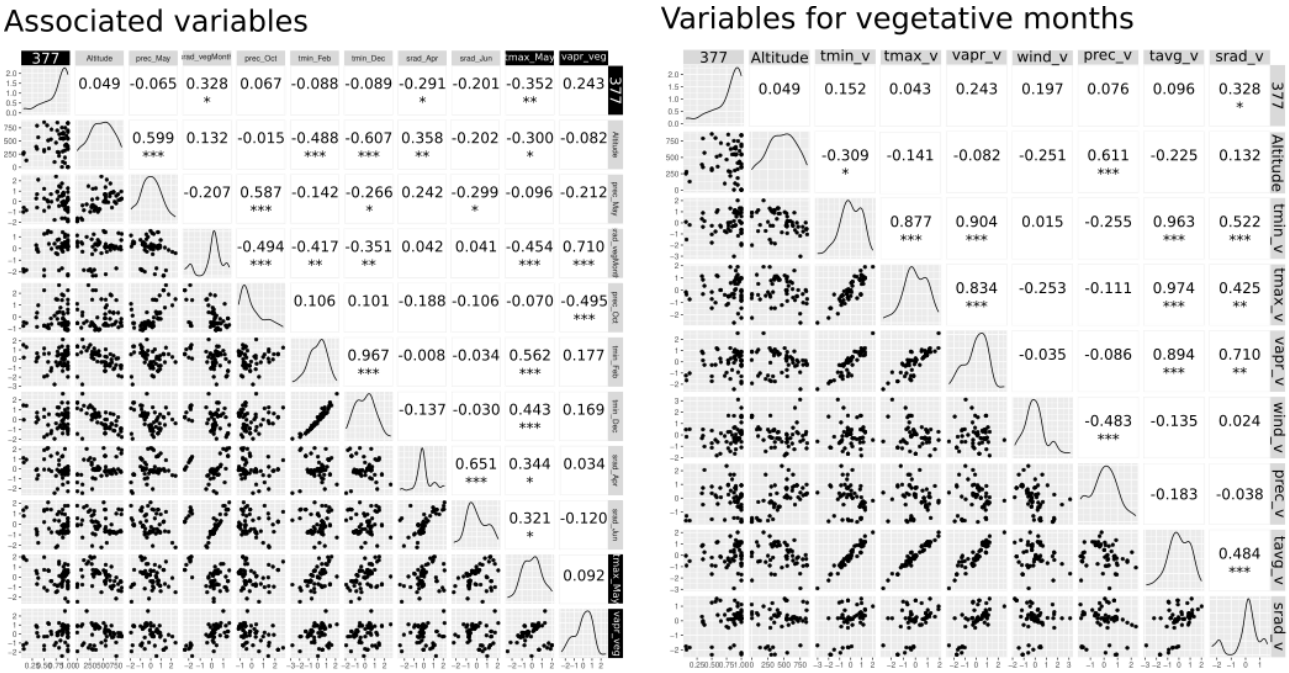

Fig. 11: Correlation of the FAR5 A allele frequency (approximated as allele frequency at position 377) with selected environmental variables, across the set of 55 foothill populations. Correlation of the best of associated variables (left) and variables for the representative vegetative month (right).

Despite the foothill character of the Pannonian region, there is a high frequency of the *A* allele, suggesting, perhaps a bit surprisingly, a shared selective regime on *FAR5* in this region and in the alpine region (Fig. 10A). Therefore, I also associated the explanatory variables with the subset of foothill populations without the populations located in this region. Only one environmental variable was significantly associated by the pRDA and that was the wind speed in the vegetative month ($p=0.018$, R^2 adjusted=0.09653, corr=0.339). Correlation between the frequency of the *A* allele and the variables for vegetative months showed also a significant correlation with the amount of precipitation (-0.305, Suppl. Fig. 10).

Discussion

Repeated adaptation provides a unique opportunity for insight into the mechanisms of evolution. The repeated use of pathways or genes suggests their evolutionary importance. This study contributes to understanding the characteristics of a repeatedly selected allele. Thus, my main objective in this chapter is to discuss why the *FAR5 A* allele was repeatedly positively selected in the alpine environment. Here I compare results of this study with the available literature dealing with similar themes.

FAR5 as a candidate gene for alpine adaptation

I firstly identified *FAR5* as a strong positively selected candidate gene in alpine adaptation and characterized the specific sites and variants which contribute to this signal. The identification of *FAR5* as a strongly repeatedly selected gene is consistent with the genomic study of alpine adaptation of *A. arenosa* (Bohutínská et al., 2021b). Highly differentiated SNPs of *FAR5* between foothill and alpine populations correspond to amino acids at positions 329, 377 and 384 and to one SNP in an intron. Especially interesting is the change at the position 377 which was shown to alter FAR5 substrate specificity in *Arabidopsis thaliana* (Chacón et al., 2013).

The *FAR5* variation from a phylogenetic perspective

I explored the variation between my foothill and alpine samples from a broader phylogenetic perspective. From the alignment across the family *Brassicaceae* I observed that the position 384 is rather conserved. However, FAR5 *A* allele of *A. arenosa* (*A allele* further) shared the same amino acid change with *E. salsugineum*. That is an extremophile plant studied for drought and salt tolerance because of its halophytic habitat (Lugan et al., 2010). Other two candidate SNPs in *E. salsugineum* are not differentiated in the same manner as the *A* allele of *A. arenosa*. Potentially interesting could be also the change in *L. sativum* at this position because its threonine has similar chemical properties as serine present in the *A* allele. The change at the position 329 was unique in my dataset but there were two similar amino acid changes to serine in *Cakile maritima* and *Diptychocarpus strictus* and to asparagine in *Eruca vesicaria*. These two amino acids are both hydrophilic as is cysteine in the *F* allele in *A. arenosa*. There are several studies dealing with different aspects of adaptation of these species because they are inhabiting salty or sandy and arid localities. The halophytic species *C. maritima* is studied due to its potential for saline agriculture (Arbelet-Bonnin et al., 2019). The factors affecting germination were examined in *E. vesicaria* (Barazani et al., 2012) and in cold desert species *D. strictus* (Lu et al., 2010). Even though the position 329 is unique in the *F* allele the reversal to the ancestral state in the *A* allele could be functional, possibly related to water management. Interestingly, the expression patterns of *FAR5* suggest its influence on seed coat (Domergue et al., 2010; Vishwanath et al., 2013). Altogether, these phylogenetic parallels may be a first indication that the different alleles of *FAR5* could be drought-related.

From the biochemical and phylogenetic point of view, the positions 329 and 384 are more interesting than the position 377. That is surprising because of a contrast with the differentiation

pattern where the position 377 shows the strongest signal. It might suggest that all three SNPs are important for adaptive change.

The correspondence between alpine alleles of *A. arenosa* and reference alleles of *A. lyrata* at three out of four candidate positions could be related to *A. lyrata's* occurrence at high latitude (Schmickl et al., 2010), as high latitude is known to share many characteristics with high altitude (Stevens, 1992).

Repeated positive selection likely acted on standing variation in *FAR5*

I propose the repeated adaptation via the *A* allele of *FAR5* as a case of adaptation from standing variation. The reasoning behind this is that the candidate selected amino acid changes are present in the foothill samples as standing variation and they are all three together repeatedly found at high frequencies in all five alpine lineages. The selective sweep appears to be narrow (only 4 differentiated SNPs, <1kb apart), suggesting a longer existence of this haplotype, a signature which differentiates sign of selection acting on standing allele from the sign of selection acting on recently introgressed allele (Lee and Coop, 2019, 2017), thus giving time for recombination in its surroundings (Barrett and Schluter, 2008).

The high frequency of the *A* allele in the Pannonian lineage could be a result of incomplete lineage sorting and following action of positive selection or genetic drift in this lineage. Similar pattern was observed in some meiotic genes of *A. arenosa*, which show high differentiation in the polyploid and in the seemingly selective-regimewise unrelated diploid Pannonian lineage in the study of adaptation to polyploidy (Wright et al., 2015; Bohutínská et al., 2021a). The incomplete lineage sorting could theoretically extend as far in the phylogeny as is the divergence between *A. arenosa* and *A. lyrata* due to shared variation between *A. lyrata* and *A* allele in *A. arenosa*. To explore this possibility, a detailed study of these two species would be necessary.

Multiple non-synonymous SNPs under selection: compensatory evolution, co-evolution or hitchhiking?

Here I show that all three identified coding SNPs differentiated between the alpine and foothill populations of *A. arenosa* are non-synonymous. The repeated positive selection of such a set of changes suggests some adaptive significance. Non-synonymous changes were reported to be adaptive before (Klim et al., 2024). The non-synonymous changes are often associated with loss of function, but they can lead to novel function of proteins (Han et al., 2022). I propose that the differentiation in *FAR5* between the foothill and alpine populations in my dataset leads to a change of function rather than a loss of function, due to the absence of coding insertions, deletions or premature stop codons. Furthermore, I elaborate on what could have contributed to the repeated positive selection of all three SNPs. I offer two possibilities: 1) only one SNP is functional and the others compensate for its possible negative side-effects or 2) all three SNPs are relevant and we witness the consequences of shared selection of all of them, possibly suggesting co-evolution or multi nucleotide mutation event. Finally, there is also a possibility of just one SNP being evolutionarily relevant and the others hitchhiking in the selective sweep.

Compensatory evolution

The connection between different amino acids in the protein can lead to unexpected evolutionary events. The hypothesis of compensatory mutations suggests that an amino acid change affecting the structure or function of the protein can be followed by a change at a different position in an attempt to compensate for the mutation. An attempt to return the protein to the original state (DePristo et al., 2005; Kimura, 1985). It would be possible that the multiple SNPs identified in my samples are caused by FAR5's efforts to return to its original function. However, the shift in substrate specificity towards the shorter fatty alcohol could be an optimal state for the alpine environment and thus the hypothesis of compensatory mutations acting here would not be supported.

Adaptation via multiple SNPs in one protein

Another possibility is that all the three amino acids are necessary for the shift in substrate specificity. In a non-selective scenario, they could arise during a multi-nucleotide mutation event (Schrider et al., 2011). But this scenario is not supported by the fact that in the closely related *A. thaliana* the substrate specificity changed with different amino acid changes. Moreover, I suggest that the *A* allele emerged from a standing variation in *A. arenosa* as I stated before.

Nevertheless, natural selection could act on multiple SNPs at once, resulting in their co-evolution. Several amino acid changes are often reported to affect the protein specificity or stability. Mutations at different positions can have separate effects on the enzyme specificity and stability (Dickmann et al., 2004) or a cumulative effect of multiple amino acid substitutions is necessary to change the enzyme specificity even though just one of the amino acids is in direct contact with the substrate (Oue et al., 1999). A non-synonymous substitution in cancer-associated enzyme IDH1 was previously thought to be a loss of function mutation. However, when one amino acid is changed the residues in the active site reorganize and enable the enzyme to change its substrate specificity (Dang et al., 2009). The single amino acid change is thanks to its placement in the 3D structure actually able to reposition some highly conserved amino acids at different positions of the protein.

Altogether, while we currently cannot distinguish between compensatory evolution, co-evolution or a mere hitchhiking, the presence of multiple amino acid changes selected together in the FAR5 *A-allele* may motivate further inquiries.

FAR5 enzyme in the alpine adaptation

The role of variation in affecting FAR5 properties

Between the *A* and *F* allele I identified four differentiated SNPs, one of them being an Ala384Ser change. This mutation induces a significant chemical change from a hydrophobic amino acid to a hydrophilic amino acid. Similar change from phenylalanine to serine was shown to affect both substrate specificity and thermal stability of cysteine sulfinic acid decarboxylase (CSAD) in mice (Mahootchi et al., 2021). However, this does not mean that the other SNPs are meaningless.

To specify if all the SNPs are truly responsible for the change in substrate specificity observed in my samples, I could construct various combinations of single and double mutants from my three identified SNPs (Cys329Gly, Val377Leu and Ala384Ser) and compare the resulting effect on enzyme behavior. This approach was previously used to successfully determine that only one of

three SNPs was responsible for altering the enzyme substrate specificity in *Paenibacillus pabuli* (Sahnoun et al., 2022).

Although directed mutagenesis is widely used in research of the enzymatic properties (Onuffer and Kirsch, 1995; Wrenbeck et al., 2017), study of the natural variation in enzymes is scarce. Palzkill, 2018 shows that natural mutations in enzymes changed the substrate specificity in order to build a resistance to antibiotics in Gram-negative bacteria, which also affected thermal stability of the protein. Nevertheless, this was compensated by the emergence of additional global suppressor mutations (Palzkill, 2018). In *Brassicaceae* the site-directed mutagenesis was used to investigate the natural variation in methylthioalkylmalate synthases (MAMs) and its effect on glucosinolate biosynthesis (Petersen et al., 2019). My study contributes to the knowledge of changes in substrate specificity and natural variation of the protein sequence of *FAR5*. By perfectly understanding the changes of protein sequence, we can achieve precise predictions about the structure and function and in turn improve the enzyme engineering (Acebes et al., 2016).

The phenotypic effect of positively selected FAR5 mutations

One of the main aims of this study was to determine the phenotypic manifestation of the derived *A* allele of *FAR5* gene. There was a significant difference in the proportion of C18:0-OH to C16:0-OH between plants with derived alpine allele and plants with ancestral foothill allele. Plants with the ancestral foothill allele produced more C18:0-OH than C16:0-OH whereas plants with derived alpine allele produced more C16:0-OH when compared to C18:0-OH. FAR5 was noted to influence production of primary alcohols of different lengths in wheat leaves (C22:0-OH in functional analysis of *TaFAR5* in yeast and C26:0, C28:0 and C30:0-OH in transgenic tomato) (Wang et al., 2015), but data from the most closely related model organism, *Arabidopsis thaliana,* support the role in producing C18:0-OH (Chacón et al., 2013; Domergue et al., 2010; Vishwanath et al., 2013).

Moreover, by a series of domain swaps particular amino acids underlying substrate specificity of the enzyme were determined. One of the amino acids was at position 377 (Chacón et al., 2013). From my data I know that this position is also altered in the derived alpine allele. Apart from this amino acid also the position 355 is mentioned to affect *A. thaliana'*s substrate specificity. In particular, amino acids at both positions 355 and 377 needed to be altered to fully shift the substrate specificity of the enzyme (Chacón et al., 2013). However, my genomic data do not suggest any positively selected mutation at the position 355. It is possible that if this amino acid was also altered, the difference in fatty alcohol composition would be more striking. Another possibility is that position 377 is solely responsible for the substrate specificity of FAR5 or that the function of the amino acid on the position 355 is complemented by mutation at position 329 or 384.

The fatty alcohols are utilized during protection against abiotic and biotic stresses. They are part of the suberin layer in roots (de Silva et al., 2021; Domergue et al., 2010; Vishwanath et al., 2013). However, the method I used to extract lipidic compounds doesn't allow us to exactly determine that the difference in composition of fatty alcohols comes from suberin. It could be from other lipidic parts of the roots, such as soluble suberin-associated waxes (Delude et al., 2016). Nevertheless, it was shown that the shorter the alcohol chain, the more likely it is to be part of suberin. (Vishwanath *et al.*, 2013) Therefore I cannot rule out the possibility of different *FAR5* alleles affecting suberin composition.

Precise characterization of different alleles and in consequence the effect of their corresponding enzymes on fatty alcohol production may be of importance in research of sustainable wax esters which are fundamental in the production of lubricants, pharmaceuticals and cosmetics (Domergue and Miklaszewska, 2022).

Role of environmental factors in the FAR5-mediated adaptation to the alpine environment

Environmental drivers of *FAR5* variation

Abiotic environmental factors present an important obstacle in the establishment of plants in the alpine environment. Therefore, I could not omit them in my study of alpine adaptation of *Arabidopsis arenosa*. I used partial redundancy analysis to associate the genetic variation in *FAR5* with the environmental predictors. My results show that increased precipitation in the spring is an important factor, positively affecting the frequency of the *A* allele. Several other studies also reported possibly adaptive associations with precipitation in their genotype-environment association studies in Norway spruce (Di Pierro et al., 2016), two snowbed species, *Achillea clusiana* and *Campanula pulla* (Felkel et al., 2023) and a set of 13 alpine plant species (Manel et al., 2012) all conducted in the range of Alps. That is consistent with the fact that precipitation and temperature are among the major ecological variables determining the distribution of plants and driving their adaptation (Berry and Bjorkman, 1980).

The lowest winter temperature was also identified as a significant factor in the distribution of genetic variation in *FAR5*. Low temperature acts as a limiting factor for the distribution of many plants, and freezing resistance has been repeatedly investigated also in *Arabidopsis* (Hannah et al., 2006; Kaplenig et al., 2022). Minimum temperature was shown to be important for the genetic diversity of four conifer species from the European Alps (Mosca et al., 2012). In the same region, the adaptive genetic variation of 13 alpine plant species was associated with temperature as one of two major explanatory factors, the other being precipitation (Manel et al., 2012).

Another essential factor for the well-being of plants is solar radiation (Yang et al., 2022). The usual expectation is that the amount of solar radiation increases with altitude (Steinhauser et al., 1958) according to (Körner, 2022). However in my dataset, I observe a negative correlation of the *A* allele frequency and solar radiation in the vegetative season. That is arising from the fact that each population had a different month as its most important vegetative month and the populations with higher frequency of *A* allele vegetate in periods with short days. In general however, the increasing trend of solar radiation with altitude is not so prominent due to increasing cloudiness in the high elevations (Körner, 2022). In spite of that, the study of alpine adaptation in Tibetan poplar (*Populus szechuanica* var. *tibetica*) identified two hotspot regions with robust signals of natural selection showing an association with altitude and solar radiation (Zheng et al., 2020).

The changes in solar radiation are associated with a tendency of increasing proportion of ultraviolet radiation with altitude which can affect plant life severely, thus posing an obstacle to plant alpine adaptation (Caldwell, 1968). Alpine plants are often preventing damage caused by the UV radiation via increased pigmentation, altered cuticle width and composition and trichome density (Koski and Ashman, 2016, 2015). The pigments can also protect the plants against drought

or cold temperatures (Chalker-Scott, 1999). That is probably why we see genes associated with response to UV and flavonoid biosynthesis as selected outliers in some cases of alpine adaptation (Sun et al., 2020). Suberin has not been reported to be related to solar radiation. I therefore hypothesize that the association with the *FAR5 A* allele could be related indirectly, for example, through the day length-dependent timing of seed germination via seed coat composition.

When examining what other genes were associated with the alpine environment, I repeatedly encountered identification of genes involved in regulation of transcription and translation (Di Pierro et al., 2016; Novikova et al., 2023; Zheng et al., 2020) or abiotic stress response, e.g. heat shock proteins (Mosca et al., 2016, 2012). As another response to abiotic stress, plants often undergo lignification to improve their tolerance (Fan et al., 2006). Two genes involved in lignin biosynthesis were associated in the study of alpine adaptation in conifers: cinnamoyl-CoA reductase (CCR1) and pinoresinol reductase (PRR1) (Mosca et al., 2012). In alpine adaptation in Siberian larch (*Larix sibirica*) several genes were identified as candidate genes associated with altitude and other bioclimatic variables (Novikova et al., 2023). One of the candidates was *FAR4*, suggesting an unrecognized importance of FAR proteins for adaptation to the alpine environment. The production of secondary compounds, including suberin, is associated with exposure to environmental stress (Chalker-Scott, 1999), hence the relevance of FARs for alpine adaptation could lie in their ability to affect suberin layer and consequently the protection of plants against drought and cold temperatures (Gou et al., 2009). In the alpine populations of two *Pinus* species there is a signal of selection for acyl-CoA oxidase associated with annual temperature (Mosca et al., 2016). This supports the importance of lipid metabolism in alpine adaptation.

Exploring the adaptive role of *FAR5*

After discovering a specific phenotypic effect of the *A* allele of *FAR5*, I could not help but to wonder about its functional impact on the alpine adaptation. Considering all the gathered information about phenotype, transcriptomic pattern, associated environmental variables, signs of co-evolution and available literature I believe that main reasons for repeated positive selection lie in its putative effect on seed dormancy, pathogen defense and/or on abiotic stress such as drought.

The effect on seed dormancy via specific suberin composition is supported by two genes showing association with similar environmental conditions as *FAR5* in *A. arenosa*. First is *ABC40* which is a membrane protein from the ABC family. The ABC transporters are believed to aid the suberin monomers in their transport through the membrane (Pighin et al., 2004; Rains et al., 2018). Mutants in another protein from the ABC family, ABCG1, demonstrated altered root suberin composition. Specifically, the *abcg1* mutants had reduced abundance of longer-chain (C20+) dicarboxylic acids, fatty alcohols and acids (Shanmugarajah et al., 2019). Furthermore, the role of ABC40 in abscisic acid (ABA) transport could be of significance considering suberization being stimulated by ABA in potato (Cottle and Kolattukudy, 1982) and the role of ABA as a phytohormone in timing of the seed dormancy (Schopfer et al., 1979).

The second interesting gene was *DOG1* due to its involvement in the seasonal timing of germination (Huo et al., 2016). Since *FAR5* is expressed in the seed coat of *A. thaliana* (Domergue et al., 2010), it could also affect germination. Moreover, suberin has been shown as a protective factor for seed germination in the presence of chromium (C^{3+}) (de Silva et al., 2021).

In a genomic study of pathogen response in *A. thaliana,* FAR5 was identified as one of three significant candidates (Kirischian, 2017). This suggests a yet unknown role in plant immunity of FAR proteins suggested already by (Domergue et al., 2010) due to their effect on suberin which

serves as a barrier for pathogens. It is also supported by antibacterial properties of long chain fatty alcohols (Hattori et al., 1987).

The production of suberin was previously associated with plant reactions to abiotic stress, such as cold, salt stress (Gou et al., 2009) or drought (Franke et al., 2012). Therefore, the ability to appropriately modify it could be beneficial during the adaptation to the alpine environment, whether for seeds or mature plants.

The apparently specific effect of the *A* allele on the production of C16:0-OH/C18:0-OH may only be only one piece of the range of the *A* allele‘s impact on local adaptation given the possible importance of *FAR5* e.g. in response to pathogens. Larger phenotypic effect size of a candidate adaptive gene would correspond to a preprint showing that repeatedly selected genes in local adaptation to climate variation have higher pleiotropy than originally thought (Yeaman et al., 2023).

Overall, the complexity of the alpine environment hinders the efforts to describe the mechanisms of local adaptation accurately. There are many biotic and abiotic factors affecting the strenuous adaptation of organisms resulting in polygenic character of the adaptation. Nevertheless, I believe that this and other future studies will significantly contribute to the understanding of the big picture of alpine adaptation.

Conclusions

In this study, I present my findings regarding the role of the candidate alpine-adaptive *A* allele of *FAR5* in the alpine adaptation of *Arabidopsis arenosa*. I revealed a detectable phenotype of the candidate allele and observed a signal of directed change in the substrate specificity in the alpine environment.

Firstly, I established the importance of *FAR5* in alpine adaptation by showing that it was highly differentiated between the foothill and alpine environments throughout the five alpine colonization events. I characterized the two alleles, *F* allele typical for foothill populations and *A* allele typical for alpine populations. I showed three linked coding SNPs and one intron SNPs as differentiating the two alleles.

Subsequently, I showed that plants with the *A* allele produced more C16:0-OH than plants with the *F* allele. The latter produced more C18:0-OH. This pattern was consistent across all my samples in both measured tissues, roots and wounded leaves. These results suggest a change in substrate specificity between the variants of FAR5 corresponding to the two alleles.

Finally, I associated the genetic variation in *FAR5* with the environmental factors. I observed the strongest association between allele frequencies and early season precipitation. Among other strong factors were solar radiation during the vegetative season and minimum winter temperature. All these factors can be associated with the challenges the alpine environment presents for plant survival. Furthermore, I identified eight genes selected under similar environmental conditions as *FAR5*. The genes are involved in timing of germination, regulation of transcription and translation and transport.

To increase our knowledge about the specific function of the enzyme and the importance of observed metabolic changes for plant life in the alpine environment, future research should be devoted to the examination of the seed coat, the effect on germination and transcriptomic analysis.

The uniqueness of this study lies in the functional validation of a clearly defined candidate allele. That is quite rare in evolutionary biology. A practical use might come from the broad industrial application of enzymes, for FAR5 particularly in pharmaceutics and cosmetics as the produced fatty alcohols are fundamental for formation of wax esters utilized in production of bio-lubricants. From the evolutionary aspect, this study contributes to the knowledge about adaptation to the steep change of conditions between the foothill and alpine environment. Understanding the molecular mechanisms of such adaptation could be beneficial in the future in the light of recent environmental changes.

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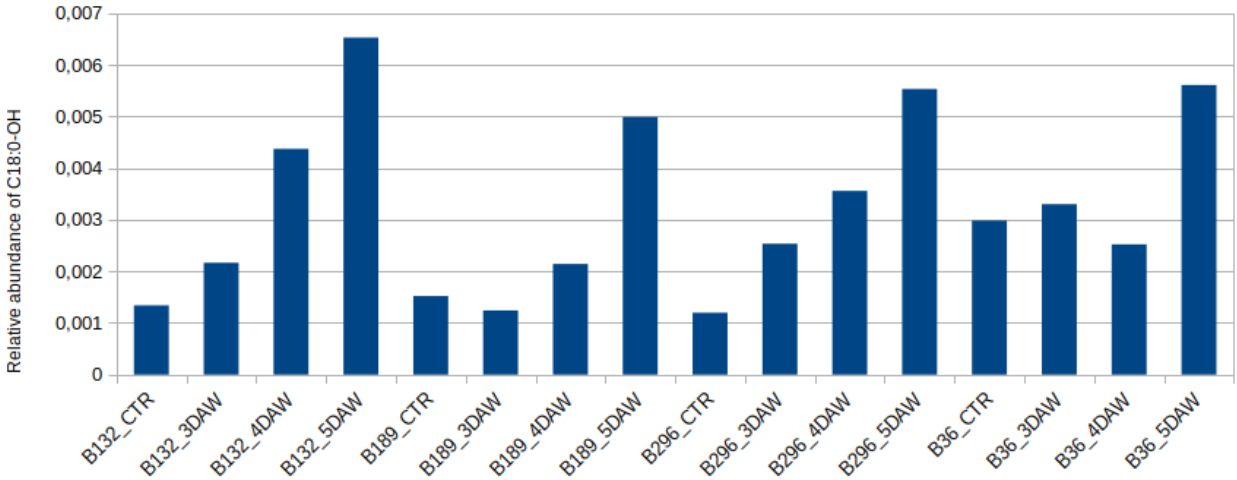
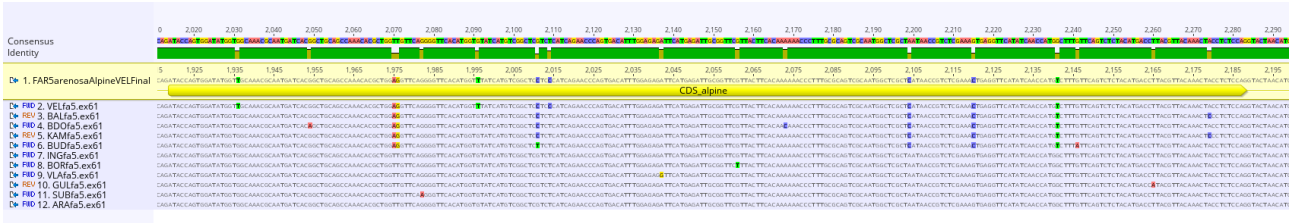
Supplements

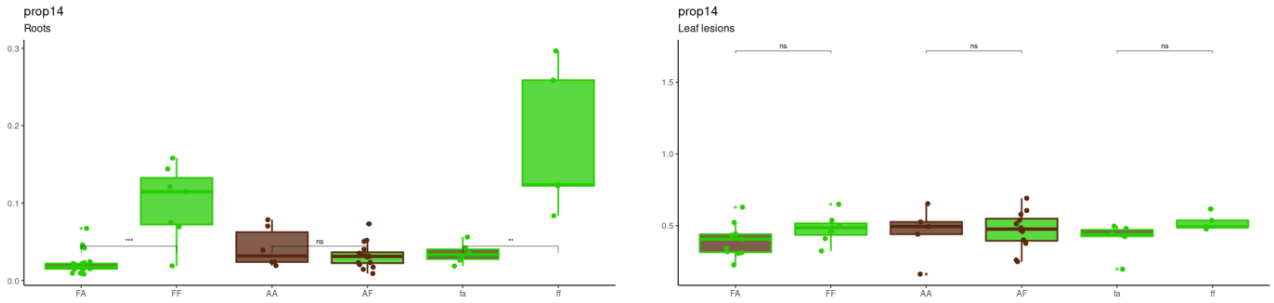


Suppl. Fig. 1: Comparison of the relative abundance of C18:0-OH between unwounded leaf (CTR) and leaves harvested after 3, 4 and 5 days after wounding (DAW). The induction of production o the fatty alcohol is strongest after 5 days.

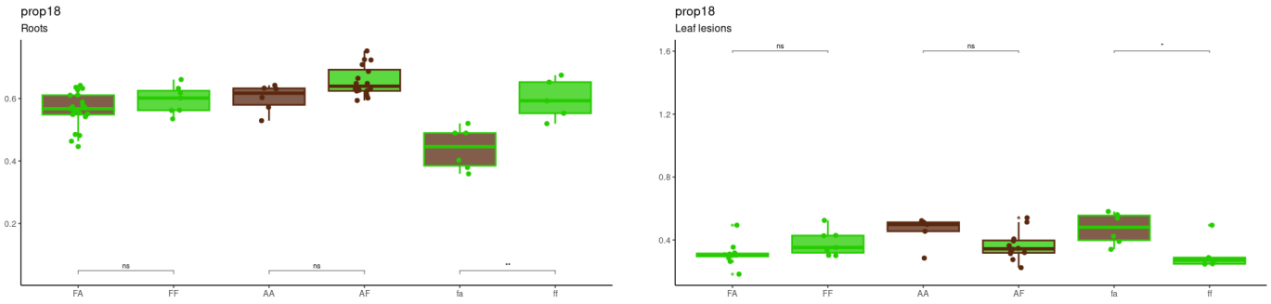


Suppl. Fig. 2: Search for structural variants among our sequences.

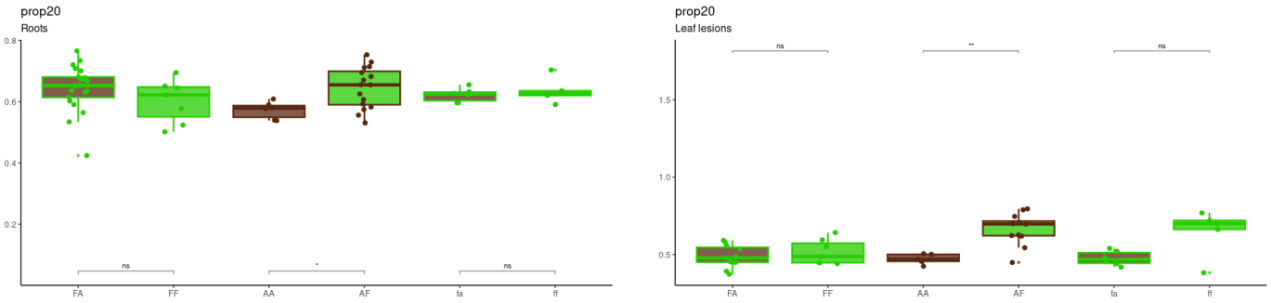
Suppl. Fig. 3: Three deletions in the intron 8.



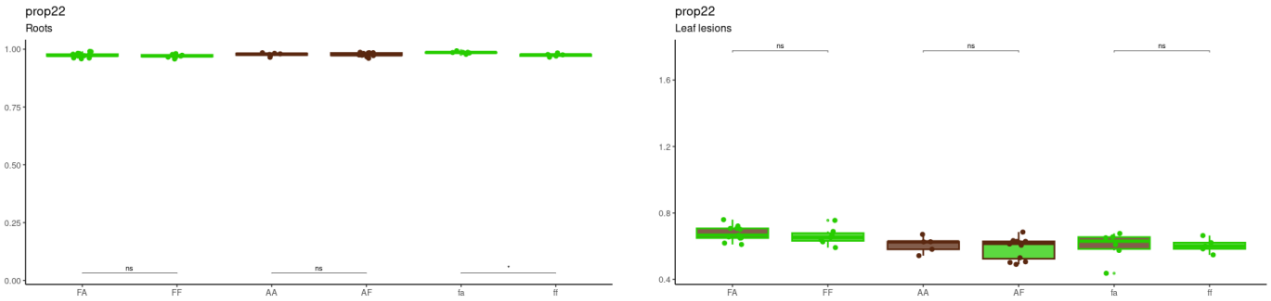
Suppl. Fig. 4: Proportion of production of tetradecanol (C14:0-OH/(C14:0-OH+C16:0-OH)) in roots (left) and wounded leaves (right).



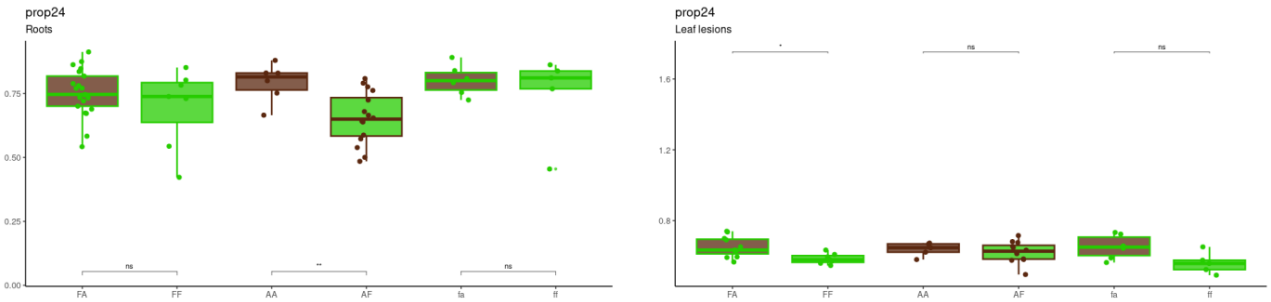
Suppl. Fig. 5: Proportion of production of octadecanol (C18:0-OH/(C18:0-OH+C20:0-OH)) in roots (left) and wounded leaves (right).



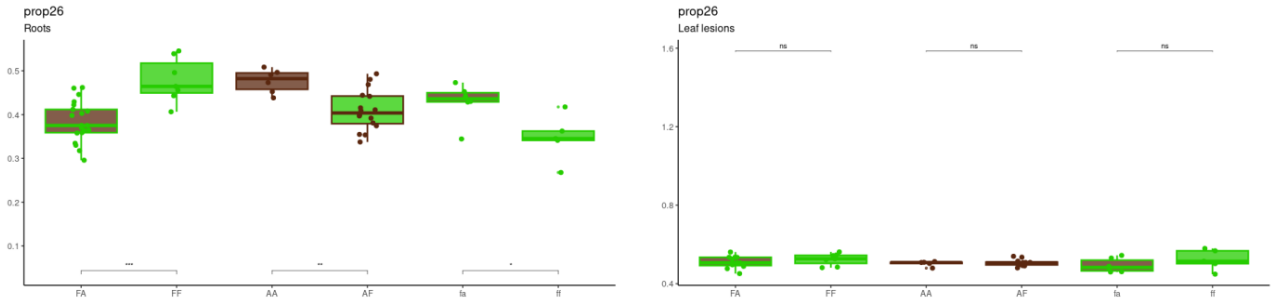
Suppl. Fig. 6: Proportion of production of eicosanol (C20:0-OH/(C20:0-OH+C22:0-OH)) in roots (left) and wounded leaves (right).



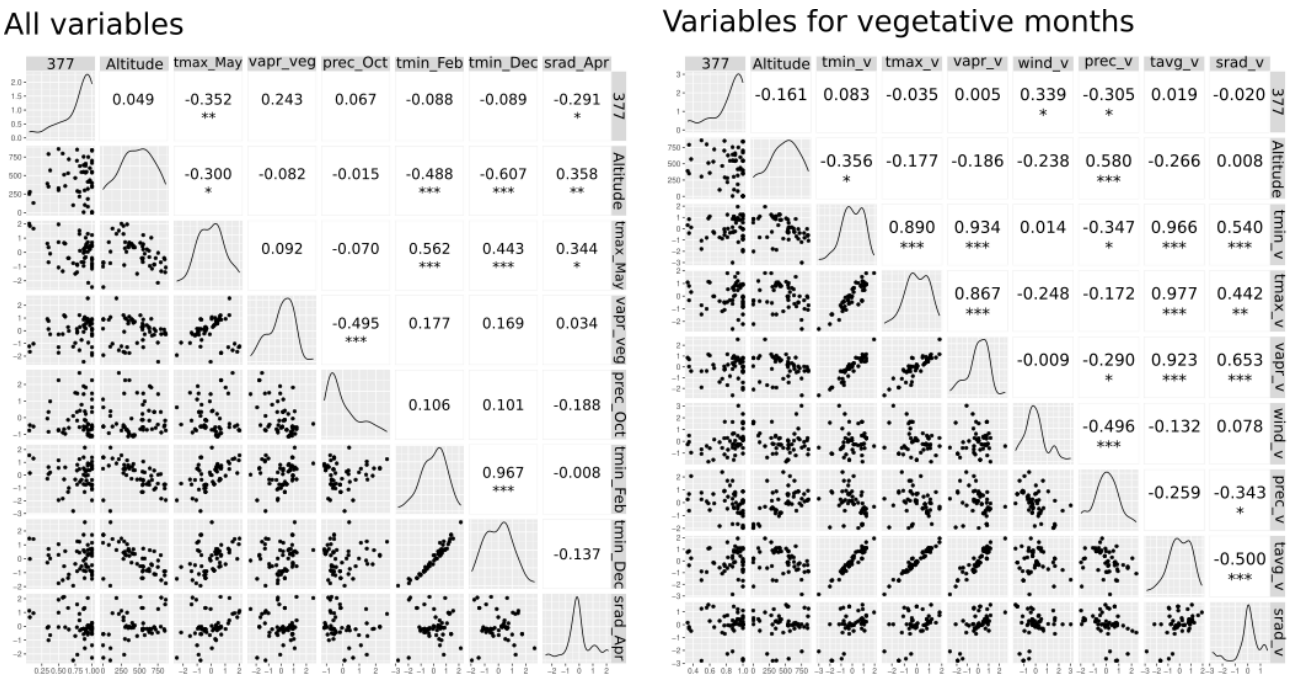
Suppl. Fig. 7: Proportion of production of docosanol (C22:0-OH/(C22:0-OH+C24:0-OH)) in roots (left) and wounded leaves (right).



Suppl. Fig. 8: Proportion of production of tetracosanol (C24:0-OH/(C24:0-OH+C26:0-OH)) in roots (left) and wounded leaves (right).



Suppl. Fig. 9: Proportion of production of hexacosanol (C26:0-OH/(C26:0-OH+C28:0-OH)) in roots (left) and wounded leaves (right).



Suppl. Fig. 10: Correlation of the A allele frequency (specifically position 377) across foothill populations without the Pannonian lineage with environmental variables. Correlation of the best associated variables (left) and variables for the vegetative month (right).

Suppl. Table 1: Information about the 73 populations of A. arenosa, Pop=code, Lin=alpine lineage, Lat=latitude, Lon=longitude, Altitude=meters above sea level, Ploidy=population ploidy, Veg=most important vegetative month, Name=local name near the pop. coordinates, State=state of locality, Nind/pop=number of individuals sampled per population, Data_source=source publication, Bedrock=calcareous (calc), silicious (silic), serpentine (serp) or metalliferous (metal) bedrock.

Pop	Lin	Lat	Lon	Altitude	Ploidy	Veg	Name	State	Nind/pop	Data_source	Bedrock
BAB	VT	49.043514	20.180772	844	2	5	Baba	SK	12	Bohutinska et al 2021	calc
BAL	FG	45.602	24.62263889	2269	4	8	Lacul Balea	RO	8	Bohutinska et al 2021	silic
BDO		47.458	18.92477778	252	2	4	Budaors	HU	8	unpubl. Filip - mixedploidy	calc
BEL		46.16167	16.115	550	2	4	Belecgrad	HR	8	Monnahan et al 2019	calc
BGS		47.62806	13.00167	570	4	5	Berchtesgaden	D	8	Monnahan et al 2019	NA
BIH		44.88181	15.89882	217	2	4	Bihac	BiH	8	Monnahan et al 2019	calc
BOR		49.6838164	15.1332558	416	4	5	Borovsko	CZ	8	Konecna et al 2021	serp
BRD		50.04967	13.89081	350	4	5	Brdatka	CZ	5	Monnahan et al 2019	silic
BUD		45.467007	25.227617	1013	2	5	Brusturet	RO	8	unpubl. Filip - mixedploidy	calc
CAR	RD	47.57594444	25.07711111	981	4	5	Carlibaba	RO	8	Bohutinska et al 2021	silic
CHO		50.59298	5.44383	103	4	5	Chokier	B	8	Monnahan et al 2019	calc
DRA	FG	45.44164	25.22394	858	4	5	Dambiovicioara	RO	8	Monnahan et al 2019	calc
FOJ		43.97502	17.82446	754	2	4	Fojnica	BiH	8	Monnahan et al 2019	silic
FUG		48.6314972	15.5572367	436	4	5	Fuglau	AT	8	Konecna et al 2021	silic
GOR		44.26528	21.54271	184	2	5	Gornjak	SRB	8	Monnahan et al 2019	calc
GUL	NT	47.281679	14.927647	628	4	5	Gulsen	AT	19	Monnahan et al 2019 + Konecna et al. 2021	serp
HAR		48.85166	15.85833	400	4	5	Hardegg	AT	2	Monnahan et al 2019	NA
HLI	VT	49.17	20.03	1650	2	8	Hlinska dolina	SK	2	Novikova et al 2016	silic
HMC	VT	48.82	19.02	700	2	5	Harmanec	SK	4	Novikova et al 2016	calc
HNE		48.26694	19	280	2	4	Hotnianske Nemce	SK	7	Monnahan et al 2019	silic
HNI	VT	48.8775	20.5275	836	2	5	Hnilcik	SK	4	Monnahan et al 2019	silic
HOC	NT	47.37	15.38667	545	4	5	Hochlantsch	AT	8	Monnahan et al 2019	silic
HRA	ZT	49.00716	20.286407	720	4	5	Hranovnica	SK	13	Bohutinska et al 2021	silic
HRN		62.6	18.03	5	4	5	Harnosand	S	6	Novikova et al 2016	NA
INE	RD	47.52734	24.88062	2017	4	8	Ineu	RO	7	Bohutinska et al 2021	silic
ING	NT	47.2840589	14.6815483	950	4	5	Ingeringgraben	AT	8	Konecna et al 2021	silic
KAM	ZT	49.210747	20.928184	633	4	5	Kamenica	SK	8	unpubl. Filip - mixedploidy	calc
KAS	NT	46.68833	14.87167	660	4	5	Kasparstein	AT	8	Monnahan et al 2019	calc
KLE		50.2440833	16.848417	750	4	5	Kletno	PL	9	Preite et al. 2019	metal
KOS	NT	47.74694	13.68972	467	4	5	Kosslbach	AT	7	Monnahan et al 2019	calc
KOW		50.763153	15.8439	670	4	5	Kow ary	PL	8	Monnahan et al 2019	NA
KRM		50.118939	25.739772	320	2	5	Kremenets	UA	8	unpubl. Filip	calc
KZL		47.72444	18.77917	330	2	4	Kesztolc	HU	5	Monnahan et al 2019	calc
LAC	FG	45.59535	24.63458	2092	4	8	Lacul Capra	RO	8	Monnahan et al 2019	silic
MIA		50.5030833	18.93816	300	4	5	Miastecko Slaskie	PL	9	Preite et al. 2019	metal
MIE		53.92109	14.42157	5	2	5	Miedzyzdroje	PL	11	Monnahan et al 2019	silic
OPP	NT	47.46403	14.23989	1750	4	8	Oppenberg	AT	8	Konecna et al 2021	serp
PAD		47.402365	24.546105	545	2	5	Parva	RO	9	unpubl. Filip - mixedploidy	silic
PAT	RD	47.40244	24.5459	531	4	5	Parva	RO	7	unpubl. Filip - mixedploidy	silic
PER	NT	47.35512	15.33697	540	4	5	Pernegg	AT	8	Konecna et al 2021	serp
PHD	VT	48.96228204	20.40193797	550	2	5	Prielom Hornadu	SK	8	unpubl. Filip - mixedploidy	calc
PHT	ZT	48.95281702	20.41887604	540	4	5	Prielom Hornadu	SK	8	unpubl. Filip - mixedploidy	calc
PRE		55.37821	21.03231	1	2	5	Preila	LT	8	Monnahan et al 2019	silic
RFT		48.10104	9.049581	790	4	5	Reiftal	D	11	Monnahan et al 2019	calc
RZA		45.37778	22.75833	850	2	5	Retezat	RO	9	Monnahan et al 2019	silic
SCH	NT	47.27767	14.3219	2240	4	8	Schiesseck	AT	7	Monnahan et al 2019	silic
SNO	VT	49.17417	18.86167	390	2	5	Strecno	SK	6	Monnahan et al 2019	calc
SPI	ZT	48.98889	20.775	550	4	5	Spis_Drevenik	SK	13	Monnahan et al 2019	calc
STE		52.28028	16.70944	80	4	5	Stenszew	PL	8	Monnahan et al 2019	NA
STG		48.62993	15.542567	415	4	5	Steinegg	AT	8	Konecna et al 2021	serp
SUB	VT	48.96030556	20.38327778	600	2	5	Suchá_Belá	SK	17	Bohutinska et al 2021	calc
SWA		48.44784	9.422422	700	4	5	Sw abia_Grindel_Stiege	D	10	Monnahan et al 2019	calc
SWJ		53.897702	14.298695	5	4	5	Sw inoujscie	PL	3	unpubl. Levi	NA
SZI		46.80667	17.43444	130	2	4	Szigliget	HU	5	Monnahan et al 2019	silic
TBG		48.13972	8.23667	640	4	5	Triberg	D	6	Monnahan et al 2019	NA
TIS	FG	45.569999	25.608265	797	4	5	Timisu de Sus	RO	8	Bohutinska et al 2021	calc
TKO	ZT	49.20451	19.7352	1783	4	8	Tri Kopy	SK	8	Monnahan et al 2019	silic
TRD	VT	49.251596	20.206285	1380	2	7	Tristar 2x	SK	5	Monnahan et al 2019	calc
TRE	ZT	48.89417	18.04472	280	4	5	Trencin	SK	8	Monnahan et al 2019	calc
TRT	ZT	49.24932	20.20498	1700	4	8	Tristar 4x	SK	9	Monnahan et al 2019	calc
TZI	FG	46.56667	23.67417	511	4	5	Cheile Turzii	RO	10	Monnahan et al 2019	calc
VEL	VT	49.162	20.15419	1823	2	8	Velicka dolina	SK	9	Monnahan et al 2019	silic
VID		45.36392	24.63756	900	2	5	Vidraru	RO	8	Monnahan et al 2019	silic
VLA		49.7349631	15.1748464	345	4	5	Vlastejovice	CZ	8	Konecna et al 2021	silic
VOR	NT	47.49876	14.16964	1010	4	6	Vorberg	AT	8	Konecna et al 2021	silic
VYR		59.41427	30.34568	100	4	5	Vyritsa (St Petersburgh)	RUS	8	unpubl. Filip	NA
WEK		48.405022	15.472906	359	4	5	Weissenkirchen	AT	8	Monnahan et al 2019	silic
WIL	NT	47.3256	14.23038	2117	4	8	Wildsee	AT	8	Bohutinska et al 2021	silic
WUL		51.308	8.487028	290	4	5	Wulmeringhausen	D	8	unpubl. Lara's pilot (Ute Kramer)	metal
ZAP	ZT	49.278343	19.96706	915	4	5	Zakopane	PL	8	Monnahan et al 2019	calc
ZEP	VT	49.20652778	20.21505556	1625	2	5	Zelené_pleso	SK	13	Bohutinska et al 2021	silic
ZID		46.10676	15.30565	303	2	4	Zidani Most-Gracnica	SLO	8	unpubl. Filip - mixedploidy	calc
ZIT		46.094332	15.343606	360	4	4	Zidani Most-Gracnica	SLO	8	unpubl. Filip - mixedploidy	calc

Suppl. Table 2: Outlier SNPs fro Picmin, locus=position in the genome, p=p-value, q=q-value, AL=code for A. lyrata, AT=code for A. thaliana, type=type of change, short description=description of a function

locus	p	q	AL	AT	type	short_description
scaffold_1_6591000	9.99990000099999e-06	0.0097033206883121	AL1G27730	AT1G15620.1	protein_coding	nnn
scaffold_1_13465000	9.99990000099999e-06	0.0097033206883121	AL1G44240	AT1G30290.1	protein_coding	Tetratricopeptide repeat (TPR)-like superfamily protein
scaffold_3_2962000	9.99990000099999e-06	0.0097033206883121	AL3G18260	AT3G07040.1	protein_coding	NB-ARC domain-containing disease resistance protein
scaffold_3_23699000	9.99990000099999e-06	0.0097033206883121	AL3G53130	AT2G18790.1	protein_coding	phytochrome B
scaffold_3_23699500	9.99990000099999e-06	0.0097033206883121	AL3G53130	AT2G18790.1	protein_coding	phytochrome B
scaffold_3_23700000	9.99990000099999e-06	0.0097033206883121	AL3G53130	AT2G18790.1	protein_coding	phytochrome B
scaffold_3_23701000	9.99990000099999e-06	0.0097033206883121	AL3G53130	AT2G18790.1	protein_coding	phytochrome B
scaffold_3_23701500	9.99990000099999e-06	0.0097033206883121	AL3G53130	AT2G18790.1	protein_coding	phytochrome B
scaffold_4_21640500	9.99990000099999e-06	0.0097033206883121	AL4G43360	AT3G10180.1	protein_coding	P-loop containing nucleoside triphosphate hydrolases superfamily protein
scaffold_5_11157500	9.99990000099999e-06	0.0097033206883121	AL5G22700	AT3G44550.1	protein_coding	fatty acid reductase 5
scaffold_6_11799500	9.99990000099999e-06	0.0097033206883121	AL6G37970	AT5G26000.1	protein_coding	thioglucoside glucohydrolase 1
scaffold_6_11799500	9.99990000099999e-06	0.0097033206883121	AL6G37970	AT5G26000.1	protein_coding	thioglucoside glucohydrolase 1
scaffold_6_11799500	9.99990000099999e-06	0.0097033206883121	AL6G37970	AT5G26000.1	protein_coding	thioglucoside glucohydrolase 1
scaffold_6_11799500	9.99990000099999e-06	0.0097033206883121	AL6G37980	AT5G26000.1	protein_coding	thioglucoside glucohydrolase 1
scaffold_6_11799500	9.99990000099999e-06	0.0097033206883121	AL6G37980	AT5G26000.1	protein_coding	thioglucoside glucohydrolase 1
scaffold_6_20422000	9.99990000099999e-06	0.0097033206883121	AL6G44610	AT4G10560.1	protein_coding	Cysteine/Histidine-rich C1 domain family protein
scaffold_8_875500	9.99990000099999e-06	0.0097033206883121	AL8G11840	AT5G46450.1	protein_coding	Disease resistance protein (TIR-NBS-LRR class) family
scaffold_8_877000	9.99990000099999e-06	0.0097033206883121	AL8G11840	AT5G46450.1	protein_coding	Disease resistance protein (TIR-NBS-LRR class) family
scaffold_8_892000	9.99990000099999e-06	0.0097033206883121	AL8G11850	AT2G34690.1	protein_coding	Glycolipid transfer protein (GLTP) family protein
scaffold_8_1695000	9.99990000099999e-06	0.0097033206883121	AL8G13230	AT5G45490.1	protein_coding	P-loop containing nucleoside triphosphate hydrolases superfamily protein
scaffold_8_2903000	9.99990000099999e-06	0.0097033206883121	AL8G14630	AT5G44870.1	protein_coding	Disease resistance protein (TIR-NBS-LRR class) family
scaffold_8_19194000	9.99990000099999e-06	0.0097033206883121	AL8G36160	AT5G59650.1	protein_coding	Leucine-rich repeat protein kinase family protein
scaffold_8_19194500	9.99990000099999e-06	0.0097033206883121	AL8G36160	AT5G59650.1	protein_coding	Leucine-rich repeat protein kinase family protein
scaffold_4_2790500	1.9999800002e-05	0.015644129272993	AL4G14810	AT4G36150.1	protein_coding	Disease resistance protein (TIR-NBS-LRR class) family
scaffold_5_10836000	1.9999800002e-05	0.015644129272993	AL5G22420	AT3G44290.1	protein_coding	NAC domain containing protein 60
scaffold_1_17705500	2.999770003e-05	0.019824887958017	AL1G50810	AT1G35910.1	protein_coding	Haloacid dehalogenase-like hydrolase (HAD) superfamily protein
scaffold_4_23319000	2.999770003e-05	0.019824887958017	AL4G47730	AT2G48160.1	protein_coding	Tudor/PWWP/MBT domain-containing protein
scaffold_8_2902500	3.9999600004e-05	0.021593305193708 6	AL8G14630	AT5G44870.1	protein_coding	Disease resistance protein (TIR-NBS-LRR class) family
scaffold_6_1066000	5.99940000599999e-05	0.027055141213293 8	AL6G13060	AT5G03560.2	protein_coding	Tetratricopeptide repeat (TPR)-like superfamily protein
scaffold_7_5550000	6.99993000069999e-05	0.029322056506210 9	AL7G23630	AT4G28850.1	protein_coding	xyloglucan endotransglucosylase/hydrolase 26
scaffold_1_8754500	7.99992000079999e-05	0.031288258545986	AL1G33430	AT5G38120.1	protein_coding	AMP-dependent synthetase and ligase family protein
scaffold_1_26831500	7.99992000079999e-05	0.031288258545986	AL1G58810	AT1G50500.2	protein_coding	Membrane trafficking VPS53 family protein
scaffold_6_1620000	7.99992000079999e-05	0.031288258545986	AL6G14390	AT5G04730.1	protein_coding	Ankyrin-repeat containing protein
scaffold_8_1731000	8.99991000089999e-05	0.032696971608483	AL8G13270	AT5G45470.1	protein_coding	Protein of unknown function (DUF594)
scaffold_6_1065000	9.99990000099999e-05	0.035163409833791 6	AL6G13060	AT5G03560.2	protein_coding	Tetratricopeptide repeat (TPR)-like superfamily protein
scaffold_2_4154500	0.000100999890001 1	0.037310556097978 8	AL2G17810	AT1G58400.1	protein_coding	Disease resistance protein (CC-NBS-LRR class) family
scaffold_6_1065500	0.000100999890001 1	0.037310556097978 8	AL6G13060	AT5G03560.2	protein_coding	Tetratricopeptide repeat (TPR)-like superfamily protein
scaffold_7_14214500	0.000119998800012	0.038977745815762 2	AL7G42020	AT4G14280.1	protein_coding	ARM repeat superfamily protein
scaffold_2_11813500	0.000139998600014	0.042251467249107	AL2G24970	AT2G43500.1	protein_coding	Plant regulator RWP-RK family protein
scaffold_7_21823500	0.000149998500015	0.043554678089582 7	AL7G48550	AT3G59290.1	protein_coding	ENTH/VHS family protein
scaffold_7_21823500	0.000149998500015	0.043554678089582 7	AL7G48550	AT1G22410.1	protein_coding	Class-II DAHP synthetase family protein
scaffold_7_8620500	0.000159998400016	0.045594785687830 9	AL7G31110	AT4G22517.1	protein_coding	Bifunctional inhibitor/lipid-transfer protein/seed storage 2S albumin superfamily protein
scaffold_7_12652000	0.000179998200018	0.048414463223788 8	AL7G39550	AT5G05850.1	protein_coding	plant intracellular ras group-related LRR 1

Suppl. Table 3: The climatic variables for the 73 populations of A. arenosa, Pop=population code, Lin=alpine lineage, Veg=most important vegetative month, Lon=longitude, Lat=latitude, Altitude=meters above sea level, srad_X=monthly amount of solar radiation

Pop	Lin	Veg	Lon	Lat	Altitude	srad_Jan	srad_Feb	srad_Mar	srad_Apr	srad_May	srad_Jun	srad_Jul	srad_Aug	srad_Sep	srad_Oct	srad_Nov	srad_Dec
BAB	VT	5	20.180772	49.043514	844	3523	6244	10357	14401	17641	18963	17806	16124	11733	7669	3833	2658
BAL	FG	8	24.62263889	45.602	2269	5032	8035	11670	15365	18091	20165	19708	17159	13541	9542	5383	3944
BDO		4	18.92477778	47.458	252	3690	6547	10402	15363	19619	21312	21405	18330	13498	8543	4091	2867
BEL		4	16.115	46.16167	550	4062	6828	10495	14762	18858	20417	21368	18484	13746	8701	4580	3276
BGS		5	13.00167	47.62806	570	3953	6747	10312	14191	17372	17760	18015	15895	11969	7961	4353	3150
BIH		4	15.89882	44.88181	217	4484	7177	10702	15217	19347	21134	22759	19617	14465	9273	4932	3699
BOR		5	15.1332558	49.6838164	416	3038	5760	9357	14552	18245	19547	18882	16494	11321	6886	3289	2303
BRD		5	13.89081	50.04967	350	2925	5474	9003	13945	17600	18658	18389	16148	11034	6686	3149	2194
BUD		5	25.227617	45.467007	1013	4887	7873	11725	15788	19208	20912	20772	18037	13899	9660	5336	3843
CAR	RD	5	25.07711111	47.57594444	981	4351	7285	11297	15381	19316	21069	20311	17554	13019	8784	4635	3278
CHO		5	5.44383	50.59298	103	2613	5017	8630	13559	17396	18340	17579	15532	10969	6555	3212	2027
DRA	FG	5	25.22394	45.44164	858	4864	7890	11709	15898	19462	21346	21244	18524	14060	9734	5353	3833
FOJ		4	17.82446	43.97502	754	5124	7828	11573	15451	18401	20940	22127	20025	15048	9983	5693	4312
FUG		5	15.5572367	48.6314972	436	3279	6114	9825	14658	18472	19620	19094	16687	11782	7181	3526	2529
GOR		5	21.54271	44.26528	184	4772	7588	11587	15982	19118	21783	22546	20011	15063	9790	5418	3878
GUL	NT	5	14.927647	47.281679	628	4018	6869	10466	14418	17916	18762	18871	16438	12416	8079	4328	3247
HAR		5	15.85833	48.85166	400	3237	6036	9767	14780	18768	19966	19470	16866	11842	7146	3434	2481
HLI	VT	8	45371	49.17	1650	3641	6352	10303	14001	16669	17718	16826	14943	11490	7670	3923	2830
HMC	VT	5	45341	48.82	700	3471	6238	10088	14573	18031	18874	18820	16341	11988	7620	3720	2657
HNE		4	19	48.26694	280	3465	6288	10308	15055	19016	20690	20227	17467	12698	8026	3808	2669
HNI	VT	5	20.5275	48.8775	836	3577	6309	10398	14482	17970	19092	18042	16392	11845	7734	3882	2708
HOC	NT	5	15.38667	47.37	545	3991	6845	10450	14476	17869	19023	18882	16512	12338	8182	4368	3246
HRA	ZT	5	20.286407	49.00716	720	3499	6243	10367	14464	17729	18908	17772	16142	11761	7695	3849	2647
HRN		5	45369	62.6	5	731	2823	7549	13098	17999	20429	19153	14168	8581	3733	1119	404
INE	RD	8	24.88062	47.52734	2017	4305	7232	11149	14996	18352	19875	19466	16723	12686	8609	4596	3201
ING	NT	5	14.6815483	47.2840589	950	4136	6995	10529	14318	17577	18091	18242	15865	12228	8271	4466	3402
KAM	ZT	5	20.928184	49.210747	633	3282	6051	10127	14332	18097	19055	18214	16351	11753	7555	3624	2479
KAS	NT	5	14.87167	46.68833	660	4034	6900	10450	14487	18146	19750	19809	17339	12833	8022	4261	3120
KLE		5	16.848417	50.2440833	750	2972	5596	9401	14318	17996	18792	18148	15894	11080	6898	3292	2273
KOS	NT	5	13.68972	47.74694	467	3955	6773	10385	14150	17218	17264	17584	15448	11790	8112	4399	3178
KOW		5	15.8439	50.763153	670	2835	5291	9081	14281	17995	18947	18235	16000	10902	6730	3151	2185
KRM		5	25.739772	50.118939	320	3223	5967	10258	14634	19418	20855	20125	17286	11999	7260	3363	2286
KZL		4	18.77917	47.72444	330	3549	6436	10310	15277	19447	21228	21173	18216	13265	8363	4017	2756
LAC	FG	8	24.63458	45.59535	2092	5016	8004	11656	15363	18074	20102	19594	17005	13517	9519	5359	3944
MIA		5	18.93816	50.5030833	300	2818	5356	9459	14004	17976	18765	18050	16026	11022	6765	3156	2100
MIE		5	14.4346	53.92109	5	1985	4089	8343	14245	18582	19737	19372	16255	9871	5695	2341	1399
OPP	NT	8	14.23989	47.46403	1750	4174	7034	10596	14383	17360	17708	17855	15632	12077	8428	4597	3429
PAD		5	24.546105	47.402365	545	4206	7207	11196	15501	19670	21376	20761	18082	13131	8775	4589	3083
PAT	RD	5	24.5459	47.40244	531	4206	7207	11196	15501	19670	21376	20761	18082	13131	8775	4589	3083
PER	NT	5	15.33697	47.35512	540	3898	6749	10375	14424	18030	19264	19172	16892	12401	8023	4228	3155
PHD	VT	5	20.40193797	48.96228204	550	3394	6107	10345	14500	17930	19016	18143	16409	11792	7692	3755	2572
PHT	ZT	5	20.41887604	48.95281702	540	3632	6329	10444	14488	17911	18963	18189	16440	11840	7755	3856	2713
PRE		5	21.03231	55.37821	1	1813	4114	9016	13702	19287	21795	19835	16371	10328	5298	2006	1202
RFT		5	9.049581	48.10104	790	3782	6541	10364	14598	17753	18952	18858	16582	12184	7633	4373	3005
RZA		5	22.75833	45.37778	850	4906	7909	11760	15675	18749	20863	20782	18292	13981	9646	5397	3928
SCH	NT	8	14.3219	47.27767	2240	4430	7367	10911	14509	17413	17693	17744	15244	12288	8816	4868	3692
SNO	VT	5	18.86167	49.17417	390	3126	5856	9777	14543	18150	19252	18946	16546	11742	7341	3483	2379
SPI	ZT	5	20.775	48.98889	550	3263	6014	10289	14505	18285	19485	18323	16511	11904	7565	3636	2488
STE		5	16.70944	52.28028	80	2327	4570	8685	14220	18489	19748	18537	16090	10645	6092	2670	1687
STG		5	15.542567	48.62993	415	3279	6114	9825	14658	18472	19620	19094	16687	11782	7181	3526	2529
SUB	VT	5	20.38327778	48.96030556	600	3394	6107	10345	14500	17930	19016	18143	16409	11792	7692	3755	2572
SWA		5	9.422422	48.44784	700	3642	6386	10134	14569	17883	18932	18878	16556	12084	7465	4218	2907
SWJ		5	14.298695	53.897702	5	1984	4062	8322	14239	18367	19634	19204	16345	9867	5713	2320	1396
SZI		4	17.43444	46.80667	130	3760	6556	10416	15250	19418	21614	21666	18752	13919	8595	4257	3013
TBG		5	8.23667	48.13972	640	3833	6512	10292	14502	17590	18965	19222	16848	12422	7755	4442	3093
TIS	FG	5	25.608265	45.569999	796.6	4915	8005	11780	16000	19561	21412	21115	18159	14123	9721	5368	3885
TKO	ZT	8	19.7352	49.20451	1783	3540	6283	10156	13982	16662	17675	16720	14904	11428	7608	3843	2762
TRD	VT	7	20.206285	49.251596	1380	3474	6263	10253	14083	17034	17924	16919	15169	11442	7548	3858	2596
TRE	ZT	5	18.04472	48.89417	280	3132	5897	9773	14904	18839	20145	19890	17182	12192	7438	3480	2399
TRT	ZT	8	20.20498	49.24932	1700	3632	6394	10344	13985	16861	17795	16747	15050	11510	7711	3972	2710
TZI	FG	5	23.67417	46.56667	511	4359	7450	11565	16037	19830	22160	21515	18629	13755	9281	4874	3300
VEL	VT	8	20.15419	49.162	1823	3568	6295	10270	14003	16836	17801	16791	14792	11335	7621	3890	2713
VID		5	24.63756	45.36392	900	4959	8086	11935	15835	19315	21528	21464	18480	14078	9694	5381	3924
VLA		5	15.1748464	49.7349631	345	3005	5702	9308	14536	18262	19557	18792	16465	11319	6852	3276	2268
VOR	NT	6	14.16964	47.49876	1010	4197	7045	10636	14414	17341	17753	17856	15620	12059	8476	4627	3436
VYR		5	30.34568	59.41427	100	1277	3642	7979	12975	18319	20217	19200	14752	8617	3892	1393	693
WEK		5	15.472906	48.405022	359	3338	6197	9919	14572	18304	19303	19027	16645	11904	7236	3624	2576
WIL	NT	8	14.23038	47.3256	2117	4378	7280	10884	14479	17248	17543	17539	15170	12140	8752	4826	3642
WUL		5	8.487028	51.308	290	2516	5127	8346	13248	17104	17420	17540	15080	10120	6097	3069	1897
ZAP	ZT	5	19.96706	49.278343	915	3526	6176	10125	14125	17078	17812	16943	15229	11341	7527	3842	2724
ZEP	VT	5	20.21505556	49.20652778	1625	3629	6348	10325	14050	16886	17674	16593	14699	11428	7647	3937	2760
ZID		4	15.30565	46.10676	303	4136	6931	10370	14578	18420	20015	20835	17956	13330	8468	4547	3352
ZIT		4	15.343606	46.094332	360	4152	6922	10374	14601	18457	20095	20827	17957	13337	8492	4571	3360

Continuation of Suppl. Table 3: The climatic variables for the 73 populations of A. arenosa, Pop=population code, prec_X=monthly amount of precipitation, tmin_X=minimum temperature for each month

Pop	prec_Jan	prec_Feb	prec_Mar	prec_Apr	prec_May	prec_Jun	prec_Jul	prec_Aug	prec_Sep	prec_Oct	prec_Nov	prec_Dec	tmin_Jan	tmin_Feb	tmin_Mar	tmin_Apr	tmin_May	tmin_Jun
BAB	27	26	32	56	83	101	92	80	62	48	43	33	-7,9280	-7,2240	-3,7680	0,5240	5,0840	7,9840
BAL	45	46	54	81	107	132	124	104	69	55	51	51	-12,0040	-12,2240	-9,5600	-4,8560	-0,3600	2,8280
BDO	33	28	31	43	59	61	51	51	45	40	53	43	-2,7280	-1,6440	1,9200	6,1880	11,1080	14,1600
BEL	50	53	70	79	86	118	100	101	97	96	96	72	-3,7480	-2,6960	0,5840	4,5360	9,0520	12,1680
BGS	85	74	91	91	119	171	185	165	114	84	94	98	-5,2280	-4,5240	-1,3000	1,9040	6,3040	9,2960
BIH	83	88	97	112	107	107	102	99	120	127	141	111	-3,1080	-2,2920	0,9720	4,8800	8,8920	12,1160
BOR	23	22	30	36	63	75	77	64	42	31	33	29	-3,8200	-3,0960	-0,1640	3,4800	8,1720	10,9960
BRD	32	29	38	34	67	74	79	67	46	38	38	37	-4,2120	-3,6320	-0,3600	2,9360	7,4960	10,5200
BUD	33	33	38	62	86	109	103	85	54	43	38	37	-9,8920	-9,7240	-6,0800	-1,2120	3,5440	6,7520
CAR	39	41	44	67	96	131	126	100	65	49	48	46	-10,2600	-9,7040	-7,1800	-1,8560	3,1440	6,5360
CHO	63	57	66	62	71	83	84	85	66	69	74	76	0,0680	-0,3480	2,2760	4,0480	7,9080	10,7280
DRA	31	31	37	59	84	103	98	80	51	40	37	35	-9,4600	-9,1800	-5,2560	-0,3560	4,3720	7,6560
FOJ	69	68	70	85	89	96	78	76	87	95	118	99	-5,1560	-4,9040	-1,4520	1,1720	5,7640	8,3760
FUG	25	26	34	45	64	85	83	67	46	33	42	32	-4,8520	-4,1560	-0,8720	2,5120	7,4000	10,5160
GOR	43	42	48	61	73	85	63	56	55	50	53	54	-4,0800	-3,0080	-0,0040	4,6440	9,3160	12,3720
GUL	37	41	61	63	88	122	134	120	92	70	61	51	-7,2040	-6,1040	-2,4160	1,3520	6,1280	9,5160
HAR	24	25	31	40	59	80	77	61	43	32	40	31	-4,1840	-3,5560	-0,3600	3,4480	8,1800	11,1160
HLI	76	77	84	111	151	189	185	168	128	93	101	97	-11,4560	-11,6080	-9,0720	-4,9960	-0,2920	2,4040
HMC	60	58	61	68	96	118	103	102	82	68	80	78	-7,8800	-7,4040	-4,2480	-0,0400	4,6360	7,3680
HNE	37	34	35	50	67	73	59	59	51	48	58	48	-5,5920	-4,6400	-0,8960	3,6240	8,5800	11,5200
HNI	33	27	32	55	82	101	89	76	58	46	45	36	-7,5120	-6,5600	-2,9520	45413,0000	6,0800	9,0080
HOC	50	51	72	77	105	132	147	128	104	79	72	64	-6,4240	-5,7560	-2,6320	0,7640	5,5160	8,6560
HRA	26	24	29	51	78	94	82	72	56	44	40	30	-7,9400	-7,1520	-3,5120	0,8040	5,4800	8,3800
HRN	55	38	46	45	42	50	63	68	74	75	86	55	-8,6905	-9,2095	-5,6190	-1,8905	2,8048	8,1905
INE	50	56	63	83	111	153	142	117	77	68	66	61	-11,2640	-11,3120	-8,9640	-4,0600	0,9320	4,0200
ING	50	52	77	81	101	142	154	133	109	83	78	68	-8,0400	-7,3280	-4,0560	-0,6120	4,0280	7,3960
KAM	51	37	44	65	93	124	115	95	70	55	56	51	-7,5000	-6,6120	-2,9400	1,3120	5,7200	8,8000
KAS	40	47	68	80	95	134	140	124	107	105	100	64	-6,4960	-5,0920	-1,2320	2,8040	7,5320	10,9080
KLE	42	37	37	48	75	109	99	104	64	49	47	52	-6,4960	-6,4040	-3,7480	-0,8800	4,1680	6,9920
KOS	96	86	114	110	125	179	201	169	128	97	110	117	-5,9720	-5,7160	-2,9400	-0,0440	4,6680	7,6040
KOW	35	31	36	46	67	86	90	81	52	42	41	44	-6,5320	-5,7920	-2,4640	1,0120	5,0040	8,3560
KRM	34	34	30	45	70	89	101	71	52	41	43	44	-6,5600	-4,9840	-2,5960	3,1640	7,6520	11,7560
KZL	34	29	31	45	61	62	53	52	45	41	53	43	-3,5560	-2,4920	1,1800	5,6320	10,5720	45425,0000
LAC	44	45	54	80	107	132	124	104	68	55	51	50	-12,1200	-12,2840	-9,5680	-4,8200	-0,3520	2,8360
MIA	34	29	33	48	72	88	91	81	62	45	41	41	-4,8760	-4,0400	-0,7440	3,0960	7,8600	10,9440
MIE	40	28	39	37	45	58	56	54	54	46	48	51	-2,4000	-2,0143	0,0000	3,0714	7,5429	11,1857
OPP	67	64	92	90	109	155	170	143	118	88	90	88	-8,4320	-7,9080	-4,7960	-1,7320	2,9880	6,1040
PAD	46	40	44	68	92	123	114	87	66	56	54	56	-8,7080	-7,8120	-4,5000	0,6040	5,6600	8,8480
PAT	46	40	44	68	92	123	114	87	66	56	54	56	-8,7080	-7,8120	-4,5000	0,6040	5,6600	8,8480
PER	35	38	55	59	90	113	123	111	85	65	54	45	-5,5160	-4,3920	-0,9600	2,7400	7,4360	10,6600
PHD	32	25	28	48	77	94	79	68	51	41	41	33	-7,4720	-6,5000	-2,7280	1,7040	6,3240	9,3240
PHT	31	26	30	54	81	100	85	74	57	45	44	35	-7,4520	-6,6600	-3,0520	1,4080	6,0120	8,9120
PRE	55	37	40	37	41	62	75	81	86	87	89	72	-4,0000	-3,9000	-1,1000	45414,0000	7,0000	10,8000
RFT	59	61	58	72	92	113	99	92	65	68	72	72	-5,0960	-4,8080	-2,0240	0,7520	5,4640	45420,0000
RZA	43	44	48	79	97	119	96	82	71	55	50	54	-7,0000	-6,5520	-3,7640	0,9760	5,1920	8,2360
SCH	93	88	126	143	149	192	201	174	155	135	140	124	-9,8640	-10,1520	-7,8120	-5,0280	-0,3920	2,8760
SNO	49	46	49	59	84	101	94	88	70	58	63	60	-6,5640	-5,5920	-1,9160	2,0920	6,6280	9,5640
SPI	39	28	31	52	79	100	90	77	55	45	46	39	-7,0400	-5,8880	-2,0440	2,3800	6,9640	10,0440
STE	29	23	32	33	47	61	75	56	44	36	34	38	-3,7040	-3,3880	-0,5840	2,5800	7,6120	10,6440
STG	25	26	34	45	64	85	83	67	46	33	42	32	-4,8520	-4,1560	-0,8720	2,5120	7,4000	10,5160
SUB	32	25	28	48	77	94	79	68	51	41	41	33	-7,4720	-6,5000	-2,7280	1,7040	6,3240	9,3240
SWA	63	61	68	73	96	114	99	92	68	68	73	74	-4,6040	-4,2040	-1,3040	1,4520	6,0600	9,0160
SWJ	40	27	40	36	47	58	55	52	53	46	47	50	-2,2875	-1,9875	0,0958	3,0500	7,5333	11,1708
SZI	28	25	33	43	62	73	69	68	56	46	54	40	-2,9600	-2,1800	1,7160	5,7520	10,7640	13,8880
TBG	114	109	96	93	112	123	119	93	84	107	123	129	-4,0480	-3,8440	-1,3560	1,1080	5,6040	8,6640
TIS	29	28	34	55	81	101	96	80	49	37	33	32	-8,8480	-8,9360	-4,9080	0,1680	4,7880	8,0160
TKO	76	77	85	106	149	184	181	167	126	89	101	99	-10,6560	-10,8080	-8,2760	-4,2840	0,5360	3,1920
TRD	57	52	61	91	126	166	167	140	106	77	74	66	-8,8200	-8,6360	-5,6600	-1,5560	2,9640	5,7960
TRE	33	32	34	46	70	86	73	70	57	45	51	46	-4,6520	-3,9520	-0,3800	3,3240	8,1560	10,9240
TRT	69	67	75	106	141	181	181	157	120	86	90	86	-10,4280	-10,5080	-7,8720	-3,8320	0,8160	3,5480
TZI	29	27	29	53	78	99	87	67	49	42	33	36	-6,7680	-5,6840	-2,0800	2,8040	7,6120	10,6680
VEL	68	68	77	105	141	178	176	158	122	88	92	85	-10,3280	-10,4960	-7,9640	-4,0360	0,7680	3,5080
VID	32	32	35	64	91	102	96	80	54	46	40	37	-7,4760	-7,1200	-3,6360	1,2360	5,9040	9,0640
VLA	24	23	30	36	63	75	78	64	42	31	33	29	-3,9960	-3,2880	-0,2960	3,2520	7,9240	10,7720
VOR	71	67	96	95	114	159	174	147	122	92	94	93	-8,3840	-7,9640	-4,9440	-1,9240	2,8040	5,8920
VYR	39	30	35	36	44	68	81	80	70	62	56	49	-10,7000	-11,0240	-6,2000	-0,2320	4,8480	9,5320
WEK	25	27	35	46	68	87	86	71	49	35	43	33	-4,2880	-3,6720	-0,2280	3,1240	7,9120	11,1320
WIL	94	89	128	144	152	193	204	175	156	134	140	125	-10,0360	-10,3040	-7,9000	-5,1240	-0,4920	2,7880
WUL	122	86	105	82	82	93	97	81	92	96	111	127	-2,8720	-3,2440	-0,8560	1,2480	5,6520	8,6240
ZAP	52	49	60	88	126	167	172	144	109	74	70	63	-8,4440	-8,2280	-5,3040	-1,2800	3,3480	6,0920
ZEP	70	69	78	105	141	183	181	161	122	89	93	87	-10,5280	-10,6480	-8,0720	-4,1160	0,6200	3,3800
ZID	52	56	79	94	102	145	119	124	114	116	112	82	-4,4400	-3,7680	-0,7240	3,1640	7,6040	10,8280
ZIT	53	57	81	96	103	144	117	124	115	116	113	84	-4,6000	-3,9000	-0,8560	3,0360	7,4720	10,7000

Continuation of Suppl. Table 3: The climatic variables for the 73 populations of A. arenosa, Pop=population code, tmin_X=minimum temperature for each month, tmax_X=maximum temperature for each month

Pop	tmin_Jul	tmin_Aug	tmin_Sep	tmin_Oct	tmin_Nov	tmin_Dec	tmax_Jan	tmax_Feb	tmax_Mar	tmax_Apr	tmax_May	tmax_Jun	tmax_Jul	tmax_Aug	tmax_Sep	tmax_Oct	tmax_Nov	tmax_Dec
BAB	9,5560	8,8760	5,6280	1,4480	-2,8240	-6,3960	-0,0400	1,2480	5,1360	10,2480	16,2960	19,2800	20,8640	20,8720	16,3400	11,3920	4,4560	0,6920
BAL	4,7520	4,6960	1,1240	-2,6040	-7,0680	-10,5000	-5,3960	-5,2040	-2,1360	1,7280	7,2680	10,4680	12,5680	12,6720	9,0520	5,0440	-0,6240	-4,4160
BDO	15,8000	15,4760	11,4000	6,4720	2,0600	-1,0880	2,7440	5,3160	10,5280	16,1560	21,6800	24,7680	26,7800	26,6200	21,5080	15,4480	7,9040	3,8120
BEL	13,7480	13,4040	9,6960	5,2640	0,7400	-2,5400	2,7520	5,5560	10,3280	14,7640	19,9600	22,8920	24,7480	24,4480	20,0560	14,3320	7,8480	3,5200
BGS	11,3320	11,2760	7,9200	3,5520	-1,0440	-3,9720	2,2640	3,9160	7,8760	11,6960	17,1440	19,5280	21,6200	21,5280	17,7400	12,8720	6,3240	2,8920
BIH	13,2560	13,0720	9,9920	6,3000	1,8520	-1,5440	4,1000	6,0800	11,2320	15,5920	20,6280	24,1240	26,6040	26,3240	22,0960	16,3760	9,9680	5,3120
BOR	12,5680	12,3880	8,6920	4,8200	0,7840	-2,6280	1,5160	3,2200	7,2120	12,7520	18,3280	21,2520	23,2800	23,4400	17,8720	12,2360	5,6440	2,0360
BRD	12,2720	11,9120	8,4800	4,1360	0,2800	-2,5880	1,0880	2,5440	7,2240	12,5240	18,1080	20,8280	22,6920	22,6080	17,9360	12,0560	5,6000	2,3400
BUD	8,2400	7,6760	4,2120	-0,2320	-4,6880	-8,0440	-1,8320	-0,9520	3,0520	8,2480	13,4760	16,3360	17,9400	18,1040	14,2960	9,8720	3,5720	-0,5440
CAR	8,2640	8,0560	4,4880	0,4680	-4,4360	-8,7040	-2,4240	-1,3840	1,8400	7,0840	13,0720	16,1960	18,0160	17,8200	13,6800	9,5480	3,0520	-1,5560
CHO	12,6200	12,5360	10,1760	6,8000	3,0680	1,2760	4,8920	5,7200	9,4760	12,7560	17,4560	20,0480	22,3800	22,6440	18,6240	14,0720	8,6080	5,9200
DRA	9,0880	8,4480	4,9520	0,2960	-4,2040	-7,5480	-1,2360	0,0120	4,4360	9,9200	15,0680	18,0240	19,5760	19,7240	15,8880	11,1840	4,5400	0,1240
FOJ	10,3840	9,6240	7,3000	3,6680	-1,4840	-4,2600	1,5920	2,8640	6,8120	11,3280	17,2640	20,6320	22,6720	22,4960	18,2440	13,5200	7,1960	2,4960
FUG	12,1720	11,6920	8,1960	3,8000	-0,2880	-3,3120	1,2880	2,9400	7,5680	12,5760	18,0960	21,0880	23,1880	23,1880	18,1480	12,1200	5,5840	2,1080
GOR	13,6480	13,2840	9,5800	5,3520	0,9440	-2,7400	2,4880	4,8600	9,5680	15,2120	20,1440	23,5200	25,7920	25,7400	20,9640	15,1560	8,3280	3,5280
GUL	11,0760	10,7360	7,1840	2,6760	-2,1360	-5,4760	1,2120	3,6640	7,8720	11,9800	17,5880	20,5960	45434,0000	22,0400	18,0080	12,3680	5,6360	1,5880
HAR	12,8760	12,5840	9,0120	4,6320	0,3800	-3,1920	1,2200	3,1520	7,6440	13,0640	18,4160	21,2960	23,5600	23,6400	18,3800	12,2920	5,6920	1,8640
HLI	4,2800	4,4120	1,2480	-2,1440	-6,7200	-9,9000	-5,2640	-5,2840	-2,7800	1,1840	8,1440	11,4120	13,1480	13,2640	8,8560	4,7160	-1,1760	-4,2160
HMC	8,9120	8,5880	5,4520	1,4800	-2,7720	-6,2160	-1,0160	0,5360	4,2600	9,4160	15,4720	18,2760	19,9440	19,8720	15,0680	10,1280	3,3920	-0,1760
HNE	13,3000	12,5840	8,4440	3,9560	0,0480	-4,0280	1,4040	4,4720	9,4640	15,7800	21,3400	24,3400	26,5680	26,0520	20,4960	14,3760	7,1200	2,2480
HNI	10,5360	10,0080	6,6680	2,4400	-2,1040	-5,8360	-0,5360	1,0000	5,4200	10,7280	16,4960	19,4160	21,0800	20,9280	16,3240	11,2760	4,2520	0,2560
HOC	10,3600	10,1960	6,8120	2,6840	-2,2200	-5,0800	1,4760	2,9080	6,3600	10,2280	15,8760	18,6520	20,7040	20,5360	16,5680	11,5320	5,3080	1,8800
HRA	9,9040	9,2320	5,9560	1,6760	-2,6560	-6,2800	-0,1800	1,2760	5,4120	10,6560	16,4840	19,4840	21,1000	21,1280	16,5880	11,5440	4,5760	0,7160
HRN	11,2429	10,1667	6,0238	1,8238	-2,9619	-6,9048	-1,9333	-1,7000	1,5524	5,5095	12,0952	17,1286	19,4857	18,2238	12,9857	7,6952	2,2000	-0,6619
INE	5,9720	6,0600	2,6160	-0,9280	-5,5880	-9,6640	-4,8600	-4,5480	-1,7240	3,0200	9,3160	12,3720	14,1920	13,9920	10,0960	6,0320	0,5400	-3,7160
ING	9,1240	8,9080	5,5200	1,3160	-3,3200	-6,5440	0,7040	2,3400	5,8280	9,5520	15,1200	18,2000	20,1480	19,9040	16,2280	11,2440	4,6760	1,0080
KAM	10,4600	9,9560	6,6200	45414,0000	-1,8520	-5,8120	-0,8760	0,7640	5,6800	11,1400	16,6320	19,3680	21,1680	20,9920	16,5160	11,5320	4,4800	0,2040
KAS	12,4200	11,9760	8,4280	3,8880	-0,8960	-4,8000	1,3440	4,5960	9,6200	14,0560	19,5520	22,5800	24,5480	23,9960	19,7920	13,7640	6,4240	1,6120
KLE	8,6040	8,5600	5,6840	2,1560	-2,3080	-5,1960	-1,8040	-1,2120	1,9000	6,6840	12,7560	15,3160	17,3400	17,0600	12,7040	8,0320	1,9680	-0,8600
KOS	9,6520	9,7560	6,4960	2,6720	-1,9360	-4,7560	0,8040	1,5520	4,6560	8,2520	14,1160	16,7040	18,7560	18,7680	15,1000	10,8480	4,5040	1,4400
KOW	10,0320	9,6440	6,8120	3,3120	-0,8080	-4,9360	-1,7600	-0,2160	4,0760	9,6640	14,8840	17,6520	19,4680	19,3680	14,9920	10,2200	3,7560	-0,5880
KRM	13,1160	13,7440	9,9240	6,7000	0,8880	-3,5120	-0,9200	-0,3280	3,8640	11,8680	17,4320	21,2800	22,5080	23,2600	19,0680	14,0200	6,1480	0,5600
KZL	15,2120	14,7800	10,6800	5,9320	1,6200	-1,9040	2,4200	5,0520	10,2400	16,1680	21,5760	24,5280	26,5920	26,3520	20,9960	15,0200	7,8240	3,4000
LAC	4,7320	4,6600	1,0840	-2,6560	-7,1240	-10,5320	-5,4280	-5,2000	-2,0320	1,8440	7,4560	10,7760	12,8080	12,8920	9,3240	5,2720	-0,5160	-4,4160
MIA	12,4600	12,0960	8,5600	4,4720	0,1760	-3,0000	0,7000	2,1960	6,7520	12,0960	17,9720	20,5560	22,1520	22,1160	17,3800	12,4960	5,8040	1,9000
MIE	13,2286	13,1143	9,9857	6,1857	2,0857	-0,5571	2,0429	2,9000	6,1429	10,4286	15,7143	19,2000	21,3286	21,5286	17,2429	12,4143	6,7143	3,5714
OPP	8,0080	7,9640	4,7560	0,8480	-3,6080	-6,9160	-0,6680	0,4760	3,5080	7,0080	13,0920	16,0400	18,0200	17,8520	14,4360	9,9920	3,4400	-0,0040
PAD	10,4680	10,0600	6,3080	1,9160	-2,7120	-6,8000	-0,7200	0,8560	5,2480	11,1160	16,4800	19,0920	20,8360	20,8120	16,4680	11,9040	5,0120	0,1800
PAT	10,4680	10,0600	6,3080	1,9160	-2,7120	-6,8000	-0,7200	0,8560	5,2480	11,1160	16,4800	19,0920	20,8360	20,8120	16,4680	11,9040	5,0120	0,1800
PER	12,2320	11,9680	8,3560	3,9480	-0,9240	-3,9680	2,1880	4,3840	8,3880	12,7240	18,2480	21,0520	22,9840	22,6280	18,4320	12,9160	6,4320	2,7520
PHD	10,8480	10,1040	6,7520	2,3840	-1,9960	-5,7080	-0,0440	1,9480	6,7400	12,2080	17,8000	20,6960	22,3200	22,3200	17,7920	12,5480	5,3520	1,0760
PHT	10,4080	9,8280	6,5640	2,3200	-2,1480	-5,8400	-0,3800	1,1120	5,2760	10,4920	16,2840	19,2640	20,8920	20,8560	16,2640	11,2160	4,2960	0,4440
PRE	13,7000	13,8000	10,2000	6,0000	45413,0000	-1,7000	0,6000	0,6000	3,4000	8,9000	15,2000	18,3000	20,2000	45432,0000	16,0000	11,0000	5,7000	2,7000
RFT	10,4120	9,9840	6,7480	3,0680	-1,3320	-3,4880	0,9840	2,3520	6,6920	10,6520	15,8480	18,6240	21,2320	21,0160	17,0360	11,3200	5,2240	2,0360
RZA	10,0520	9,7080	6,1800	2,2280	-2,3560	-5,8080	-0,9480	0,3360	3,7960	8,8480	14,3440	17,5840	19,8720	19,6400	15,2360	10,4240	3,9320	-0,0520
SCH	4,9800	5,2360	2,0920	-1,3560	-5,9280	-8,5480	-2,4040	-2,3240	-0,3280	2,6560	8,7560	11,7880	13,8400	13,9840	10,9960	7,4120	1,3200	-1,6480
SNO	11,0080	10,5320	7,3720	3,4160	-0,9280	-4,5640	0,4640	2,6320	7,3680	12,9040	18,6680	21,4880	23,3440	23,1040	18,1280	12,7680	5,7320	1,7760
SPI	11,6000	11,0240	7,5280	3,0520	-1,3520	-5,1640	-0,1600	1,9600	7,6120	13,3160	18,5800	21,3440	23,0480	22,9560	18,3800	13,0720	5,7680	1,1040
STE	12,2040	11,9320	8,4520	4,5520	0,6160	-2,0000	1,5680	2,9480	7,1440	12,9200	18,8880	21,4760	23,2040	23,4840	18,3120	12,7560	6,2280	2,8120
STG	12,1720	11,6920	8,1960	3,8000	-0,2880	-3,3120	1,2880	2,9400	7,5680	12,5760	18,0960	21,0880	23,1880	23,1880	18,1480	12,1200	5,5840	2,1080
SUB	10,8480	10,1040	6,7520	2,3840	-1,9960	-5,7080	-0,0440	1,9480	6,7400	12,2080	17,8000	20,6960	22,3200	22,3200	17,7920	12,5480	5,3520	1,0760
SWA	11,0400	10,8440	7,5360	3,7920	-0,8960	-2,9240	0,9280	2,1960	6,5960	10,4520	15,5440	18,2280	20,6400	20,6280	16,7000	11,2680	5,2320	2,1800
SWJ	13,2125	13,1125	9,9125	6,1792	2,2000	-0,5375	2,0458	3,0333	6,4000	10,6042	15,8625	19,3625	21,5125	21,6583	17,4000	12,4167	6,6292	3,6000
SZI	15,3520	15,0560	11,2080	6,1160	1,7000	-1,1560	2,7000	4,9760	10,2360	15,0200	20,9360	23,8480	26,0160	25,8720	21,1240	15,1360	7,9400	3,9960
TBG	10,7680	10,3120	7,0640	3,2880	-0,7880	-2,7640	2,4720	3,4360	6,5280	9,8280	15,2960	18,2600	20,8040	20,6120	16,6640	11,8720	5,9720	3,2400
TIS	9,5520	8,7080	5,3640	0,8000	-3,6160	-7,0960	-0,8040	0,1720	4,0200	9,1520	14,4960	17,6200	19,1960	19,1640	15,2960	10,6600	4,2280	0,0880
TKO	5,1000	5,1280	1,9200	-1,5480	-6,0040	-9,2000	-4,1880	-4,1640	-1,6200	2,4480	9,3840	12,5200	14,2120	14,2720	9,8200	5,6200	-0,3320	-3,3320
TRD	7,4520	7,1600	4,0400	0,3080	-3,9680	-7,2600	-1,7680	-1,3280	1,6400	6,4600	12,8880	15,5640	17,2200	17,3040	12,7960	8,4320	2,1920	-1,0840
TRE	12,4320	12,2360	8,7360	4,5920	0,4160	-3,1160	1,4600	3,6120	8,6800	14,3240	20,1200	23,0400	25,0080	24,6680	19,5160	13,7680	6,5840	2,5840
TRT	5,3120	5,3480	2,1840	-1,2280	-5,7000	-8,8960	-4,1200	-4,0960	-1,4280	2,8360	9,4720	12,4880	14,2080	14,3280	9,8720	5,6680	-0,2680	-3,2560
TZI	12,3120	11,6160	7,6840	2,9280	-1,7080	-5,0840	-0,1760	2,4000	8,2200	13,7320	18,7760	21,3720	23,2640	23,1400	18,9600	13,7000	6,0120	1,0200
VEL	5,3480	5,3120	2,1560	-1,4400	-5,8920	-9,0200	-3,5360	-3,5040	-0,8880	3,3920	9,9840	12,8960	14,6080	14,7320	10,3760	6,2680	0,2960	-2,6920
VID	10,5520	10,0800	6,5680	1,9040	-2,7880	-5,7360	0,4200	1,4120	5,5920	10,6920	15,7720	19,0200	20,7240	20,8240	16,8760	11,9360	5,4760	1,5640
VLA	12,3200	12,1320	8,4720	4,5960	0,5240	-2,7920	1,2880	3,1040	7,1560	12,7400	18,2720	21,1840	23,2080	23,3680	17,8760	12,1760	5,5200	1,9080
VOR	7,8240	7,8560	4,6720	0,7920	-3,6520	-6,9240	-0,7600	0,2320	3,1640	6,5640	12,6320	15,5600	17,5560	17,4440	14,0120	9,6560	3,2360	-0,0720
VYR	11,7360	10,3360	6,1280	1,7880	-3,7680	-7,9000	-4,6000	-3,8240	1,6320	8,1000	15,7200	20,0520	21,7000	19,6440	13,8480	7,5040	0,8920	-2,4040
WEK	12,7480	12,2880	8,7920	4,4200	0,0720	-2,9080	2,3240	3,9080	8,2680	12,9520	18,6560	21,5800	23,5920	23,1840	18,4360	12,6840	6,3560	3,0880
WIL	4,8760	5,1120	2,0640	-1,3560	-5,9520	-8,7000	-2,8960	-2,6800	-0,7240	2,1000	8,1880	11,4480	13,5920	13,7080	10,6400	7,0080	0,9560	-1,9520
WUL	10,5400	10,0320	7,3440	4,0440	0,7080	-1,4960	2,3400	2,9960	6,2040	9,9360	15,4240	18,0520	19,9720	19,8400	15,7920	11,2520	5,8360	3,2520
ZAP	7,7640	7,3680	4,1640	0,4200	-3,6640	-6,7320	-0,9560	-0,2200	2,8480	7,6720	13,8600	16,6800	18,2840	18,3360	13,8480	9,4280	3,0160	-0,2920
ZEP	5,1920	5,1840	2,0520	-1,5080	-5,9560	-9,1840	-4,0000	-4,0440	-1,4320	2,7280	9,3560	12,3640	14,1760	14,2000	9,9040	5,7360	-0,1560	-3,0960
ZID	12,3800	11,8600	8,5440	4,4200	-0,1960	-3,4360	2,8760	5,0240	9,3840	13,6320	18,8880	22,0840	24,2000	23,6920	19,5480	13,8400	45419,0000	3,3320
ZIT	12,2560	11,7200	8,3760	4,2880	-0,3200	-3,5800	2,7720	4,9080	9,3200	13,6240	18,8400	22,0640	24,1720	23,6760	19,5240	13,7880	7,4920	3,2800

Continuation of Suppl. Table 3: The climatic variables for the 73 populations of A. arenosa, Pop=population code, wind_X=wind speed for each month, vapr_X=water vapor pressure for each month

Pop	wind_Jan	wind_Feb	wind_Mar	wind_Apr	wind_May	wind_Jun	wind_Jul	wind_Aug	wind_Sep	wind_Oct	wind_Nov	wind_Dec	vapr_Jan	vapr_Feb	vapr_Mar	vapr_Apr	vapr_May	vapr_Jun
BAB	3,3040	3,3000	3,4640	3,3840	3,0440	2,8640	2,8640	2,6160	2,9280	2,9880	3,1480	3,2800	0,3628	0,3924	0,4876	0,6448	0,9188	1,1484
BAL	4,3240	4,6520	4,3720	3,9480	3,3800	3,1400	3,1040	2,7840	3,5120	3,5280	4,2440	4,3440	0,2728	0,2824	0,3444	0,5008	0,6856	0,8968
BDO	2,6960	2,8920	3,2120	3,1800	2,8840	2,7400	2,7680	2,4440	2,5440	2,4400	2,6440	2,7000	0,4784	0,5060	0,6120	0,8128	1,1608	1,4164
BEL	1,9560	2,1320	2,4920	2,4600	2,3400	2,0440	2,0040	1,8360	1,8640	1,9560	2,0560	2,0360	0,4856	0,5120	0,6260	0,8052	1,1660	1,4064
BGS	1,9200	1,9880	2,1560	2,3240	2,1880	2,0280	2,1280	1,9240	1,9320	1,9440	1,9760	1,9280	0,4124	0,4276	0,5528	0,6704	0,9132	1,1772
BIH	45413,0000	1,6160	1,9360	1,9000	1,7640	1,5840	1,5600	1,4000	1,4000	1,4840	1,5920	1,6600	0,5080	0,5088	0,6296	0,7804	1,1604	1,4380
BOR	3,4800	3,5320	3,5880	3,2960	3,0440	2,7520	2,7320	2,5280	2,7400	3,0680	3,2600	3,4400	0,4496	0,4768	0,5852	0,7132	1,0088	1,2564
BRD	3,6960	3,6440	3,8280	3,4360	3,1880	2,9400	2,9080	2,7080	2,9080	3,0440	3,2760	3,5960	0,4696	0,4936	0,6016	0,7316	1,0240	1,2804
BUD	2,5680	2,8560	3,1200	2,9920	2,6040	2,4720	2,3600	2,0920	2,5440	2,4240	2,5880	2,4880	0,3316	0,3516	0,4396	0,6276	0,8572	1,1280
CAR	2,4640	2,6240	2,7800	2,7160	2,2640	2,2800	2,1360	1,9040	2,2800	2,2560	2,3560	2,3840	0,3236	0,3396	0,4260	0,6176	0,8840	1,1244
CHO	4,3920	4,0200	4,1320	3,6880	3,3200	3,1880	3,1840	2,9920	3,3200	3,5640	3,9640	4,2520	0,6228	0,6044	0,7176	0,7824	1,0564	1,2980
DRA	2,0920	2,4000	2,7520	2,7320	2,3840	2,2600	2,1280	1,9040	2,2480	2,1000	2,1760	2,0200	0,3492	0,3732	0,4684	0,6680	0,9124	1,1988
FOJ	1,8800	2,2760	2,4360	2,4840	2,2160	1,9400	1,9000	1,8000	1,8600	2,0160	2,1440	2,1080	0,4192	0,4352	0,5312	0,6836	0,9084	1,1996
FUG	2,5080	2,6840	2,7560	2,7120	2,6480	2,4560	2,4720	2,2720	2,2840	2,3960	2,3960	2,4560	0,4480	0,4552	0,5768	0,7340	1,0180	1,2644
GOR	2,5400	2,9480	3,3520	3,0000	2,5680	2,3960	2,2520	2,3320	2,3400	2,7560	3,0200	2,5600	0,4840	0,5068	0,6088	0,8540	1,2136	1,4928
GUL	1,7800	1,9520	2,2600	2,3720	2,3600	2,1280	2,0440	1,8520	1,8120	1,8720	1,7960	1,6800	0,3928	0,4116	0,5356	0,6676	0,9740	1,1644
HAR	2,9520	3,1680	3,3040	3,2520	3,0120	2,8000	2,8440	2,6400	2,7280	2,7960	2,8760	2,9400	0,4572	0,4620	0,5724	0,7216	1,0348	1,2692
HLI	7,6240	7,1800	6,6880	6,0400	5,3400	5,0640	5,0280	4,6720	5,7720	6,3920	7,0920	7,5840	0,2696	0,2740	0,3324	0,4508	0,6348	0,8104
HMC	3,9440	3,8440	3,9960	3,9840	3,6000	3,3000	3,2640	3,0880	3,4960	3,7160	3,9760	3,9040	0,3856	0,3888	0,4876	0,6300	0,9092	1,1248
HNE	2,0440	2,2040	2,6160	2,7600	2,5480	2,3640	2,3640	2,1320	2,1600	2,0440	2,1640	2,0000	0,4516	0,4736	0,5888	0,7672	1,0900	1,3676
HNI	2,9400	2,9960	3,2400	3,2200	2,9040	2,7120	2,7040	2,4880	2,7160	2,7200	2,8040	2,9320	0,3640	0,4056	0,5004	0,6696	0,9528	1,2116
HOC	2,4800	2,6440	2,8200	2,9400	2,8680	2,5800	2,5640	2,3720	2,4280	2,5800	2,5120	2,4320	0,3752	0,4008	0,4940	0,6020	0,8660	1,1100
HRA	3,1160	3,1360	3,3480	3,2840	2,9560	2,7680	2,7680	2,5440	2,8080	2,8560	2,9840	3,1040	0,3744	0,3992	0,4964	0,6452	0,9408	1,1848
HRN	4,4190	4,2333	4,1238	3,9905	3,9429	4,0381	3,8619	3,8905	4,1143	4,2952	4,5143	4,4476	0,3805	0,3657	0,4038	0,5581	0,7390	1,0500
INE	4,6040	4,5440	4,1520	3,7160	3,0920	3,0480	2,9000	2,6120	3,3280	3,4400	4,0480	4,4680	0,2840	0,2924	0,3612	0,5364	0,7576	0,9716
ING	2,2560	2,4320	2,6760	2,6720	2,6040	2,3560	2,2840	2,1360	2,1800	2,2920	2,2040	2,1480	0,3644	0,3760	0,4740	0,5796	0,8284	1,0316
KAM	3,0960	3,1400	3,3080	3,2320	2,8920	2,6920	2,6600	2,4120	2,6920	2,7760	2,9000	3,1240	0,3800	0,3968	0,4944	0,6560	0,9608	1,2144
KAS	1,3240	1,4680	1,9120	2,0480	2,0240	1,8320	1,6720	1,5320	1,3960	1,3640	1,4160	1,1640	0,4396	0,4532	0,5932	0,7376	1,0416	1,3372
KLE	7,1320	6,5440	6,4240	5,5400	4,9400	4,4240	4,4560	4,3200	5,1520	6,2480	6,6840	7,1480	0,3852	0,3916	0,4792	0,5880	0,8436	1,0432
KOS	2,6840	2,7280	2,8360	2,6720	2,4640	2,2920	2,3760	2,1240	2,3160	2,4280	2,5600	2,6480	0,3764	0,3956	0,4916	0,6028	0,8408	1,0468
KOW	6,6240	6,1720	6,0360	5,1480	4,4560	4,1720	4,1560	3,9280	4,6160	45417,0000	6,1080	6,6080	0,4348	0,4404	0,5276	0,6448	0,9024	1,1144
KRM	3,8080	3,7240	3,5320	3,2000	2,6920	2,5880	2,5320	2,2000	2,6840	3,2000	3,6480	3,8200	0,3668	0,3884	0,5024	0,7028	1,0412	1,3224
KZL	2,5520	2,7480	3,0880	3,1200	2,8440	2,6680	2,6920	2,4000	2,4680	2,3760	2,5760	2,5520	0,4640	0,4968	0,6040	0,8056	1,1292	1,4140
LAC	4,2720	4,5960	4,3320	3,9200	3,3600	3,1200	3,0760	2,7320	3,4800	3,4880	4,1880	4,2760	0,2756	0,2864	0,3480	0,5056	0,6948	0,9072
MIA	45415,0000	3,3400	3,4560	3,1000	2,7120	2,6000	2,5320	2,4000	2,6000	2,9160	3,3000	3,4960	0,4444	0,4600	0,5716	0,7348	1,0492	1,3092
MIE	4,6857	4,5143	4,6286	4,4000	4,0000	3,8571	3,8571	3,7000	4,0143	4,2286	4,6286	4,7000	0,5443	0,5486	0,6214	0,7414	1,0400	1,3071
OPP	2,7600	2,8800	3,0080	2,8320	2,6800	2,4920	2,4720	2,2720	2,4280	2,5840	2,6120	2,6960	0,3380	0,3568	0,4472	0,5580	0,7852	0,9912
PAD	1,3920	1,6240	1,9440	2,1080	1,7640	1,7440	1,6240	1,4320	1,6000	1,4840	1,4600	1,3440	0,3564	0,3804	0,4804	0,6792	0,9732	1,2300
PAT	1,3920	1,6240	1,9440	2,1080	1,7640	1,7440	1,6240	1,4320	1,6000	1,4840	1,4600	1,3440	0,3564	0,3804	0,4804	0,6792	0,9732	1,2300
PER	1,8280	2,0240	2,2880	2,4440	2,4240	2,1960	2,1360	1,9200	1,8600	1,8960	1,8560	1,8000	0,4132	0,4384	0,5636	0,7064	1,0024	1,2452
PHD	2,5480	2,6480	2,9320	2,9320	2,6720	45414,0000	45414,0000	2,2840	2,4280	2,4000	2,4520	2,5480	0,3960	0,4140	0,5224	0,6792	0,9884	1,2644
PHT	3,0000	3,0440	3,2680	3,2240	2,9200	2,7280	2,7240	45414,0000	2,7560	2,7640	2,8560	2,9880	0,3388	0,4064	0,5024	0,6632	0,9520	1,2164
PRE	5,2000	4,8000	45416,0000	4,2000	3,9000	3,8000	3,8000	3,7000	4,3000	4,7000	5,2000	5,0000	0,4700	0,4500	0,5400	0,7100	0,9600	1,2900
RFT	3,0000	3,0640	3,1560	2,9920	2,8200	2,6320	2,5440	2,3920	2,5040	2,5960	2,8120	3,0080	0,4792	0,4820	0,5792	0,6900	0,9564	1,1736
RZA	1,8800	2,2520	2,3920	2,3920	2,0800	1,9560	1,8840	1,8200	1,9720	1,9720	2,0880	1,8560	0,3752	0,3920	0,4764	0,6628	0,9264	1,1876
SCH	5,2160	5,1200	5,0160	4,4840	4,0360	3,7760	3,7440	3,5480	4,0600	4,5440	4,8480	5,1720	0,2756	0,2840	0,3676	0,4780	0,6604	0,8196
SNO	2,4840	45414,0000	2,8160	2,8920	2,6720	2,4560	2,3920	2,2280	2,3400	2,4080	2,5280	2,4840	0,4384	0,4432	0,5652	0,7308	1,0404	1,3044
SPI	2,4040	2,5440	2,8600	2,8880	2,6160	2,4280	2,3920	2,1800	2,3040	2,2720	2,3160	2,4080	0,4100	0,4296	0,5332	0,7184	1,0364	1,2744
STE	3,8880	3,7600	3,9000	3,5240	3,1840	3,0280	3,0040	2,7720	3,0000	3,2040	3,5800	3,8200	0,4920	0,5048	0,6084	0,7508	1,0352	1,3144
STG	2,5080	2,6840	2,7560	2,7120	2,6480	2,4560	2,4720	2,2720	2,2840	2,3960	2,3960	2,4560	0,4480	0,4552	0,5768	0,7340	1,0180	1,2644
SUB	2,5480	2,6480	2,9320	2,9320	2,6720	45414,0000	45414,0000	2,2840	2,4280	2,4000	2,4520	2,5480	0,3960	0,4140	0,5224	0,6792	0,9884	1,2644
SWA	3,4880	3,4880	3,5360	3,2920	3,0360	2,8360	2,7600	2,6000	2,7600	2,9360	3,2480	3,4720	0,4788	0,4824	0,5840	0,6880	0,9580	1,1808
SWJ	4,5750	4,4292	4,5875	4,3792	3,9875	3,8500	3,8500	3,6833	3,9667	4,1750	4,5250	4,5833	0,5375	0,5533	0,6221	0,7537	1,0354	1,3229
SZI	2,6880	2,8320	3,1080	3,2000	2,8080	2,6520	2,5720	2,2880	2,3280	2,3280	2,6280	2,7280	0,4992	0,5256	0,6572	0,8344	1,2104	1,5480
TBG	4,1280	3,8520	3,9320	3,5280	3,2880	3,1320	3,0080	2,8440	3,0840	3,2440	3,7560	4,1040	0,4868	0,4812	0,5828	0,6844	0,9332	1,1484
TIS	2,4960	2,7160	3,0520	2,9280	2,5760	2,4560	2,3080	2,0560	2,4600	2,3360	2,4520	2,4000	0,3504	0,3728	0,4684	0,6748	0,9144	1,2144
TKO	7,7320	7,2560	6,7760	6,1600	5,4320	5,0840	5,0440	4,7240	5,8400	6,5560	7,3240	7,6520	0,2864	0,2844	0,3508	0,4712	0,6568	0,8380
TRD	4,9560	4,7720	4,6680	4,3600	3,8760	3,6520	3,6480	3,3640	4,0000	4,3120	4,6520	4,9480	0,3252	0,3352	0,4248	0,5592	0,8004	1,0052
TRE	2,9720	3,0680	3,3480	3,4160	3,0480	2,7360	2,6800	2,5360	2,6800	2,8240	3,0680	3,0120	0,4640	0,4748	0,5876	0,7336	1,0728	1,3172
TRT	6,5560	6,2120	5,8560	5,3440	4,7440	4,4960	4,4680	4,1480	5,0680	5,5560	6,0840	6,5520	0,2876	0,2956	0,3572	0,4876	0,6952	0,8664
TZI	1,1800	1,4560	1,7520	1,9240	1,6560	1,6200	1,5400	1,3480	1,4120	1,2400	1,2600	1,1440	0,4028	0,4328	0,5420	0,7672	1,0720	1,3620
VEL	6,6840	6,3400	5,9800	5,4560	4,8400	4,5720	4,5680	4,2320	5,1720	5,6560	6,2240	6,6760	0,2892	0,2912	0,3580	0,4904	0,6880	0,8624
VID	45413,0000	1,8480	2,1880	2,3080	1,9960	1,8760	1,7920	1,5960	1,8240	1,6560	1,6440	1,4360	0,3700	0,3964	0,4976	0,7000	0,9692	1,2576
VLA	3,6200	3,6720	3,7000	3,3800	3,1280	2,8200	2,8080	2,5960	2,8320	3,1880	3,3920	3,5800	0,4580	0,4832	0,5804	0,7120	1,0024	1,2472
VOR	2,9520	3,0480	3,1640	2,9440	2,7760	2,5840	2,5680	2,3560	2,5480	2,7120	2,7800	2,8920	0,3376	0,3464	0,4380	0,5536	0,7836	1,0004
VYR	3,1200	3,3000	2,8000	3,1920	2,8000	2,6000	2,8440	2,6480	3,0000	3,1960	3,2800	3,3880	0,2800	0,2700	0,3600	0,5500	0,8100	1,1800
WEK	2,2600	2,3760	2,4440	2,4440	2,4480	2,2600	2,2640	2,0480	2,0000	2,1000	2,1000	2,1840	0,4584	0,4720	0,5972	0,7580	1,0604	1,2996
WIL	5,1920	5,0960	4,9960	4,4360	3,9920	3,7480	3,7160	3,5040	4,0240	4,5080	4,8040	5,1520	0,2776	0,2908	0,3756	0,4820	0,6516	0,8252
WUL	5,2320	4,9880	4,9200	4,3320	4,0000	3,8040	3,8880	3,7280	4,0400	4,5680	4,8680	5,0000	0,5132	0,4940	0,6016	0,6944	0,9344	1,1792
ZAP	4,6600	4,4920	4,4560	4,1920	3,7320	3,4960	3,4880	3,2360	3,8040	4,1160	4,4320	4,6360	0,3320	0,3520	0,4356	0,5808	0,8268	1,0380
ZEP	6,7280	6,3640	5,9920	5,4600	4,8400	4,6000	4,5840	4,2360	5,1760	5,6640	6,2200	6,7360	0,2848	0,2852	0,3532	0,4788	0,6844	0,8440
ZID	1,6000	1,7520	2,1040	2,1160	2,0680	1,8480	1,7360	1,6440	1,5440	1,6200	1,7400	1,6200	0,4620	0,4724	0,5964	0,7592	1,0664	1,3424
ZIT	1,6280	1,7640	2,1320	2,1360	2,0880	1,8720	1,7520	1,6480	1,5640	1,6600	1,7720	1,6680	0,4620	0,4740	0,5924	0,7568	1,0756	1,3476

Continuation of Suppl. Table 3: The climatic variables for the 73 populations of A. arenosa, Pop=population code, vapr_X=water vapor pressure for each month, X_vegMonth=value for each variable for the most important vegetative month

Pop	vapr_Jul	vapr_Aug	vapr_Sep	vapr_Oct	vapr_Nov	vapr_Dec	tmin_vegMonth	tmax_vegMonth	vapr_vegMonth	wind_vegMonth	prec_vegMonth	tavg_vegMonth	srad_vegMonth
BAB	1,2660	1,2616	1,0156	0,7488	0,5472	0,4232	5,0840	16,2960	0,9188	3,0440	83	10,6920	17641
BAL	1,0076	0,9760	0,7676	0,5516	0,3776	0,3024	4,6960	12,6720	0,9760	2,7840	104	8,6720	17159
BDO	1,5336	1,5220	1,2412	0,9472	0,6844	0,5312	6,1880	16,1560	0,8128	3,1800	43	11,1800	15363
BEL	1,6116	1,5632	1,3016	0,9776	0,6820	0,5256	4,5360	14,7640	0,8052	2,4600	79	9,6560	14762
BGS	1,3420	1,3676	1,0976	0,8360	0,5960	0,4512	6,3040	17,1440	0,9132	2,1880	119	11,7160	17372
BIH	1,6404	1,5780	1,2912	0,9996	0,7120	0,5336	4,8800	15,5920	0,7804	1,9000	112	10,2320	15217
BOR	1,3788	1,3676	1,1640	0,8744	0,6468	0,4928	8,1720	18,3280	1,0088	3,0440	63	13,2520	18245
BRD	1,4080	1,4032	1,1652	0,8884	0,6640	0,5256	7,4960	18,1080	1,0240	3,1880	67	12,8120	17600
BUD	1,2436	1,2044	0,9540	0,6908	0,4732	0,3676	3,5440	13,4760	0,8572	2,6040	86	8,5160	19208
CAR	1,2504	1,2380	0,9720	0,6908	0,4796	0,3600	3,1440	13,0720	0,8840	2,2640	96	8,1120	19316
CHO	1,4564	1,4520	1,2880	1,0352	0,7980	0,6904	7,9080	17,4560	1,0564	3,3200	71	12,6800	17396
DRA	1,3184	1,2788	1,0124	0,7356	0,5056	0,3884	4,3720	15,0680	0,9124	2,3840	84	9,7280	19462
FOJ	1,3204	1,3296	1,1004	0,8464	0,6124	0,4828	1,1720	11,3280	0,6836	2,4840	85	6,2560	15451
FUG	1,3776	1,3716	1,1520	0,8748	0,6452	0,4888	7,4000	18,0960	1,0180	2,6480	64	12,7680	18472
GOR	1,6268	1,5928	1,3076	0,9728	0,6840	0,5360	9,3160	20,1440	1,2136	2,5680	73	14,7240	19118
GUL	1,3452	1,3148	1,1276	0,8068	0,5736	0,4352	6,1280	17,5880	0,9740	2,3600	88	11,8520	17916
HAR	1,4048	1,3476	1,1540	0,8692	0,6468	0,4980	8,1800	18,4160	1,0348	3,0120	59	13,2920	18768
HLI	0,9276	0,9460	0,7420	0,5340	0,3828	0,3040	4,4120	13,2640	0,9460	4,6720	168	8,8520	14943
HMC	1,2324	1,2492	1,0340	0,7488	0,5352	0,4368	4,6360	15,4720	0,9092	3,6000	96	10,0640	18031
HNE	1,4444	1,4600	1,1836	0,9024	0,6456	0,5000	3,6240	15,7800	0,7672	2,7600	50	9,7000	15055
HNI	1,3304	1,2880	1,0784	0,7672	0,5612	0,4288	6,0800	16,4960	0,9528	2,9040	82	11,3040	17970
HOC	1,2164	1,2280	1,0232	0,7676	0,5348	0,4096	5,5160	15,8760	0,8660	2,8680	105	10,7000	17869
HRA	1,3240	1,2976	1,0520	0,7644	0,5580	0,4320	5,4800	16,4840	0,9408	2,9560	78	10,9800	17729
HRN	1,4100	1,3524	1,0338	0,7105	0,5452	0,3971	2,8048	12,0952	0,7390	3,9429	42	7,4524	17999
INE	1,0916	1,0864	0,8444	0,5920	0,4080	0,3148	6,0600	13,9920	1,0864	2,6120	117	10,0480	16723
ING	1,1684	1,2292	0,9652	0,7324	0,5120	0,3908	4,0280	15,1200	0,8284	2,6040	101	9,5760	17577
KAM	1,3100	1,2980	1,0740	0,7784	0,5576	0,4312	5,7200	16,6320	0,9608	2,8920	93	11,1680	18097
KAS	1,5160	1,4816	1,2592	0,9016	0,6312	0,4720	7,5320	19,5520	1,0416	2,0240	95	13,5440	18146
KLE	1,1612	1,1948	0,9932	0,7272	0,5296	0,4296	4,1680	12,7560	0,8436	4,9400	75	8,4680	17996
KOS	1,2208	1,2400	1,0288	0,7276	0,5192	0,4104	4,6680	14,1160	0,8408	2,4640	125	9,4000	17218
KOW	1,2420	1,2712	1,0716	0,8060	0,5864	0,4584	5,0040	14,8840	0,9024	4,4560	67	9,9440	17995
KRM	1,4340	1,3940	1,1248	0,8120	0,5868	0,4476	7,6520	17,4320	1,0412	2,6920	70	12,5440	19418
KZL	1,5072	1,5120	1,2244	0,9460	0,6736	0,5288	5,6320	16,1680	0,8056	3,1200	45	10,9120	15277
LAC	1,0188	0,9856	0,7784	0,5604	0,3816	0,3068	4,6600	12,8920	0,9856	2,7320	104	8,7880	17005
MIA	1,4600	1,4360	1,1976	0,8996	0,6636	0,5140	7,8600	17,9720	1,0492	2,7120	72	12,9160	17976
MIE	1,5014	45413,0000	1,2686	0,9957	0,7400	0,5829	7,5429	15,7143	1,0400	4,0000	45	11,6286	18582
OPP	1,1472	1,1600	0,9296	0,7168	0,4876	0,3684	7,9640	17,8520	1,1600	2,2720	143	12,9160	15632
PAD	1,3508	1,3380	1,0648	0,7668	0,5380	0,4020	5,6600	16,4800	0,9732	1,7640	92	11,0720	19670
PAT	1,3508	1,3380	1,0648	0,7668	0,5380	0,4020	5,6600	16,4800	0,9732	1,7640	92	11,0720	19670
PER	1,3936	1,4476	1,1496	0,8464	0,6020	0,4508	7,4360	18,2480	1,0024	2,4240	90	12,8360	18030
PHD	1,3564	1,3340	1,1280	0,7976	0,5788	0,4488	6,3240	17,8000	0,9884	2,6720	77	12,0600	17930
PHT	1,3040	1,2800	1,0732	0,7652	0,5596	0,4212	6,0120	16,2840	0,9520	2,9200	81	11,1440	17911
PRE	1,5200	1,5100	1,1800	0,9100	0,6900	0,5400	7,0000	15,2000	0,9600	3,9000	41	11,1000	19287
RFT	1,3512	1,3464	1,1040	0,8632	0,6208	0,5148	5,4640	15,8480	0,9564	2,8200	92	10,6520	17753
RZA	1,3164	1,2796	1,0280	0,7656	0,5264	0,4052	5,1920	14,3440	0,9264	2,0800	97	9,7680	18749
SCH	0,9136	0,9572	0,7792	0,5568	0,3852	0,3024	5,2360	13,9840	0,9572	3,5480	174	9,6080	15244
SNO	1,3940	1,3936	1,1776	0,8636	0,6180	0,4952	6,6280	18,6680	1,0404	2,6720	84	12,6480	18150
SPI	1,4012	1,3780	1,1416	0,8392	0,6004	0,4644	6,9640	18,5800	1,0364	2,6160	79	12,7720	18285
STE	1,4464	1,4308	1,2112	0,9244	0,6872	0,5688	7,6120	18,8880	1,0352	3,1840	47	13,2520	18489
STG	1,3776	1,3716	1,1520	0,8748	0,6452	0,4888	7,4000	18,0960	1,0180	2,6480	64	12,7680	18472
SUB	1,3564	1,3340	1,1280	0,7976	0,5788	0,4488	6,3240	17,8000	0,9884	2,6720	77	12,0600	17930
SWA	1,3504	1,3384	1,1216	0,8620	0,6240	0,5224	6,0600	15,5440	0,9580	3,0360	96	10,8000	17883
SWJ	1,4967	1,5404	1,2725	0,9946	0,7504	0,5975	7,5333	15,8625	1,0354	3,9875	47	11,7125	18367
SZI	1,6352	1,6212	1,3544	0,9876	0,7176	0,5624	5,7520	15,0200	0,8344	3,2000	43	10,3800	15250
TBG	1,3256	1,3476	1,0812	0,8584	0,6192	0,5248	5,6040	15,2960	0,9332	3,2880	112	10,4520	17590
TIS	1,3344	1,2968	1,0224	0,7380	0,5056	0,3864	4,7880	14,4960	0,9144	2,5760	81	9,6400	19561
TKO	0,9500	0,9788	0,7624	0,5556	0,3984	0,3260	5,1280	14,2720	0,9788	4,7240	167	9,7040	14904
TRD	1,1244	1,1488	0,9112	0,6664	0,4756	0,3732	7,4520	17,2200	1,1244	3,6480	167	12,3400	16919
TRE	1,4456	1,4304	1,1972	0,9012	0,6524	0,5184	8,1560	20,1200	1,0728	3,0480	70	14,1480	18839
TRT	0,9812	1,0028	0,7980	0,5668	0,4124	0,3316	5,3480	14,3280	1,0028	4,1480	157	9,8440	15050
TZI	1,5008	1,4676	1,1748	0,8552	0,5928	0,4572	7,6120	18,7760	1,0720	1,6560	78	13,1920	19830
VEL	0,9768	0,9880	0,7696	0,5692	0,4072	0,3264	5,3120	14,7320	0,9880	4,2320	158	10,0200	14792
VID	1,3844	1,3368	1,0636	0,7816	0,5348	0,4180	5,9040	15,7720	0,9692	1,9960	91	10,8440	19315
VLA	1,3712	1,3608	1,1540	0,8616	0,6432	0,5064	7,9240	18,2720	1,0024	3,1280	63	13,1080	18262
VOR	1,1348	1,1472	0,9248	0,7056	0,4792	0,3716	5,8920	15,5600	1,0004	2,5840	159	10,7160	17753
VYR	1,4240	1,3300	0,9324	0,7048	0,5200	0,3600	4,8480	15,7200	0,8100	2,8000	44	10,2920	18319
WEK	1,4136	1,3972	1,2028	0,9016	0,6540	0,4996	7,9120	18,6560	1,0604	2,4480	68	13,2800	18304
WIL	0,9340	0,9544	0,7856	0,5684	0,3872	0,3024	5,1120	13,7080	0,9544	3,5040	175	9,4040	15170
WUL	1,3204	1,3036	1,1132	0,8708	0,6656	0,5704	5,6520	15,4240	0,9344	4,0000	82	10,5440	17104
ZAP	1,1724	1,1916	0,9408	0,6792	0,4972	0,3596	3,3480	13,8600	0,8268	3,7320	126	8,6040	17078
ZEP	0,9500	0,9656	0,7668	0,5584	0,4008	0,3256	0,6200	9,3560	0,6844	4,8400	141	4,9840	16886
ZID	1,5192	1,5020	1,2492	0,9424	0,6544	0,5044	3,1640	13,6320	0,7592	2,1160	94	8,4080	14578
ZIT	1,5080	1,4980	1,2288	0,9364	0,6556	0,5020	3,0360	13,6240	0,7568	2,1360	96	8,3320	14601

Suppl. Table 4: Outlier SNPs from environmental GWAS, Loci=position in the genome, p.value=p-value, chromosome=chromosome number according to A. lyrata, gene=A. lyrata gene code, AT=A. thaliana gene code, gene_model=type of change, gene_name=short gene name, short_description=description of a function, Curator_summary=details about the function

Loci	p.value	chromosome	gene	AT	gene_model_t	gene_name	short_description	Curator_summary
AL2G25830.Arg900Ser.12364349	6.14E-60	2	AL2G25830	AT1G67310.1	protein_coding	CAMTA	Calmodulin-binding transcription activator protein with CG-1 and Ankyrin domains	nnn
AL1G36270.AlaYVal.10031268	1.06E-59	1	AL1G36270	AT1G22730.1	protein_coding	MRP2	MA3 domain-containing protein	nnn
AL5G22700.Leu377Val.11157690	5.72E-58	5	AL5G22700	AT3G44550.1	protein_coding	FAR5	fatty acid reductase 5	Encodes a member of the eight-member gene family encoding alcohol-forming fatty acyl-CoA reductases (FARs) identified in Arabidopsis thaliana. Three of the FARs, FAR1 (At5g22500), FAR4 (At3g44540) and FAR5 (At3g44550) are show n to generate the fatty alcohols found in root, seed coat and w ound-induced leaf tissue. The mRNA is cell-to-cell mobile.
AL1G36270.Glu5Gln.10031261	2.15E-57	1	AL1G36270	AT1G22730.1	protein_coding	MRP2	MA3 domain-containing protein	nnn
AL5G22700.Gly329Cys.11157546	5.84E-56	5	AL5G22700	AT3G44550.1	protein_coding	FAR5	fatty acid reductase 5	Encodes a member of the eight-member gene family encoding alcohol-forming fatty acyl-CoA reductases (FARs) identified in Arabidopsis thaliana. Three of the FARs, FAR1 (At5g22500), FAR4 (At3g44540) and FAR5 (At3g44550) are show n to generate the fatty alcohols found in root, seed coat and w ound-induced leaf tissue. The mRNA is cell-to-cell mobile.
AL7G27590.Asp43His.7115393	1.32E-55	7	AL7G27590	AT4G25500.3	protein_coding	RSP35	arginine/serine-rich splicing factor 35	Encodes an arginine/serine-rich splicing factor. The transcript is alternatively spliced and is differentially expressed in different tissues (flow ers, roots, stems and leaves) examined. Barta et al (2010) have proposed a nomenclature for Serine/Arginine-Rich Protein Splicing Factors (SR proteins): Plant Cell. 2010;22:2926. RS40 binds to HY L1 and co-localizes to the nuclear dicing body. Along w ith RS41 it appears to be involved in pri-mRNA processing and miRNA biogenesis (DOI:10.1093/nar/gkv751).
AL7G27590.Asp43His.7115393	1.32E-55	7	AL7G27590	AT4G25500.3	protein_coding	RSP35	arginine/serine-rich splicing factor 35	Encodes an arginine/serine-rich splicing factor. The transcript is alternatively spliced and is differentially expressed in different tissues (flow ers, roots, stems and leaves) examined. Barta et al (2010) have proposed a nomenclature for Serine/Arginine-Rich Protein Splicing Factors (SR proteins): Plant Cell. 2010;22:2926. RS40 binds to HY L1 and co-localizes to the nuclear dicing body. Along w ith RS41 it appears to be involved in pri-mRNA processing and miRNA biogenesis (DOI:10.1093/nar/gkv751).
AL7G27590.Asp43His.7115393	1.32E-55	7	AL7G27590	AT4G25500.4	protein_coding	RSP35	arginine/serine-rich splicing factor 35	Encodes an arginine/serine-rich splicing factor. The transcript is alternatively spliced and is differentially expressed in different tissues (flow ers, roots, stems and leaves) examined. Barta et al (2010) have proposed a nomenclature for Serine/Arginine-Rich Protein Splicing Factors (SR proteins): Plant Cell. 2010;22:2926. RS40 binds to HY L1 and co-localizes to the nuclear dicing body. Along w ith RS41 it appears to be involved in pri-mRNA processing and miRNA biogenesis (DOI:10.1093/nar/gkv751).
AL1G27640.Val352Ile.6546673	3.38E-55	1	AL1G27640	AT1G15520.1	protein_coding	ABCG40	pleiotropic drug resistance 12	ABC transporter family involved in ABA transport and resistance to lead. Localizes to plasma membrane. Upregulated by lead. Expressed in leaves, flow ers, stomata and roots.
AL5G22700.Ala384Ser.11157711	8.00E-55	5	AL5G22700	AT3G44550.1	protein_coding	FAR5	fatty acid reductase 5	Encodes a member of the eight-member gene family encoding alcohol-forming fatty acyl-CoA reductases (FARs) identified in Arabidopsis thaliana. Three of the FARs, FAR1 (At5g22500), FAR4 (At3g44540) and FAR5 (At3g44550) are show n to generate the fatty alcohols found in root, seed coat and w ound-induced leaf tissue. The mRNA is cell-to-cell mobile.
AL2G12590.Ile561Val.1293985	1.76E-54	2	AL2G12590	AT1G63010.4	protein_coding	VPT1	Major Facilitator Superfamily w ith SPX (SYG1/Pho81/XPR1) domain-containing protein	Encodes an SPX domain protein that transports Pi into the vacuole and is essential for phosphate homeostasis.
AL1G36270.Gln46Arg.10031475	4.28E-54	1	AL1G36270	AT1G22730.1	protein_coding	MRP2	MA3 domain-containing protein	nnn
AL4G31620.Asp99Gly.16861419	4.68E-54	4	AL4G31620	AT2G35585.1	protein_coding	CFTR	cystic fibrosis transmembrane conductance regulator	nnn
AL2G12590.Leu564Met.1293994	7.04E-54	2	AL2G12590	AT1G63010.4	protein_coding	VPT1	Major Facilitator Superfamily w ith SPX (SYG1/Pho81/XPR1) domain-containing protein	Encodes an SPX domain protein that transports Pi into the vacuole and is essential for phosphate homeostasis.
AL1G36270.Val96Ile.10031705	1.31E-53	1	AL1G36270	AT1G22730.1	protein_coding	MRP2	MA3 domain-containing protein	nnn
AL4G31620.Asn83Tyr.16861400	6.69E-53	4	AL4G31620	AT2G35585.1	protein_coding	CFTR	cystic fibrosis transmembrane conductance regulator	nnn
AL7G35570.Glu14Lys.10656658	1.14E-52	7	AL7G35570	AT4G18680.1	protein_coding	DOG1	delay of germination protein	nnn
AL4G31620.Asn93Thr.16861401	1.94E-52	4	AL4G31620	AT2G35585.1	protein_coding	CFTR	cystic fibrosis transmembrane conductance regulator	nnn
AL7G22550.Ala698Ser.5158884	1.57E-50	7	AL7G22550	AT4G29750.1	protein_coding	CRM	CRS1 / YhbY (CRM) domain-containing protein	nnn

Suppl. Table 5: Metabolite data for wounded leaves, first column describes the individual, gro=genotype (e.g. AA=alpine plant with alpine allele, AF=alpine plant with foothill allele etc.), allele=A or F allele, pop=original ecotype, Adosage=allele dosage of the A allele in the individual, further columns show individual compounds. The data are normalized by internal standard, dry weight od the sample and by the control amount in the unwounded leaf.

	gro	allele	pop	Adosage	Pentadecanol.1tms	FA17.0.ME	w.OH.FA15.0.ME.1tms	Tetradecanol.1tms	p.coumaric.1ME.1tms	Loliolide.1tms	Methyl.4.hydroxy.3.5.dimethoxybenzoate.1tm	X3.4.dihydroxybenzoate.3tms	Ferulic.acid.1ME.1tms	FA15.0.1ME	Myristoate.1tms	Indole.3.acetonitrile.1tms	FA16.2.ME	FA16.3.ME	IAA.1ME.1tms	FA16.1a.ME	FA16.1b.ME	FA16.1c.ME	FA16.0.ME	Ferulic.acid.1ME.1tms	Hexadecanol.1tms
P100	ff	F	F	0	1.038341173	0.998492504	0.974479591	1.181082894	1.070020833	1.502064621	1.383598209	1.109608973	1.399798339	1.398593922	1.111709582	0.070950022	1.022643583	0.665506768	0.139934979	0.909114661	0.919470754	1.019478399	1.056752376	1.059126785	1.218099863
P112	AF	F	A	NA	1.228846758	1.07457032	1.231713614	1.243638584	1.115513565	1.897487883	1.044262398	3.040790663	1.313849758	1.314111985	0.998112706	0.184111398	0.813980815	0.776290371	0.068849659	0.992687899	0.84676662	0.905314621	1.090598139	1.40150922	1.319843823
P113	fa	A	F	1	1.062910045	1.068462324	0.958520114	1.656352354	1.449771029	1.80944054	0.913346891	0.663098256	1.081814623	1.080700619	0.914391408	NA	0.93258857	0.574707755	0.826203621	0.712756815	0.701142483	0.922464594	1.048500454	0.732639471	2.071411778
P115	FA	A	F	0.5	0.78241185	0.899679664	0.837324138	1.034778225	0.680828421	0.946429755	1.153357675	0.632548842	1.099597944	1.100135809	1.081128793	0.009586224	0.853225539	0.681741296	0.030237815	0.792463209	0.730520347	0.800557958	1.031228529	0.643424241	2.267086965
P116	AA	A	A	1	0.977602704	0.973521523	0.999526376	3.362553563	1.139352622	0.797549005	1.108320952	1.848396024	1.126106271	1.190562731	0.609700419	1.141995968	0.763348843	0.803571332	1.065291508	0.878948202	0.833653599	0.807998611	0.991028513	1.477805444	3.432256171
P150	AF	F	A	0.5	1.10982255	1.099856272	1.081270897	1.098212632	1.574774895	1.448760059	1.807577561	2.399467094	1.288208877	1.292585926	1.050581907	0.305484848	0.518684617	1.003953801	0.158353683	0.899761623	0.923233989	1.089856381	1.16780933	2.194012967	3.102350454
P151	FA	A	F	0.5	1.096242071	1.096736133	1.125843673	0.371088422	0.882211846	1.150151006	1.154712675	0.745790907	1.118381845	1.15503403	1.66129654	NA	0.851273277	0.713491557	0.558606939	0.937788087	0.918560645	1.18664099	0.949836564	1.738850586	1.263288891
P152	FA	A	F	1	0.817440858	0.939824858	0.893999157	5.975622976	1.301504302	2.63177933	1.352624526	0.42843069	1.366063343	1.365208009	1.074644785	0.543701867	0.768801139	0.786512744	0.683563565	1.014625126	1.058750579	1.324841906	1.252440657	1.215489774	3.520301887
P156	FF	F	F	NA	0.867907883	0.971266967	0.923507643	0.923439123	1.036482454	1.325496119	1.494863784	0.538377944	1.251693009	1.251324847	0.886416651	NA	0.347683996	0.431059015	NA	0.655119599	0.647922915	0.932802131	1.100904468	0.907223622	1.919210223
P158	AA	A	A	1	0.949879009	0.970782924	0.976401042	1.187780917	1.345654552	1.291329573	1.059365303	0.966998537	1.094591746	1.094575106	1.198068458	0.649449015	0.622216611	0.89004157	0.563343143	0.930501023	0.826926679	0.991230236	1.080561757	1.274590917	1.504392526
P159	ff	F	F	0	0.877140103	0.893299503	0.932178714	1.153931514	0.769781899	1.81298241	0.592106614	0.441451671	0.910942514	0.911054339	0.815794897	NA	1.08713261	0.585772813	NA	0.813561651	0.603517315	1.018856465	1.049281176	0.30980063	1.188745319
P161	fa	A	F	1	1.054854253	0.97735924	1.028340893	1.270924781	1.169135263	1.601033747	0.621399139	1.118998231	1.442162263	1.441948098	1.236350702	NA	0.631849082	0.670011047	1.009219623	0.823540156	0.90861261	1.598218263	0.965738737	1.025024521	1.373058761
P175	FA	A	F	1	1.007106519	0.955799171	0.964222462	1.242670797	1.513047015	0.964864772	1.450558991	1.398137003	1.101223838	1.101526499	1.434393085	1.612668414	0.794961343	0.995898376	0.74142371	1.158705739	0.992170745	1.137194151	0.999773137	1.247855339	1.564240404
P181	FA	A	F	0.5	1.754779539	1.717918014	1.873552753	1.893893466	0.474483432	2.311965709	0.16906586	0.361866458	1.132646942	1.133105131	2.003868501	2.219887906	0.924262718	0.469695545	NA	0.888687865	0.815454955	1.534218709	1.518655534	0.215457147	2.422096502
P184	AF	F	A	0.25	1.038773872	1.092216694	1.114764832	1.52853568	1.103857835	0.962824648	1.401495362	1.821415699	1.191158387	1.191114237	1.181558637	0.561074274	0.742936187	0.806590585	0.228486624	0.851634101	0.923612232	0.930007655	1.060236553	1.595972707	0.992584024
P199	AA	A	A	1	1.071955613	1.039782511	1.237323211	0.492635202	1.551531252	3.148838163	1.784970556	0.844708659	1.275633334	1.275629274	1.280087931	2.086467859	0.599875339	1.29888798	1.543610922	1.151250219	1.557711933	1.284238934	1.408966293	2.821958175	2.531803291
P200	fa	A	F	0.5	0.98331138	1.045822825	1.034365689	1.192731273	0.576787649	2.406931839	0.794301968	1.107687025	0.932905138	0.933327446	0.868779041	NA	0.703078807	0.668649658	0.778064716	0.763909748	0.872749777	1.010551203	1.226625933	0.348512024	1.558859826
P201	FF	F	F	0	1.325545111	1.301908035	1.251828137	1.250212288	0.933576148	2.844962199	1.015546178	1.976742147	1.497590531	1.49949004	1.27566067	0.107953434	0.896395079	0.665340829	0.185522514	0.863502583	0.823263753	1.021865852	1.113963698	0.614909955	1.319329705
P209	FA	A	F	0.5	0.943048011	0.930652325	0.871161422	1.162341031	1.273965869	1.173820328	1.465215385	0.638180521	1.235730544	1.236530849	1.279674445	1.983914915	0.766850253	0.858139634	0.56582997	1.103089579	1.005069478	1.03141426	0.920353944	0.999053462	2.620084244
P211	AF	F	A	0	1.078659467	1.0805608	1.060740514	1.698384226	0.991185448	1.689812933	0.798160843	0.742306488	1.345117872	1.338856865	1.218381106	NA	0.782134126	0.670785898	0.126799832	0.950433201	0.819772759	1.011193193	1.080182113	1.218498543	0.756497322
P230	FF	F	F	0	1.064428241	1.147898142	1.056718742	1.447831029	1.511984016	1.096188248	0.87726602	0.411935647	1.070919195	1.071694962	1.116748409	0.966585759	0.482587171	0.816451507	1.655668963	0.648999009	0.777182172	0.92067977	1.292415573	1.205573125	1.686547124
P246	AF	F	A	0.25	0.894634144	0.984442437	0.94492953	2.425364381	1.155353597	0.84143303	1.339501428	1.17294464	1.092806968	1.091377515	0.706973141	0.088746957	0.597145294	0.781703594	0.617056083	0.834131604	0.826854195	0.920941873	1.065272092	1.655649866	2.068976279
P258	AF	F	A	0.25	1.206113676	1.089371237	1.158719276	1.49374874	1.302597644	3.16228627	1.9541645	1.058184693	1.870032684	1.873377983	1.391083284	0.109100223	0.588604026	0.901693486	1.608306195	0.946068703	0.980621843	1.152481419	1.121709313	1.821276978	1.748881347
P273	FF	F	F	0	1.009103054	0.999729606	1.018548818	1.392256923	0.740727567	2.33717387	1.871702872	1.046390942	1.129188267	1.128179666	0.966634037	NA	1.023402831	0.69938405	0.002520562	0.768025583	0.729214642	0.953243943	1.144098747	0.758548366	1.999316643
P28	AF	F	A	0.5	1.172168193	1.208991882	1.180572448	1.828682259	1.699443951	2.084668295	1.37937981	0.885273662	1.700959489	1.70212503	1.220127999	0.934066763	1.163809281	0.467482837	0.718682717	0.815595934	1.049269622	1.208530686	1.118850434	1.756169302	2.725237587
P281	fa	A	F	1	0.944540076	0.868506914	0.902952168	0.948324071	1.114215672	2.375308258	1.341267938	1.339550561	0.910084223	0.910039395	1.275317636	0.723110793	1.381270377	1.087871255	0.173618248	1.226547892	1.167019282	1.06056782	1.06987158	1.357133868	3.85113534
P284	ff	F	F	0	1.001511101	1.03675944	1.089034266	1.377487491	0.857666638	1.434387597	0.903770517	0.562763417	1.2883059	1.288436176	0.560920365	0.324627453	0.6822617	0.585489227	0.806622257	0.745770088	0.630046223	1.033819746	1.156077778	0.656078094	1.18604378
P287	FA	A	F	0.5	1.324017041	1.32234094	1.389450367	0.915692302	0.682470496	2.582946262	1.512778884	1.766173671	1.098904556	1.098976675	1.203374957	0.003667199	0.886149928	0.726045285	0.112209319	0.939255052	0.692214124	1.141360669	1.153675081	0.792597178	1.95829716
P289	AF	F	A	0.25	1.047307704	1.077051608	1.06079465	1.505896897	1.644949413	2.009997543	1.457440676	0.677264971	1.398506517	1.398899824	1.465754508	NA	0.727717125	0.543506416	0.367396566	0.776215183	0.85623597	1.119198119	1.220913115	1.14669387	2.484895756
P291	ff	F	F	0	1.137302167	1.064490462	1.07487252	1.425867899	1.15445395	1.847018171	1.243335952	0.828311031	1.099399447	1.102187945	1.223400903	0.002648938	1.163913331	0.794294904	0.002140192	0.913049558	0.813882856	1.034513405	1.10222763	0.989827592	1.560178224
P3	AA	A	A	1	1.07640445	1.081749291	1.061721456	3.08718388	1.135873857	0.958961146	1.515661954	0.287800297	1.073981196	1.073792738	1.146540472	0.144428916	0.542808949	0.692113393	NA	0.834299615	0.879750699	0.945752128	1.038849884	1.205050265	1.632947174
P302	ff	F	F	0	0.913329519	0.990490984	1.013429025	1.931068464	0.759625639	1.979254187	0.65622185	0.569750941	0.927575225	0.926525108	0.521081041	1.059962088	0.744417305	0.839192978	4.497792486	0.816226282	0.831448348	1.019815397	1.134610573	0.792663176	1.200315508
P34	FA	A	F	1	1.373627192	0.971654304	1.083051395	1.61852901	1.23513759	1.051594972	1.371457465	0.942013899	1.125632448	1.132573948	1.436522977	0.080084762	0.848733143	0.860479729	0.560035112	0.729212215	0.772699159	0.95437946	1.050930619	1.021923366	1.478452744
P35	AF	F	A	0.25	0.873265874	0.847983894	0.873208695	0.546481887	1.826478399	0.523545201	1.187755404	0.864217368	0.863716452	0.865040206	0.980884584	0.4402899	0.75278273	0.710011164	0.49626269	0.939938086	0.653014052	0.744249122	0.919280467	1.331803555	1.639577944
P4	AF	F	A	0	0.965719507	1.076835926	1.077595607	1.237635308	0.899593336	1.677253454	0.807318026	0.7576688	1.015383623	1.018568275	1.065272929	NA	0.577747583	0.688670644	0.144583188	0.834846173	0.729614598	1.013195746	1.237174538	0.95415816	0.898340615
P46	FA	A	F	0.5	1.72081892	1.647621156	1.772101396	1.562605594	1.165171622	1.871640398	0.861939929	0.431813855	1.479959065	1.459874677	1.648481206	NA	0.699917671	0.607597246	1.411053618	0.758371346	0.524989745	1.105220728	1.421640938	0.833395882	2.032471703
P47	FF	F	F	0	1.529734316	1.575597035	1.465309763	1.863667462	0.932041585	5.817867039	1.391631252	5.283892221	1.213911819	1.213125899	0.749697409	0.050692881	0.52145189	0.85462093	0.008544307	0.793559613	0.880880021	1.501191121	1.331264077	1.153780379	1.002974611
P54	fa	A	F	0.5	1.030519199	1.036282143	0.999742335	1.331630496	0.955504903	1.893819868	1.75943224	0.635780089	1.469193164	1.468126545	1.120827135	0.02069574	0.767332018	0.627315165	NA	0.744482616	0.882943174	1.193510237	1.074477645	0.966790776	1.802653016
P56	AA	A	A	1	1.390411719	1.357857743	1.423845491	2.199062843	1.128363414	1.544559461	1.28714556	2.036329368	1.380982971	1.381137415	1.039242801	1.038310639	0.639717199	0.870915488	0.526399482	0.978795531	0.962351152	1.027400233	1.298216664	1.279832371	1.974387755
P72	AF	F	A	0.25	0.827551512	0.831933623	0.867228918	1.481637701	1.612974074	1.779617411	1.506601538	0.538913384	1.409590901	1.409273162	1.447933183	0.008092599	0.779380593	0.756448268	0.160079787	1.070377769	1.123268201	0.990867871	1.244230823	2.41997849	1.402657658
P73	FA	A	F	1	0.947321981	1.011071576	0.984619031	1.10984626	0.695094538	0.807933546	1.136463534	1.818473689	1.016160976	1.015943329	1.149774735	0.450353396	0.740728431	1.03395216	0.49687197	0.785942763	1.200202234	0.794937236	0.965784226	0.695465248	1.618503413
P79	fa	A	F	0.5	1.104568597	1.109588233	1.081239972	1.482960592	1.522361877	1.632194915	1.403970551	1.041936284	1.263396906	1.268951876	1.142889272	0.059749027	0.942418451	0.680416777	0.388921051	0.741266463	0.953606906	0.922701241	1.132680795	1.088444658	1.499376719
P8	FF	F	F	0.25	1.141159426	1.039653743	1.007701156	1.192232954	1.08247598	1.342692953	1.256417601	2.722742381	1.296687901	1.296815236	1.122936159	0.586773306	0.756745248	0.834637509	0.171797301	0.868380066	0.878072185	1.009145502	1.009719357	1.022880359	1.020824365
P85	FF	F	F	0	1.379502132	1.426252271	1.419739403	1.049958694	0.659546455	1.959460361	1.060718707	0.892724222	0.991381004	0.989421813	1.200999601	0.059241405	0.462896094	0.564622984	0.076946779	0.73688591	0.808860147	0.810927555	1.233075007	0.8802261	1.073186688
P91	FA	A	F	1	1.071445339	1.131271115	1.126240277	1.45714312	0.805673543	1.708336153	1.07902729	0.398217296	1.198742965	1.199190513	1.337500458	0.041393198	0.659398099	0.768092834	0.6360212	0.883697959	0.868133794	1.081283345	1.058700956	1.292854474	2.810418059
P99	AF	F	A	0.25	1.225767981	1.227997542	1.215978706	2.270748314	1.161146843	2.806369904	2.5187392	2.349306926	1.704573791	1.686689367	1.093708427	0.070430451	0.490212526	0.605513404	0.005565251	0.707750509	0.788368218	1.033173683	1.189064526	1.52680475	2.576664049

Continuation of the Suppl. Table 5: Metabolite data for wounded leaves, first column describes the individual, further columns show individual compounds.

	X1.2.dihydro.2.oxoquinoline.4.carboxylate.ME	Caffeic.acid.2tms.1ME	X3.7.11.15.Tetramethyl.2.hexadecen.1.ol	FA18.2.ME	FA18.3.ME	FA18.1.ME	X3.5.Dimethoxy.4.hydroxycinnamic.ME.1tms	X2.OH.C16.0.1ME.1tms	FA18.0.1ME	Octadecanol.1tms	X6.hydroxy.1H.indole.3.carboxylate.ME.2tms
P100	0.826243499	0.917369216	0.923807963	0.878587096	0.823586957	13.34698464	0.236864863	1.051246729	1.127737352	2.590062351	1.370934703
P112	0.718799864	1.417386553	0.884845688	0.918434738	0.815870478	0.654847802	0.639600838	1.342449771	1.233807147	2.898321373	2.245804146
P113	0.735398452	0.569726738	0.720778897	0.814974405	0.743311769	0.012509921	0.010248209	1.534682411	1.211051702	2.323679809	0.721867544
P115	0.81820591	0.409789858	0.914331062	0.937365932	0.724994297	NA	0.001879669	1.094975905	1.256818837	2.482408237	0.344506927
P116	1.436968223	1.090714545	0.91772431	0.974061302	0.921339665	0.761778511	0.737122989	0.845005913	1.293391877	2.288853009	0.774772425
P150	1.092214037	1.562808724	1.126668601	0.961271276	1.097417571	1.022018084	0.41201657	1.341878022	1.314842868	3.553173309	1.422363439
P151	1.334137849	0.569812598	1.023631822	0.888223405	0.927490279	NA	1.929592291	1.219159899	1.15265388	1.55327451	0.923045
P152	0.530896615	0.996159181	0.937499265	0.986020255	1.070913622	0.064330122	0.925741777	1.486014676	1.530707786	1.771408701	2.074431826
P156	0.780291148	0.638659188	0.571747739	0.642871111	1.543015633	NA	0.076782366	1.311017797	1.30283945	3.049436682	0.668637963
P158	0.903494636	1.1972213	0.804935027	0.882157447	0.95401763	2.826751078	0.807026062	1.192094469	1.118409695	0.914487736	1.00211806
P159	0.385419942	0.024826203	0.780629921	0.617438225	0.674053594	NA	0.000955892	1.169071394	1.131708021	1.586708374	0.071994992
P161	0.766712449	0.587747574	0.970403421	0.762712124	1.814536787	NA	0.211114848	1.131769808	1.195388865	2.451723647	0.584195064
P175	1.986147748	2.38545745	1.016459562	0.995021969	0.959987018	NA	90.81995366	1.170019701	1.146274623	1.304043232	1.305204713
P181	0.39413003	0.070176304	1.248275248	0.62818202	NA	NA	3.022719157	1.324350956	1.767063171	1.847857215	0.087102376
P184	1.185769962	1.323617057	0.922509611	0.84570676	0.969979881	0.082719231	0.653609411	1.130273002	1.203725653	3.504170372	0.883913747
P199	1.966511831	2.365683715	1.445099235	1.168340163	1.375868987	1.379143345	1.571069977	1.765134151	1.331842886	3.152146423	2.57451888
P200	1.071481844	0.208307592	1.011660798	0.922887073	0.79700359	NA	0.001191509	1.81283369	1.171163977	1.417967628	0.377211323
P201	1.085095276	0.120168699	0.895697931	0.884612301	0.779091233	0.812418952	0.005884631	1.589626238	1.205101408	1.898008139	1.31542255
P209	1.007419428	0.803455324	0.999477428	0.970749656	0.872075267	0.887468309	1.46953999	1.134211476	1.08393769	3.851526068	0.8693656
P211	0.561582729	0.575105919	0.831510068	0.76913895	0.836545094	0.854521065	0.011061258	1.679841873	1.296138023	5.222992618	0.941621084
P230	0.756109009	1.137852457	0.747505418	0.786255084	1.055278527	1.05236586	1.187133809	1.121159343	1.112735687	2.884281676	1.529751412
P246	1.134376076	1.169998458	0.868238285	0.80665579	0.872451616	0.391064549	0.166036926	1.104383828	1.164547419	3.735846112	1.093226964
P258	1.328176101	0.902753211	1.236809603	0.836963348	0.981684576	13.04469454	0.001743708	1.709721918	1.262088172	2.327799843	1.639965314
P273	0.471587168	0.475871674	0.912094133	0.826030604	0.739563057	NA	0.001353686	1.628028202	1.047843223	3.018767565	0.668845549
P28	1.108373216	1.318641686	1.051656914	0.886255768	0.806337913	0.069957773	0.888069331	1.865608566	1.430708714	4.346404193	1.610397387
P281	1.327197243	2.121531855	1.241564235	1.055339837	0.982074935	0.055093307	0.489499029	1.161338882	1.501356096	4.648921524	0.637906393
P284	0.705297247	0.140261668	0.677884222	0.733270551	0.798776837	NA	0.002302412	1.249468431	1.301611134	2.096681278	0.26886035
P287	0.662101445	0.370918226	1.114270062	0.879165407	0.963036105	NA	0.002773086	1.564800805	1.128072538	1.615461512	0.473860331
P289	0.714395306	0.491132283	0.766914137	0.737490654	0.738330996	NA	0.027797984	1.379570564	1.452627193	3.471006232	0.726631927
P291	0.340408386	0.598852942	0.923165405	0.874533123	0.840794379	NA	0.001157497	1.521620372	1.402649722	2.707592574	0.623976839
P3	1.480261839	1.068409256	0.906659909	0.808590022	0.883536755	0.027942076	0.239287691	1.113044892	1.016630733	4.098121577	0.992577226
P302	0.622201027	0.641439988	0.860277657	0.886636847	1.023788172	1.175869905	1.063396035	1.230362808	1.057645828	1.259361717	0.904090385
P34	0.720341344	0.743186197	0.964077232	0.87534951	0.962427387	0.014349552	0.141796112	1.399001073	1.184390693	1.041587858	1.206558734
P35	0.994556175	1.38981732	0.6267382	0.814151912	0.800351225	0.055987587	0.746369967	0.831457037	0.762313616	2.030443271	0.896879172
P4	0.383599771	0.431187774	0.843589227	0.753280581	0.805246071	0.018860279	0.000692508	1.415468571	1.274315921	0.952242522	0.80279628
P46	0.571210389	0.058881502	0.72794491	0.935047061	1.086085391	NA	0.004485882	1.392769582	1.272647343	2.407776083	0.307867469
P47	0.527354625	0.994973428	1.08031347	0.699030046	NA	1.04462636	0.333626207	1.833026858	1.299163856	3.186850511	1.455338661
P54	0.94804913	0.888023099	1.009332275	0.783220765	0.831540565	NA	0.034766415	1.491694774	1.290653868	2.685770021	1.098839641
P56	2.208716156	1.449191759	1.062858569	0.904598201	0.998021446	1.460183758	1.010599338	1.177743437	1.24412529	2.338558463	1.335581498
P72	1.047115023	1.484909475	0.831106931	0.91122745	0.943795338	NA	0.095815332	1.348758101	1.402145136	5.269453899	1.328165215
P73	0.82934198	0.790479956	1.057807798	0.800417171	0.924037203	NA	7.862401987	1.155208765	0.813077634	1.421243637	1.871283383
P79	0.971379208	1.383405432	0.78078161	0.886834068	0.873300081	0.692042025	0.201380774	1.28666267	1.151482842	2.545801958	1.148293254
P8	1.033095791	1.089073097	0.94907528	0.917414447	NA	0.931515527	0.974601259	1.482170193	1.080315343	1.966363712	0.896073301
P85	0.763710257	0.710774823	0.800250835	0.767081271	0.917330171	0.026303595	0.08842252	1.194387366	1.179360383	1.501366851	0.566097472
P91	0.934721359	0.823523975	0.924352038	0.782239301	0.866996379	0.861047493	0.046650724	0.960586925	1.273441646	2.95921968	1.112931641
P99	1.344362521	1.233792978	0.883310061	0.718813341	0.813355783	0.042688945	0.260475577	1.811200948	1.3433079	4.202430901	1.871274321

	Sinapinate.trans.2tms	DCA16.0.2ME	w.OH.FA16.0.1ME.1tms	FA20.2.ME	FA20.1.1ME	FA20.0.1ME	Eicosanol.1tms	X10.16.OH.FA16.0.ME.2tms
P100	NA	1.132100766	1.331431762	0.827778756	0.935397609	4.274500294	7.914779266	1.178135716
P112	2.006751411	1.535751348	1.839683482	0.98696149	1.271029733	3.821240417	2.45480108	2.17060944
P113	NA	1.173501208	1.558664422	0.739354548	0.817680341	3.233059566	3.158448216	1.262514929
P115	NA	1.882316067	1.996138928	0.979870588	1.221423174	6.491502609	4.520131246	1.508411361
P116	1.317735583	1.22510124	1.260673678	1.030504172	1.144559776	3.198513927	2.297442868	1.331116935
P150	0.6096832	1.163524579	1.371317752	0.931687602	0.897389016	3.589717738	3.362545481	1.012780911
P151	NA	0.932095141	1.093900524	0.75299105	1.018055949	3.869890411	3.446350545	0.869306268
P152	NA	0.844161445	0.937240671	0.912883766	1.134903244	2.165789824	3.800313338	1.019839291
P156	NA	0.830112804	0.808705445	0.484887038	0.711478278	3.455357516	7.026655381	1.043060935
P158	0.763760853	1.143317323	1.074893037	0.895886461	1.048130877	2.383112145	2.294096727	1.073924678
P159	0.050214921	1.296812848	1.284872627	0.544259981	0.895493347	2.508892024	4.794820302	1.053392666
P161	NA	1.291046722	1.362740357	0.690807692	0.850899944	3.422134082	4.746108115	1.093030892
P175	NA	1.350323918	1.494253447	1.062681196	1.198658149	1.656073734	2.969489686	1.370837321
P181	NA	1.593990243	1.710245168	0.475204665	0.525848324	4.016665287	1.890956259	1.417957601
P184	0.249760899	1.091881884	1.397702567	1.040980454	1.256292323	5.596171599	6.597560579	1.131220522
P199	NA	1.317434797	1.102300135	0.976329504	1.077791733	3.754558253	2.8761209	1.322577354
P200	NA	2.119159845	1.871158512	0.857685688	0.852269136	1.226278109	1.020407187	2.966417531
P201	NA	1.268703579	1.509017807	0.706656818	0.925651099	2.504373719	3.75902868	1.495493619
P209	NA	0.980153576	1.242952388	0.929384999	1.022367303	5.474981417	10.73593367	0.907027665
P211	NA	1.195764528	1.585713684	0.861347522	1.176785024	7.270812658	7.61577296	1.143983228
P230	0.195881908	1.095424665	1.257219759	0.672706709	0.706576948	4.541928377	2.611762582	1.305886752
P246	NA	1.013900869	1.094750269	0.778852392	0.908100224	3.990802284	12.93004049	1.117143533
P258	NA	1.238328966	1.02521943	0.895526177	0.899953747	2.267426646	4.946385566	0.978101635
P273	NA	1.162304081	1.233465552	0.667884442	0.672597523	3.706224801	4.047703066	1.291793724
P28	1.949860108	1.424636318	1.851272174	0.588873404	0.83563099	5.124195476	11.43378611	1.709709777
P281	0.89241031	1.089373858	1.56032426	1.17659756	1.006016961	4.746062993	3.635406063	1.423290422
P284	NA	1.508681195	1.302037966	0.587288039	0.698768835	2.338253666	5.57704749	1.319454323
P287	NA	1.070100252	1.106298087	0.901030279	0.885495454	2.523689957	3.600300906	0.879942271
P289	NA	1.35644073	1.413949842	0.502225946	1.030806884	2.003725731	6.692842631	1.40604157
P291	NA	1.247724	1.733377107	0.940535616	0.995543193	4.22827117	6.681965184	1.445602552
P3	NA	1.079072545	1.202605274	0.656338866	0.724446761	3.653461706	3.895999999	1.207537555
P302	1.868074728	1.064839287	1.123204309	0.77185428	0.713159711	2.230786194	1.289430221	0.948538545
P34	NA	0.699320956	0.816002178	0.875829103	1.159519134	2.876933123	2.374082288	1.109379289
P35	0.22930843	1.183272071	1.380875324	0.891127872	0.914512033	3.89426156	3.542717474	1.340359238
P4	NA	1.122359023	1.12489966	0.625562442	0.917244652	1.517272965	1.463809866	1.109069172
P46	NA	0.958695139	0.711295247	0.730922888	0.564893209	3.18749134	6.011656199	0.919755838
P47	0.398681778	0.684841375	0.687100237	0.48216814	0.599084378	2.312422131	7.404362077	1.073438247
P54	NA	1.257970292	1.313322055	0.673401068	0.813823743	2.833133001	4.190922049	1.356425153
P56	0.181842046	1.697954216	1.71516387	0.934595846	0.965446006	3.576152902	2.794507358	1.438090786
P72	NA	1.015207985	1.358323977	0.791019521	1.232202806	5.042540287	10.63196976	0.9640696
P73	NA	0.827456007	0.778682485	0.732335825	0.665592305	1.51648136	6.34087377	0.657889047
P79	0.150397016	1.054725638	1.022047788	0.840144964	0.861892825	3.16758412	2.178678561	1.293695707
P8	2.443969288	0.949690465	1.058086966	0.93325744	1.028214638	2.180097403	2.610903403	1.001791816
P85	NA	1.732207462	1.824245153	0.878151669	0.90735083	2.229231393	2.754829973	1.586085699
P91	NA	1.228104369	1.226712728	0.75031234	0.693270606	5.139743583	6.702963455	0.88208503
P99	0.103021962	1.686747335	2.28299088	0.598174165	0.665187588	3.59852014	9.195868524	2.20483053

	DCA18.0.2ME	FA22.1.ME	FA22.0.1ME	Docosanol.1tms	Monopalmitin.2tms	X.P..FA23.1	FA23.0.1ME	FA24.0.1ME	Tetracosanol.1tms	Monostearin.1tms	X2.OH.FA23.0.1ME.1tms
P100	1.198199733	1.099282022	2.921399371	3.410202496	0.50046298	1.089909581	1.59475113	1.450086519	1.72324967	0.586581443	1.200560605
P112	1.537606293	1.218563196	3.174983133	1.515314439	1.682126514	1.232095698	1.533280894	1.554155567	1.572202866	1.515090708	1.301872174
P113	1.015228878	1.181619339	2.335544179	2.906655186	0.666192565	0.929378241	1.386421318	1.369248944	2.151388806	0.757541254	1.222834723
P115	1.612503079	0.941288712	5.26809838	3.593779453	0.525031803	0.839670423	1.163774124	1.44433033	1.884482356	0.708274207	0.822824731
P116	1.263026455	4.3635696	2.614608154	2.745789722	0.819741296	1.035139778	1.19505931	1.272991448	2.310383193	0.841749876	0.905137886
P150	1.272926151	1.446553379	2.462344278	1.471207864	1.954542802	1.371695609	1.640781028	1.518894113	1.435019149	2.026629244	1.41578084
P151	1.049046907	0.855271636	3.070662307	3.650260607	2.095680792	1.329216066	1.486385743	1.223724736	1.509273463	2.010004742	1.331551149
P152	1.061840396	2.019098262	2.748568143	4.353726938	0.981582429	1.224523462	1.93838697	1.601011696	2.356486916	0.89811414	1.747545036
P156	0.996738237	1.163767994	3.740199027	7.419254918	0.766824513	1.462088866	3.068622528	1.876424827	2.401364706	0.931383405	1.89505083
P158	1.029361375	1.141972717	2.168795194	2.290391639	1.440157565	1.214753572	1.405268911	1.264669797	1.648646312	1.524888892	1.117543709
P159	0.986370937	1.352105033	1.367210512	1.446019995	0.58083763	0.648840931	0.825846679	0.939015113	1.19297705	0.69258689	0.855968726
P161	1.26305836	1.074222136	2.519658666	5.101626887	1.410604371	1.462425996	1.932674129	1.62704957	2.6706344	1.592329275	1.480410993
P175	1.336848144	0.937434018	1.380437896	3.596433345	0.662195424	0.852497538	0.894945243	1.22812919	2.29509598	0.614949028	1.014300979
P181	1.624122067	0.884492907	3.400779417	2.943980557	2.093592573	0.660262556	1.796300728	1.783939108	1.814869434	2.058148177	1.0513567
P184	1.165677428	1.059372846	3.502679635	2.849417691	1.976986632	1.170013351	1.346302046	1.29469729	1.850424256	2.274583925	0.915778337
P199	1.396444393	0.920152888	2.621073311	3.263724104	1.454370529	1.622665847	1.690091797	1.624709268	1.947056411	1.251178275	1.374355179
P200	1.398211441	0.843139076	1.553561748	1.300046248	1.010292457	0.69400411	1.013702214	1.356446759	1.673893008	0.991334406	1.354570253
P201	0.95579641	1.103803312	2.929284809	2.56984641	1.051724766	1.191585133	1.8522786	1.505995465	1.771198906	1.304755132	1.722502269
P209	1.083807796	1.456416455	3.089112676	7.757997181	1.880147818	1.190555245	1.324392917	1.281448587	2.453461299	1.811026893	1.214599366
P211	1.250894443	1.511609327	4.74229669	2.044047345	2.748099474	1.179588502	1.699488507	1.346658036	1.808722305	2.583249991	1.458431236
P230	1.235411455	0.849816726	3.68402652	3.243755559	1.353191083	1.00828627	1.528855585	1.313793782	1.46586354	1.491779747	1.179394323
P246	1.18685607	2.015198064	4.122502963	5.385295916	0.373533427	1.175541695	1.596534489	1.370939639	2.474105924	0.444542262	1.350035263
P258	1.098736226	1.22940586	3.030254651	4.156002241	1.326444234	1.652293331	2.278782219	1.729410298	2.53757556	1.255918546	1.790111792
P273	0.952257431	0.987680284	3.16798478	3.301904959	1.967190576	0.865564286	1.472129888	1.589532576	1.970980676	1.938682833	1.537163631
P28	1.858344145	1.504029583	4.386567346	2.956519696	1.85693646	1.591551804	2.660601048	1.685725069	1.862298705	1.837859177	2.232781075
P281	1.183668411	0.924821393	3.044163262	4.380890471	0.806034469	0.77941229	0.934813518	1.483454932	2.092414529	0.807317081	0.915995014
P284	1.218972192	0.759008548	2.154620082	2.172946123	0.910251731	0.78834958	1.370883107	1.278875079	1.452299474	0.951265431	1.206965777
P287	1.049050052	0.883324194	2.026442082	4.431221318	2.77881775	0.884760264	1.05288799	1.401127909	2.386764788	2.453872476	1.023095283
P289	1.281793565	0.993493796	2.343863738	4.002067887	2.209593351	0.865040988	1.647009009	1.635923364	2.311672758	2.343413805	1.415057765
P291	1.30402227	0.998454512	3.092672997	3.41095397	1.944984142	0.663999864	1.165861918	1.429443346	2.076637758	2.206328305	1.135320655
P3	1.155974066	1.282292015	2.498976753	3.834168221	0.895896287	1.267222484	1.378834384	1.303514753	1.878527921	0.908688569	1.127312653
P302	1.032298599	1.394866046	1.475535362	2.088085611	2.067481005	1.002863491	1.179303743	1.153677287	1.486973668	2.225293366	1.129655171
P34	0.914364236	0.922759464	2.60253381	4.001138767	1.396704734	1.016021767	1.366913551	1.218657724	1.697814441	1.101308248	1.476675179
P35	1.112229936	0.526620305	2.551788149	2.152933956	0.651714309	1.000514086	0.985074105	1.101419751	1.269401133	0.656976469	0.819510669
P4	1.038331939	0.880655795	1.784437725	1.803162983	1.179221748	0.9316083	1.199948057	1.34988474	1.787483954	1.256405342	1.251858226
P46	1.07654476	1.132683372	2.563939812	5.249207674	2.004053634	1.524936554	2.437745211	1.635787433	2.024110145	1.882976615	1.80003772
P47	1.063547647	0.979975005	1.816798192	4.143173139	0.41855742	1.066425101	1.645065785	1.292710062	2.200210276	NA	1.979882981
P54	0.890960244	0.993175723	2.566187171	3.584812412	0.820031865	1.135208763	1.890729046	1.589452708	2.294379008	0.973174044	1.5457693
P56	1.26882004	1.061829772	2.913357021	3.805196786	1.64727949	1.214635564	1.367741123	1.443954176	2.265044597	1.757700488	1.147621567
P72	1.184672498	1.233067259	5.087679984	3.628420343	0.897577024	1.454756316	2.037790174	1.405179277	2.138891717	0.844814647	1.587084409
P73	0.864647056	0.611288205	1.917319848	4.396742361	1.374027495	0.992011865	1.263125118	1.169158229	1.820227256	1.805637073	1.265717684
P79	0.927274093	1.081949343	2.394407071	3.03441598	0.882531139	1.041169989	1.621801886	1.425216649	1.626525775	0.925804353	1.319698004
P8	1.023010061	0.931428716	2.094352567	3.314393698	0.896445533	1.137504594	1.422241958	1.327542955	1.640679756	0.970422149	1.352131474
P85	1.403372656	1.143211938	2.307467618	3.401849971	0.666735677	0.925655202	1.289747888	1.352131731	1.926667766	0.724695443	1.234897557
P91	1.032675617	0.824629018	3.097089491	7.324587353	1.213595226	1.189565719	1.841192565	1.514828085	3.670485487	1.093453887	1.099582324
P99	1.644185743	0.983203484	4.014682517	3.871860358	0.814983978	1.236748257	2.393628147	1.762295125	2.350193973	0.920147586	2.195019453

Continuation of the Suppl. Table 5: Metabolite data for wounded leaves, first column describes the individual, further columns show individual compounds.

	FA25.1.1ME	FA25.0.1ME	Alpha.Tocospiro.A	wOH.FA22.0.ME.1tms	X2.OH.FA24.1.ME.1tms	X2.OH.FA24.0.ME.1tms	FA26.0.1ME	Hexacosanol.1tms	X2.OH.FA25.0.ME.1tms	X3.5.7.Trihydroxy.2..4.hydroxyphenyl..4H.chro	Kaempferol.4tms	X2OH.FA26.0.ME.1tms	Stigmasta.3.5.diene	FA28.0.ME	Octacosanol.1tms	Cholesterol.1tms	Quercetin.5tms	Campesterol	Campesterol.1tms	Beta.Sitosterol.1ME	Stigmasterol.TMS	Stigmast.5.ene.1tms	Stigmastanol.1tms	Isofucosterol.1tms	FA32.0.ME	prop16	c16toc18	sum	prop14	prop18	prop20	prop22	prop24	prop26
P100	1.068690753	1.383228563	0.859628175	26.73641188	0.890504025	1.256375388	1.427610685	1.264440957	1.236486113	0.871543227	0.057438035	1.324042775	1.06283926	1.563801342	0.963396636	0.962313859	NA	0.894048719	1.115611933	0.953033904	NA	1.127570551	1.471851301	0.799277798	1.471501668	0.3198655	0.4702975	3.8081622	0.4922855	0.2465589	0.698877882	0.664309783	0.57678317	0.567564243
P112	1.018327956	1.248341174	0.772702374	6.887846098	1.05847385	1.139961317	1.454685022	1.15579201	1.062501491	0.874967389	2.595044831	1.138641236	0.969929997	1.405809553	1.005583161	0.991052606	0.437290233	NA	1.196270582	1.019295062	NA	1.037307127	1.06940187	1.248606611	1.211552484	0.3128952	0.4553821	4.2181651	0.4851363	0.5414263	0.618319812	0.490787351	0.576321781	0.534748444
P113	0.827830914	1.117966037	0.884355856	7.525256303	0.978046374	1.342452222	1.181533898	1.499112044	1.252813057	0.057206145	0.004775826	1.284767166	0.83574881	1.332038476	1.639466845	0.81687124	NA	1.648376569	0.951368815	0.936610584	NA	0.913425029	1.099120599	0.910532383	1.250017634	0.4713011	0.8914359	4.3950915	0.4443286	0.4238645	0.520757522	0.574659926	0.589340722	0.47764039
P115	0.974558275	1.132926785	0.53406427	7.050606908	1.058697341	1.139762116	1.125548843	1.441479876	0.833278737	0.041750573	0.000192423	1.038480092	0.665768762	1.372471185	1.127322936	0.802265718	0.0000053	NA	0.889070497	0.770344833	NA	0.705152469	0.821984122	0.702493855	0.83773074	0.4773321	0.9132611	4.7494952	0.3133920	0.3545011	0.557084175	0.656007248	0.566597641	0.561148512
P116	0.901154776	1.075649815	0.854564604	4.530396706	0.887158297	0.92554645	1.24043427	1.143639343	0.865746105	1.101574734	0.485646037	0.920258357	0.865927353	1.371707696	1.130005591	0.939098402	0.277979081	NA	1.021751771	0.941837012	NA	0.979185684	1.119318579	0.435346202	0.866449802	0.5999284	1.4995529	5.7211091	0.4948708	0.4990635	0.455549655	0.543056926	0.668896386	0.502998215
P150	1.857614777	1.645166297	1.213688884	16.47568778	1.222596205	1.320573941	1.394503371	1.45708956	1.176028899	1.20075508	0.483736853	1.154870588	0.950558647	1.156701188	1.416828868	1.23122506	NA	NA	1.229380739	1.004075501	NA	1.073017229	1.448724609	0.405691874	1.265881447	0.4661316	0.8731210	6.6555237	0.2614441	0.5137822	0.695638615	0.506226065	0.496184374	0.507004495
P151	1.125869579	1.359332718	1.156109785	6.775809435	0.943870233	1.242375073	1.245050143	0.870406697	1.258893813	0.180552572	0.197535593	1.198311397	1.162219371	1.079190191	0.883625604	0.860499039	0.190049258	NA	1.170092016	1.196924746	NA	1.1180077	1.284597604	1.953773423	1.016958959	0.4485213	0.8133069	2.8165634	0.2270518	0.3106781	0.485633279	0.707478729	0.634233746	0.496231852
P152	1.001938667	1.481775925	0.94813602	5.540233714	1.239184081	1.500254881	1.648557243	1.256359344	1.635550715	0.751933166	15.06646121	1.516286616	1.263366174	1.448815335	1.09261197	0.94614134	2.678796951	1.108620205	1.102274037	1.288023229	NA	1.277567923	1.454423214	1.45584235	1.407822422	0.6652483	1.9872894	5.2917105	0.6292828	0.3179284	0.466065068	0.648820892	0.652252199	0.534855124
P156	1.029581811	1.961606319	1.23045683	36.79480668	1.000344453	1.578314613	1.990678147	1.743211459	1.966350026	0.309902915	0.309839166	1.78003171	1.454409528	2.275476414	1.358852803	1.119775795	NA	NA	1.336566977	1.403510408	NA	1.359610147	1.676369684	2.74112492	1.597447104	0.3862641	0.6293654	4.9686469	0.3248515	0.3026408	0.486411395	0.755477272	0.579399343	0.561952078
P158	1.150184714	1.166766837	0.795389009	11.45554964	0.957807692	1.1455952	1.330933409	1.001575232	1.075456815	1.164483106	0.867401546	1.102870681	0.931207468	1.405736742	1.087591303	0.941688274	0.554196963	NA	1.08026961	0.964645996	NA	1.016980466	1.269910586	0.815779812	1.044200926	0.6219375	1.6450658	2.4188802	0.4411977	0.2850128	0.50040409	0.581459653	0.622078677	0.479413783
P159	0.702107255	0.817475739	0.43414291	7.301055918	0.8614367	1.054703955	0.961654326	1.084547357	0.846741728	0.00286423	0.0000347	1.019707366	0.52158928	1.006930072	1.024832514	0.863957044	NA	1.059059996	0.776483682	0.79923084	0.216785206	0.765620357	0.794704468	1.022782134	0.943256676	0.4283066	0.7491895	2.7754536	0.4925696	0.2486407	0.768297228	0.547943014	0.523804288	0.514154597
P161	0.940536949	1.39717948	0.933121258	13.80370048	0.712566972	1.14954979	1.505293468	0.970256711	1.218771339	0.01873806	NA	1.101978775	1.061761186	1.813579819	0.858972665	0.971331511	2.492605038	NA	1.102763496	1.168022524	NA	1.025641213	1.2388084	1.261883044	1.645711934	0.3589900	0.5600381	3.8247824	0.4806855	0.3406197	0.481949211	0.656389009	0.733511198	0.530418286
P175	1.094546633	1.115397296	0.748521102	3.528898177	1.169938581	1.199880882	1.213944179	1.559256253	1.098194423	87.54713688	170.1789043	1.346626458	1.15417363	1.217651333	1.410848795	1.121390585	6.390581979	NA	0.981289407	0.929148531	NA	0.900865451	1.068197965	0.759453187	1.020369154	0.5453576	1.1995310	2.8682836	0.4427182	0.3051440	0.452257767	0.610441389	0.595455693	0.524983537
P181	0.390031801	1.141087745	0.490976878	3.155800109	0.715657732	1.203826422	1.819501849	1.066466762	1.111771929	0.053542922	0.011516827	1.26120422	0.955190947	2.083002169	1.041739666	1.043220383	NA	5.217973061	1.160683783	0.948766222	NA	1.099280304	1.150263351	0.714746441	1.458819474	0.5672418	1.3107595	4.2699537	0.4388085	0.4942362	0.391102579	0.618632771	0.629870765	0.505864487
P184	0.966816555	0.978522392	0.814202282	51.04965532	1.03223727	1.054719931	1.154872418	0.97213834	0.920829328	1.103909525	0.451903631	1.03614086	0.835138545	1.256871852	0.915975749	1.047173079	0.408557477	NA	1.038048991	0.872431738	NA	0.914669922	0.688315094	0.994014005	0.870548287	0.2207334	0.2832579	4.4967543	0.6062923	0.3468881	0.698377872	0.606279471	0.655583071	0.514872669
P199	1.284866068	1.576301129	1.352342205	8.44412535	1.409599578	1.486302778	1.468496382	1.40680001	1.38802738	0.698075274	2.808554912	1.315351944	1.438901929	1.265654123	1.363218734	1.42711877	NA	1.217126268	1.430444933	1.438945496	NA	1.427754335	1.795767791	4.450489331	1.492620653	0.4454302	0.8031997	5.6839497	0.1628848	0.5228942	0.468435424	0.626340736	0.580542566	0.507866603
P200	0.77329472	1.1530388	0.498004448	1.138016731	1.508460698	1.645039582	1.278859116	1.294245471	1.369922568	0.00524062	0.000821376	1.716102128	0.794307572	1.279970734	1.520894277	1.117317101	NA	0.344322959	1.095628406	0.920514747	NA	0.990009816	1.25372207	0.598346079	1.413452175	0.5236648	1.0993620	2.9768274	0.4334696	0.5815216	0.439744738	0.437146201	0.563953811	0.459744662
P201	0.843312391	1.385905535	0.700396187	8.787904147	0.891967247	1.311084361	1.681747849	1.334333496	1.564902613	0.007826645	0.0000448	1.260210155	0.760403218	1.762604652	1.123390371	0.729117248	0.000318132	NA	0.961626559	1.129760427	NA	1.041817805	1.368356764	1.9100135	1.369142131	0.4100687	0.6951127	3.2173378	0.4865506	0.3355127	0.593948945	0.591987925	0.570336637	0.542914326
P209	0.993492617	1.216039726	1.075978349	24.86964092	1.10710529	1.245772109	1.301739399	1.095758709	1.171391244	0.885454153	1.062062086	1.177523347	1.042856967	1.46438794	1.331959473	1.222715588	NA	NA	1.216530194	0.937249916	0.909250864	1.092349525	1.31719771	0.902717569	1.195871936	0.4048581	0.6802717	6.4716103	0.3073004	0.2640299	0.580511183	0.759734488	0.691267742	0.45135334
P211	1.680181223	1.400986256	0.894392795	67.43186965	1.03807466	1.437708086	1.224906283	1.304856875	1.46412586	0.134004937	0.058154532	1.373948922	1.003541023	1.276426482	1.411349968	0.851355875	NA	NA	0.894118879	1.138785016	NA	0.941086906	1.399565957	1.477987162	1.212789043	0.1265153	0.1448398	5.9794899	0.6918395	0.4068142	0.78839696	0.530539724	0.580914183	0.480396726
P230	0.71984186	1.131337617	0.927305426	13.47127818	0.817390382	1.239626026	1.099138492	1.215334476	1.080385447	1.251933962	1.266591422	1.117247925	0.839833551	1.241713953	1.308234919	0.922789622	1.611964944	NA	0.98250744	0.79532996	NA	1.009140876	1.003267253	0.974232971	0.981154988	0.3689805	0.5847373	4.5708288	0.4619197	0.5247922	0.44603441	0.688751148	0.546719612	0.481593444
P246	0.910289965	1.310731631	0.906020829	164.8917014	1.04031382	1.092707653	1.325936791	1.154177204	1.166639183	0.770653034	0.050046481	1.093858893	0.861149973	1.498128891	1.188580015	0.881080029	NA	NA	0.916399059	1.022579981	NA	0.96302654	1.027946967	1.118399221	1.26071114	0.3564237	0.5538173	5.8048223	0.5396485	0.2241612	0.70596795	0.685204297	0.681894394	0.492657623
P258	1.509949639	1.795977402	0.879516051	28.27964666	1.26694114	1.392674869	1.61109118	1.544133741	1.504645542	0.040034651	0.004081988	1.532138253	0.87293401	1.845565658	1.318147579	1.200374413	NA	NA	1.139999443	1.033836844	NA	1.126910137	1.25132686	1.54556961	1.263964667	0.4289963	0.7513022	4.0766811	0.4606596	0.3200083	0.543416263	0.620893992	0.621694337	0.539476581
P273	0.834586905	1.2944802	0.702492736	25.34241753	1.091040749	1.362678548	1.504889779	1.552002951	1.187642877	0.287692211	0.038335394	1.466738767	0.690157685	1.43563019	1.393444647	0.894523527	0.000100716	0.564400313	0.98884989	0.880568816	NA	1.010761335	1.321652314	0.933785586	1.078100799	0.3984222	0.6622956	5.0180842	0.4105047	0.4271959	0.550737271	0.626204547	0.559463479	0.526915825
P28	0.651205796	1.59369481	1.158485799	56.06870219	1.02810705	1.734155538	1.956054482	0.890063731	1.793846292	1.231124373	0.092813404	1.566198943	1.329250353	2.059028447	0.888494183	0.982362848	0.169073525	NA	1.244500937	1.26899621	NA	1.10998184	1.373933367	5.727892864	2.360057978	0.3853755	0.6270097	7.0716417	0.4015622	0.2754342	0.79454782	0.613536234	0.676618268	0.500441242
P281	0.730985099	1.086554591	0.491179767	8.161371744	1.167827042	1.285995929	1.326984539	0.797616574	0.937913619	1.566574623	0.329034411	1.431213845	0.857853	1.004022523	0.668208447	0.679644191	NA	1.53586336	0.760281101	0.775472531	NA	0.816142531	0.94854379	0.571162982	0.571612817	0.4530717	0.8283932	8.5000568	0.1975897	0.5611706	0.453501944	0.676762561	0.724011076	0.544141738
P284	0.6116432	1.152486819	0.66797436	9.491169729	0.88516294	1.206737565	1.25999774	1.496812386	1.012067123	0.002404717	NA	1.246587997	0.78641779	1.520567678	1.484568017	0.80649154	NA	NA	1.011294484	1.094815169	NA	0.967344539	1.080823124	1.246337395	1.294067198	0.3612985	0.5656767	3.2827250	0.5373398	0.2732284	0.719619624	0.599392804	0.492453166	0.502053473
P287	0.788463422	1.102039521	0.585956691	5.512785434	1.066776749	1.22131356	1.01704564	1.643388446	1.02037832	0.208551049	0.009407622	1.107391186	0.75863422	1.232595842	1.422742582	0.863992966	NA	NA	0.917606177	0.873790996	NA	0.934272957	1.201796426	0.656292447	0.872375274	0.5479656	1.2122214	3.5737586	0.3186136	0.3097268	0.4482713	0.649931116	0.592226809	0.535981154
P289	0.988776415	1.498257635	0.719020594	33.53723701	0.75013417	1.507100405	1.75624699	0.916390847	1.456165858	0.010759592	0.000427305	1.370989958	0.840920308	1.711618077	0.950887339	0.850340977	NA	2.338546642	1.029125197	0.969296491	NA	0.965031171	1.3155118	0.942162601	1.413093374	0.4172156	0.7159006	5.9559019	0.3773428	0.3415051	0.625796973	0.633866374	0.716117475	0.490762894
P291	0.697233018	1.172536645	0.663918384	11.26912096	0.960750896	1.373222849	1.724166021	1.108648019	1.104742881	0.070394599	0.006903214	1.484053583	0.706782168	1.577265453	0.804349852	0.777197381	NA	0.707935122	0.787672889	0.828163726	0.705102254	0.846642167	1.408309729	0.599107916	1.003217111	0.3655721	0.5762234	4.2677707	0.4775103	0.2883620	0.662044854	0.621575755	0.651947079	0.579534372
P3	0.895884884	1.055861397	0.835654409	10.86874359	1.030520137	1.162538876	1.408678581	0.910886618	1.060768557	0.749731975	0.367927335	1.185206526	1.058462637	1.549307362	0.865819142	0.937689569	0.018032433	NA	1.11275119	1.094186095	NA	1.048867725	1.867852377	1.333702659	1.287505748	0.2849289	0.3984623	5.7310687	0.6540462	0.5126418	0.503999381	0.67116614	0.673448817	0.512682875
P302	0.703391513	0.96058496	0.774338022	0.747457781	0.998937563	1.134633671	1.116045768	1.175511616	1.034230242	1.087650383	0.85487749	1.093855205	0.990332157	1.200527225	1.445176648	1.214962895	1.142805424	0.840646058	1.15575328	0.943953729	NA	1.002862845	1.24860861	1.761884961	1.101460271	0.4879971	0.9531141	2.4596772	0.6166821	0.4941014	0.381768816	0.584070206	0.558490849	0.448550723
P34	1.294585341	1.207345438	1.186953612	6.089574319	1.042011729	1.10984194	1.110438745	0.608446107	1.366535124	0.35787714	0.210551352	1.156296106	0.829614815	1.106044012	0.637411105	1.088011705	0.198684913	1.228288179	1.256537391	0.888162785	NA	1.198703191	1.399120066	0.738225002	1.191493741	0.5866781	1.4194220	2.5200406	0.5226149	0.3049439	0.372392152	0.702083106	0.736176336	0.488375474
P35	0.713498869	0.834996494	0.727635438	10.46314692	0.764979784	0.791023638	1.054188683	0.799436858	0.729144339	0.92572721	0.648428849	0.746892869	0.789363814	1.113035643	0.810041691	0.708768431	0.298298194	0.867699909	0.831285063	0.780550346	NA	0.761994885	0.895419475	0.627911613	0.899432365	0.4467489	0.8074975	3.6700212	0.2499848	0.3643252	0.622003913	0.629083331	0.613581701	0.496705507
P4	0.71790536	1.149655316	0.629135012	3.830727375	0.923608986	1.284548585	1.311166793	1.274954167	1.256674773	0.037150928	0.005496932	1.355415388	0.851777527	1.251747807	1.240376029	0.862921717	0.000230835	NA	0.915011046	0.916241196	NA	0.968902262	1.208660666	1.325404562	1.283994965	0.4854365	0.9433947	1.8505831	0.5794238	0.3941315	0.448063064	0.502183315	0.583680023	0.506873479
P46	1.328692373	1.880198103	1.480552862	28.61835553	0.895967723	1.259403549	1.557850099	0.869246858	1.804680638	0.003251546	0.000214977	1.5013202	1.111764438	1.566998022	0.758754794	0.886064493	NA	NA	1.343434146	1.363876619	NA	1.350755872	1.504895505	1.081977289	1.231984316	0.4577383	0.8441282	4.4402477	0.4346514	0.2859784	0.533853909	0.721707452	0.699571516	0.533934875
P47	0.89072023	1.517602354	1.18671853	9.930958634	0.925325861	1.723153127	1.533339487	1.269219304	1.843302265	0.557610063	0.716753777	1.804211348	1.020796769	1.375126345	1.055653251	1.311574088	0.012914945	NA	1.038600302	1.178267733	NA	1.08382037	1.262537333	1.626669847	1.238750564	0.2393834	0.3147228	4.1898251	0.6501221	0.3008957	0.641207144	0.65314878	0.634170611	0.545930701
P54	1.009748541	1.52923678	0.908497473	20.01654667	1.120000414	1.343223715	1.613617779	1.266485372	1.433262963	0.652622057	0.182502129	1.456345833	1.148112103	1.582303135	1.326976365	0.926280332	NA	NA	1.06752997	1.14667911	NA	1.12804683	1.404434532	0.997487043	1.215533769	0.4016227	0.6711866	4.4884230	0.4248596	0.3905613	0.53897443	0.609745823	0.644332039	0.48833779
P56	0.993400135	1.19854623	2.915727647	4.192573346	1.045371673	1.100344922	1.598303792	1.233605315	1.050115242	1.338950969	1.200201415	1.095606481	0.968687918	1.482899974	1.190519684	1.038574999	1.901359133	NA	1.19592416	1.048998865	NA	1.214897554	NA	0.595961572	1.001180671	0.4577816	0.8442755	4.3129462	0.5269171	0.4555870	0.423429187	0.626860869	0.647405329	0.508886842
P72	0.887584596	1.39762193	1.081102572	101.3704297	0.965927421	1.302173918	1.230522902	1.159229576	1.380204073	0.349769817	0.034114087	1.278300145	1.059101779	1.688211137	1.12254192	0.967585999	0.000204928	NA	0.979649589	1.138375103	NA	1.08010019	1.285748421	3.199968002	1.919714423	0.2102269	0.2661865	6.6721115	0.5136913	0.3313825	0.745559531	0.629135428	0.64851821	0.508039292
P73	0.731882262	1.147978048	0.889976072	6.33964366	0.950292617	1.11413979	1.470893365	1.061224073	1.210546339	1.443539887	1.954951657	1.170910085	1.134343652	1.23592135	1.165718661	0.827039844	NA	0.853759159	1.017494213	0.962012605	NA	1.12263689	0.910778416	1.962345362	0.89457634	0.5324467	1.1387937	3.0397470	0.4067829	0.1830999	0.590529005	0.707216318	0.631705015	0.476538555
P79	0.90840812	1.291337898	1.243330526	5.281248011	0.893535579	1.262071813	1.188795846	0.847225391	1.261813112	0.866211176	0.041959129	1.234964401	1.159427443	1.12013918	0.99071251	0.795777717	NA	2.042079632	1.007264786	1.177318013	NA	1.014155031	1.346380554	0.790920501	1.139751691	0.3706577	0.5889604	4.0451786	0.4972477	0.5388533	0.417924237	0.651030658	0.657513899	0.460965188
P8	0.984930657	1.294045574	0.875304032	5.139155739	1.126005607	1.264362726	1.466775648	1.052078347	1.327553873	1.059122827	0.854520192	1.325809592	0.96353724	1.637702179	1.119365867	1.057878463	0.546814084	NA	0.971965116	1.000372146	NA	NA	NA	0.961090349	1.107041151	0.3417342	0.5191432	2.9871880	0.5387266	0.4295933	0.440636707	0.668888913	0.609293406	0.484506275
P85	0.741769816	1.22132326	0.871640899	2.941651461	1.038695822	1.343305097	1.37439306	1.307054893	1.245208389	0.6128416	0.444668878	1.238454985	0.855556149	1.179470091	1.194593862	0.881263886	0.005560427	NA	0.953879131	0.914702946	0.593355321	1.013266075	1.281764694	0.944445464	0.999306766	0.4168438	0.7148064	2.5745535	0.4945298	0.3527484	0.447453822	0.638423317	0.595804888	0.522477382
P91	0.914574411	1.437747494	1.082442487	16.54599548	0.87462393	1.075515089	1.364268716	1.289153193	1.155941017	0.388778219	0.012694037	0.973574949	0.964122913	1.340030638	1.25559152	1.172598228	0.002178726	1.514984099	0.971521297	1.046165623	NA	1.036081414	1.116624555	1.382807538	1.01611487	0.4871047	0.9497159	5.7696377	0.3414463	0.3062682	0.47784275	0.666169971	0.740071147	0.50659431
P99	0.813676763	1.774689283	0.973028351	70.73740744	1.047048918	1.667040059	1.915834023	1.359039259	1.820905437	1.25268408	0.108230782	1.534897842	0.972689037	2.572332048	1.314992345	1.039321587	0.005369264	NA	0.99967543	1.039988823	NA	1.064257206	1.570579031	0.847000863	2.470057895	0.3800896	0.6131365	6.7790949	0.4684454	0.3136540	0.703708242	0.622280062	0.633606416	0.50823605

Suppl. Table 6: Metabolite profiling data from roots, first column=individual, gro=genotype (e.g. AA=alpine plant with alpine allele, AF=alpine plant with foothill allele etc.), Adosage=allele dosage of the A allele in the individual, further columns show individual compounds. The data are normalized by internal standard and dry weight of the sample.

Continuation of the Suppl. Table 6: Metabolite data for roots, first column describes the individual, further columns show individual compounds.

	w.OH.FA16.0.1ME.1tms	FA20.2.ME_2295_81_FA_I4	FA20.1.1ME	FA20.0.1ME	Eicosanol.1tms	DCA18.0.2ME	w.OH.FA18.0.1ME.1tms	FA22.0.1ME	Docosanol.1tms	Monopalmitin.2tms_2580_371_MAG_I2	X.P..FA23.1_2602_334_FA	FA23.0.1ME_2627_74_FA_I2	Tricosanol.1tms
P100	0.345110167	0.003526874	0.00091184	0.05530302	0.532961812	0.020347448	0.095857857	0.050768274	0.305641784	0.000559762	0.001484112	0.012122099	0.003246651
P113	0.311327671	0.001648466	0.000538205	0.042489024	0.524738829	0.019004264	0.095355722	0.045282045	0.354255015	0.000416646	0.001335117	0.01047716	0.002315568
P115	0.621286459	0.005371529	0.000653401	0.045597238	0.388624748	0.02783249	0.141250015	0.032711412	0.207414534	0.009212451	0.00143131	0.009300934	0.001954255
P116	0.346238843	0.005148451	0.000758495	0.032241943	0.513306686	0.017685928	0.062810776	0.045938033	0.375118225	0.004674009	0.001530574	0.015716514	0.00355799
P120	0.366390001	0.006282217	0.00076643	0.045196601	0.412735653	0.029917031	0.126747932	0.042685327	0.247366116	0.00624106	0.001830914	0.014280135	0.002689751
P121	0.390217616	0.005867478	0.000349249	0.044812298	0.507836405	0.022836713	0.104418706	0.04652966	0.319304441	0.003946552	0.002312054	0.018007648	0.003921652
P136	0.514562248	0.006429342	0.000472894	0.040039257	0.389127816	0.026815653	0.125785972	0.029105883	0.339400657	0.001197315	0.001572304	0.007591801	0.002328687
P150	0.576107021	0.00659336	0.000558128	0.036622278	0.226500456	0.025292604	0.109073519	0.028336994	0.091775526	0.001317416	0.001045591	0.007660061	0.001049933
P151	0.606377313	0.005873765	0.000726463	0.055236778	0.544922257	0.027324105	0.135975048	0.046242701	0.27169063	0.005283687	0.001729299	0.010676475	0.003173797
P152	0.514700886	0.007187349	0.000840084	0.045252914	0.601628018	0.022592231	0.114939407	0.056296005	0.319740778	0.002496443	0.001877816	0.016166926	0.004216341
P159	0.478865762	0.006748979	0.000749859	0.041781411	0.288323422	0.034071912	0.158911746	0.028849541	0.171896344	0.00304936	0.00166501	0.010322692	0.002431754
P161	0.434014992	0.005516474	0.000380243	0.045330654	0.728407145	0.02889907	0.122242724	0.046871242	0.493991119	0.002006845	0.001327719	0.00759968	0.002394725
P172	0.328427375	0.007227196	0.000621276	0.039053407	0.272108597	0.02192514	0.093532092	0.032024394	0.119319658	0.001515598	0.001898236	0.01621167	0.001818178
P175	0.490051333	0.004936914	0.000542588	0.058490504	0.657642202	0.02228691	0.125817471	0.057776755	0.384604195	0.005192089	0.001856295	0.014533252	0.003728794
P181	0.391501964	0.004837454	0.000525485	0.041155737	0.381617249	0.021604534	0.109658232	0.036532259	0.219106727	0.001759478	0.00178221	0.01449383	0.002322389
P189	0.340583023	0.004657277	0.000849791	0.039642255	0.392824814	0.019738376	0.085756709	0.046541436	0.334995607	0.009822777	0.002107114	0.021706635	0.003788875
P194	0.29460905	0.006022547	0.00076194	0.042332854	0.384731222	0.023447365	0.097143475	0.044473262	0.340448166	0.001302584	0.001602106	0.016153186	0.003577189
P199	0.346330518	0.00718722	0.000826662	0.032250883	0.29810738	0.017553849	0.074256607	0.038097549	0.215985456	0.001463868	0.001261718	0.009507975	0.002197694
P200	0.451137837	0.005886139	0.000380701	0.041211307	0.519181988	0.02301499	0.099462895	0.034991869	0.273027541	0.00497612	0.001148866	0.005893337	0.001133307
P201	0.3727699	0.004641802	0.000558838	0.038446009	0.513809789	0.025766993	0.121674951	0.036444644	0.275864736	0.004410344	0.001826487	0.012059856	0.002862138
P204	0.351315829	0.007551308	0.000608466	0.038771702	0.546595233	0.016028252	0.071786058	0.058345614	0.422014758	0.003840611	0.002543679	0.025602312	0.005293007
P209	0.336661011	0.007098027	0.000483145	0.040951683	0.420758943	0.018359646	0.079114249	0.034168077	0.179599767	0.003132279	0.001856376	0.011328726	0.00186936
P211	0.384181078	0.006173809	0.000477123	0.030521541	0.252597194	0.01999706	0.088028103	0.025018163	0.117647672	0.006091132	0.001232534	0.007131001	0.001181568
P222	0.279374363	0.0046455	0.000371049	0.021731786	0.260490817	0.014606613	0.038821004	0.039684714	0.35357108	0.00627046	0.001508901	0.015345524	0.003718975
P223	0.382638038	0.003184072	0.000595719	0.039339138	0.258671258	0.027269082	0.11769461	0.038070943	0.158355384	0.000563157	0.00080628	0.012094363	0.001096538
P227	0.464569927	0.007531911	0.000553239	0.038965975	0.510266212	0.017482135	0.084939846	0.042943375	0.353752765	0.001419793	0.002090223	0.016873182	0.003613208
P229	0.380847285	0.002056585	0.000897146	0.042188368	0.409184475	0.019072883	0.090002584	0.052325573	0.303015745	0.000428575	0.002203508	0.018558035	0.003042863
P230	0.466898962	0.007445177	0.000788996	0.034819378	0.286743764	0.021783253	0.078500776	0.055765621	0.26068095	0.001477577	0.001784637	0.012883943	0.002859361
P241	0.371328233	0.005257734	0.000678626	0.028023222	0.245355329	0.016910891	0.06605926	0.031460489	0.210373739	0.001542041	0.001183466	0.007161508	0.001605942
P246	0.558168552	0.007783575	0.000954251	0.056046036	0.492029849	0.029013464	0.117367214	0.04838721	0.258983062	0.001752935	0.00176827	0.010583097	0.001959824
P249	0.390107082	0.006801888	0.000548173	0.048512792	0.398038771	0.024010475	0.114770081	0.047068522	0.241995435	0.001381003	0.00194839	0.013598139	0.003096286
P258	0.48240912	0.001794388	0.000948596	0.049608548	0.395593696	0.028905131	0.14503054	0.040694824	0.208541806	0.000533141	0.001516314	0.010186282	0.00216697
P261	0.667386466	0.006635877	0.001049925	0.080171406	0.597464865	0.035262812	0.195398702	0.054460607	0.245813725	0.011626544	0.001932228	0.0091793	0.002016994
P264	0.392140128	0.001620489	0.000676536	0.034877044	0.258197001	0.017662526	0.089872765	0.030450559	0.206120473	0.000437073	0.001370596	0.006896652	0.001558479
P273	0.397251746	0.002186552	0.000415835	0.028516785	0.373159418	0.025313368	0.095608644	0.021841852	0.163852713	0.000514295	0.002067612	0.008686962	0.001556011
P28	0.378535949	0.004268957	0.000619921	0.037692349	0.309556201	0.024168529	0.093234986	0.037415477	0.200390737	0.003323313	0.00157906	0.012383582	0.002458944
P281	0.451533109	0.007487282	0.000539775	0.045750238	0.775777814	0.029101112	0.1033214	0.047884726	0.450569516	0.00261829	0.001721264	0.008333784	0.002293435
P284	0.42496638	0.004317951	0.001002603	0.047871061	0.429609844	0.018176675	0.076997438	0.054579279	0.181058291	0.000519809	0.000999659	0.009305248	0.001729058
P287	0.564628644	0.007376427	0.000991252	0.047829894	0.510894913	0.020032409	0.119244457	0.033527737	0.197997988	0.00143421	0.001984768	0.009435318	0.00245326
P289	0.388416933	0.005433079	0.000924942	0.045892469	0.441868953	0.02711092	0.106680252	0.041362335	0.217135227	0.004714264	0.001759243	0.012274864	0.002234873
P296	0.468879649	0.00729488	0.000631089	0.047939898	0.37635235	0.023834529	0.161110007	0.037555621	0.206952901	0.001309309	0.002594837	0.010154502	0.002395238
P299	0.434525022	0.005389883	0.000510039	0.038126468	0.481584824	0.020238829	0.09075687	0.026404503	0.19244744	0.006021502	0.001591534	0.007841509	0.00157459
P3	0.33235514	0.004914609	0.000618335	0.031544224	0.306910802	0.021070221	0.087026754	0.037824528	0.213546476	0.005984549	0.001282653	0.008381877	0.001848288
P301	0.517422329	0.00700253	0.000471146	0.032261314	0.423654542	0.019853791	0.077745281	0.031033755	0.204018491	0.001548922	0.002770929	0.011046467	0.002584622
P302	0.342355456	0.004395588	0.000692735	0.044057514	0.394607108	0.022566319	0.089087068	0.046810263	0.273332906	0.006434624	0.000748263	0.008707724	0.001666785
P34	0.414961308	0.004633607	0.000450682	0.03203519	0.3521453	0.019707169	0.086504935	0.025875634	0.107736898	0.003190485	0.001479975	0.007490461	0.00115793
P35	0.371922617	0.004357246	0.000628867	0.036242424	0.274929759	0.020249609	0.085150014	0.023840912	0.090031735	0.002826536	0.001399913	0.006799687	0.001029186
P45	0.392569511	0.004752779	0.000628082	0.046163408	0.646324985	0.021173028	0.091547196	0.043997128	0.30606771	0.003989839	0.00205156	0.010791054	0.002519324
P46	0.466412691	0.00459355	0.000507999	0.037933018	0.540461032	0.019512627	0.103359332	0.037024866	0.253394884	0.003748671	0.001924675	0.011912046	0.003339799
P47	0.269658017	0.005266111	0.000759089	0.049344805	0.357430433	0.022072693	0.128739304	0.05328683	0.261556659	0.004076984	0.002028012	0.019634732	0.004934859
P54	0.445222441	0.002650555	0.000463767	0.048336172	0.622408937	0.026127741	0.122381287	0.049862693	0.370054679	0.000541443	0.001110118	0.006661776	0.001581207
P55	0.631519909	0.004105771	0.000788365	0.040811165	0.415010239	0.021694263	0.097482843	0.027550739	0.153834974	0.002502355	0.001456159	0.007044086	0.001315397
P56	0.627100628	0.00422382	0.000807763	0.045710397	0.30024063	0.031226602	0.153838644	0.033557423	0.192847533	0.008324992	0.001756798	0.010666231	0.001719044
P61	0.413239992	0.005400868	0.000588026	0.050566141	0.410539818	0.024093777	0.129999656	0.026936415	0.148623904	0.005851073	0.001469563	0.006127404	0.001214967
P72	0.425981222	0.00387314	0.000757083	0.041640223	0.319555131	0.027478292	0.100508042	0.029424563	0.219718418	0.00607161	0.001251711	0.007589641	0.00139466
P73	0.517449252	0.003457989	0.000447627	0.041195964	0.546192118	0.020349616	0.111126942	0.040670078	0.360920187	0.004147815	0.002452089	0.019943174	0.003615816
P79	0.459727407	0.002720085	0.000322798	0.04258595	0.448676592	0.021225794	0.095671904	0.040380055	0.271642806	0.000483944	0.001154437	0.006509349	0.001510385
P85	0.262372532	0.005210531	0.000952229	0.035736961	0.300880102	0.021742465	0.100308823	0.043998528	0.298729464	0.003309472	0.002031684	0.016004132	0.003761523
P91	0.440177185	0.006568421	0.000814023	0.043723426	0.457280527	0.019303191	0.098544814	0.047077264	0.261195061	0.003891568	0.001909244	0.01314959	0.003209614
P96	0.436163197	0.005834586	0.000600669	0.050077594	0.476651982	0.025652437	0.122568831	0.046333589	0.231802125	0.006046869	0.001639167	0.012936411	0.002950032
P99	0.420118749	0.003533154	0.00054795	0.033819596	0.309973931	0.022817758	0.095563363	0.029854371	0.222050796	0.003983129	0.001576933	0.007804586	0.001572201

	DCA20.0.2ME_2564_112_DCA_I2	w.OH.FA20.0.1ME.1tms	FA24.1.ME	FA24.0.1ME	Tetracosanol.1tms	Monostearin.1tms_2773_399_MAG_I2	X2.OH.FA23.0.1ME.1tms_2802_397_OH.FA_I	FA25.1.1ME_2804_362_FA_I3	FA25.0.1ME_2828_143_FA_I2	DCA22.0.2ME_2857_98_DCA_I2	w.OH.FA22.0.1ME.1tms	X2.OH.FA24.1.ME.1tms	X2.OH.FA24.0.1ME.1tms
P100	0.013040452	0.217890294	0.007124049	0.015056686	0.005019822	0.000300352	0.003272678	0.000801185	0.002426926	0.085151399	0.447071336	0.019711324	0.062666671
P113	0.010892496	0.191859575	0.006716789	0.022491858	0.008136965	0.000240193	0.002184361	0.000832043	0.002202191	0.057998348	0.330680852	0.015497953	0.057352441
P115	0.022593561	0.29475247	0.006308703	0.011761646	0.003753241	0.005685292	0.00219573	0.000984799	0.001964833	0.102670776	0.37717325	0.016197268	0.041255538
P116	0.017653857	0.163806647	0.007911575	0.019266278	0.010120388	0.00256684	0.003193539	0.000690194	0.002671868	0.097147697	0.379984221	0.018239783	0.077213772
P120	0.021765819	0.292527909	0.010479976	0.021572206	0.006372861	0.003282028	0.003084518	0.000791675	0.002427857	0.098802288	0.35977857	0.021247204	0.074306142
P121	0.014288996	0.206498292	0.006025963	0.020256644	0.008595007	0.002500363	0.005015447	0.001096511	0.003678652	0.079494599	0.393298912	0.017872321	0.061363671
P136	0.019749021	0.258707845	0.006468914	0.012049999	0.00648333	0.000855911	0.002288381	0.000946048	0.001848627	0.080382991	0.317170617	0.015433272	0.03857751
P150	0.017330097	0.207228468	0.009813273	0.012832878	0.002481798	0.000995091	0.001996874	0.000631158	0.001542854	0.078178762	0.279326745	0.021971679	0.052732716
P151	0.018359474	0.257532837	0.007582025	0.019344382	0.007897307	0.003240179	0.002161921	0.000913091	0.001941685	0.077424918	0.399156682	0.013781952	0.036922151
P152	0.014960109	0.205761631	0.009387504	0.035952998	0.012560577	0.00195247	0.002359424	0.000921441	0.003564283	0.09771279	0.42194348	0.013403258	0.055992525
P159	0.01401764	0.221700091	0.008469607	0.014200492	0.006177352	0.002728745	0.003210261	0.000853135	0.002065372	0.072390807	0.326340127	0.016999381	0.066908493
P161	0.017957957	0.25072348	0.01082077	0.015071363	0.006964113	0.001591313	0.002306073	0.000598525	0.001003612	0.067426724	0.423386878	0.023409127	0.052077275
P172	0.012693119	0.176213416	0.008672801	0.021309409	0.004888493	0.001240363	0.003159134	0.00093283	0.003817399	0.068188555	0.27305814	0.020565743	0.086443817
P175	0.01537236	0.24007959	0.007829464	0.027398979	0.010331237	0.003511355	0.002935974	0.000729201	0.00247003	0.089482326	0.464009591	0.017512521	0.056275458
P181	0.011551714	0.17214307	0.006273816	0.020577809	0.005596586	0.001230305	0.003925078	0.000890618	0.003007892	0.071974392	0.331156879	0.017226666	0.062495925
P189	0.014886017	0.169628077	0.007224168	0.024270015	0.012185804	0.00496955	0.003585613	0.000776233	0.003194886	0.064211846	0.338730591	0.017637364	0.090616618
P194	0.017299962	0.22664255	0.008397292	0.031067985	0.01168334	0.000948537	0.002670258	0.000659623	0.00287495	0.086984464	0.342903713	0.018258928	0.073145969
P199	0.013778926	0.157742888	0.008603532	0.012891879	0.00507085	0.000878969	0.002032731	0.000655458	0.001539201	0.06471597	0.376886571	0.018387968	0.050629781
P200	0.015296944	0.232566067	0.007988663	0.008005167	0.001906072	0.003326863	0.001900097	0.00050531	0.000737766	0.06777495	0.389539514	0.020094613	0.046543123
P201	0.015096068	0.214274088	0.006424798	0.0257415	0.008339234	0.002452908	0.00262471	0.001004953	0.002921639	0.074612497	0.288341106	0.015355311	0.057853078
P204	0.010715912	0.151888083	0.006533048	0.041211754	0.018297216	0.002413382	0.004198373	0.000850213	0.005071516	0.064631676	0.35590593	0.01341875	0.084712071
P209	0.012780946	0.210536661	0.007767335	0.019063166	0.005125281	0.001815177	0.002303909	0.000923701	0.0025729	0.085018181	0.353207657	0.014050773	0.043690622
P211	0.014883915	0.173129122	0.007039409	0.01034556	0.002775589	0.003119403	0.001568198	0.000634385	0.001179798	0.074300937	0.225930043	0.016593303	0.040516602
P222	0.011684124	0.125587307	0.005604594	0.032097642	0.014064636	0.003649464	0.002951906	0.000681373	0.003378222	0.096872563	0.376964246	0.014900659	0.05661058
P223	0.019229426	0.209010728	0.005605927	0.02376353	0.003965392	0.000377397	0.001722182	0.000401511	0.001814906	0.092980847	0.35213958	0.022327119	0.081244041
P227	0.011130888	0.169849914	0.00676829	0.03310035	0.01114737	0.001004939	0.003415114	0.000816685	0.003127193	0.075594381	0.309875658	0.014238706	0.057340325
P229	0.015654683	0.177901175	0.008367031	0.034660616	0.008627474	0.000305498	0.002859808	0.000818408	0.003371667	0.070998353	0.314396901	0.017481451	0.070164155
P230	0.017517641	0.188785222	0.007310408	0.03332928	0.008052761	0.000952354	0.002144824	0.000968582	0.003040543	0.108584742	0.418668872	0.015441982	0.055353555
P241	0.013024437	0.144591714	0.007188152	0.007184788	0.003286812	0.001135956	0.001891657	0.000658452	0.000982015	0.071421252	0.334263294	0.019060928	0.042112976
P246	0.021805123	0.263473894	0.010419052	0.017911437	0.004846156	0.001347588	0.002419974	0.000916999	0.00191053	0.11834238	0.397890549	0.024072939	0.063650071
P249	0.015232955	0.220211206	0.008094653	0.016104646	0.005644461	0.001098392	0.004418989	0.00113474	0.003039674	0.107782046	0.359571713	0.014753909	0.057782993
P258	0.021041697	0.279307556	0.008747309	0.017084945	0.005719233	0.000372288	0.00193396	0.000630731	0.001817417	0.104520575	0.347710297	0.019913477	0.049212648
P261	0.021908189	0.31092126	0.008681334	0.012570504	0.002645726	0.006143016	0.001992714	0.001261277	0.001847516	0.093300579	0.472249472	0.020580116	0.048564427
P264	0.014654547	0.183298068	0.007778107	0.010016985	0.003850487	0.000252549	0.001754552	0.000644379	0.001366774	0.077793994	0.304328005	0.020647227	0.042883353
P273	0.01908178	0.205777245	0.00552517	0.0104439	0.003199036	0.000262248	0.002261318	0.001026878	0.002156032	0.079151519	0.258157327	0.013700185	0.042724341
P28	0.014391183	0.193099518	0.007268784	0.019312605	0.005249695	0.002287096	0.003061105	0.000729436	0.002446788	0.075990957	0.319070758	0.019614796	0.06925837
P281	0.020544988	0.238806663	0.009286442	0.015060408	0.006124385	0.001907809	0.001598763	0.00065897	0.001321912	0.084088929	0.479454502	0.018639057	0.048775248
P284	0.013596619	0.18744719	0.007835945	0.017610582	0.004275933	0.000260928	0.001941866	0.000863849	0.002239585	0.104116844	0.452573014	0.017923274	0.060229166
P287	0.014190705	0.237374954	0.008755601	0.013342452	0.004447691	0.001004644	0.00237184	0.001290581	0.002363558	0.078949426	0.317193272	0.017048073	0.045135703
P289	0.018257234	0.236378594	0.011438023	0.020939036	0.006003444	0.002722376	0.002431393	0.000786358	0.002339732	0.098034772	0.353255947	0.019030718	0.056957101
P296	0.016116523	0.272947429	0.010218359	0.013761142	0.005576567	0.001073512	0.002921432	0.001341228	0.002399394	0.100419942	0.348869211	0.016805792	0.047484212
P299	0.012686364	0.203475675	0.010325027	0.010160947	0.002992661	0.003657211	0.001907876	0.000767891	0.001406875	0.063521997	0.269357524	0.020441825	0.043913724
P3	0.01352839	0.166019812	0.006715551	0.01044871	0.004449294	0.003132169	0.001956457	0.000620812	0.001643425	0.058504122	0.333094279	0.018621175	0.050613069
P301	0.020549612	0.278986712	0.007812906	0.015690686	0.005926853	0.001157743	0.003747994	0.001594869	0.003179529	0.101505966	0.428339539	0.019037054	0.052088431
P302	0.017717835	0.221169132	0.006044486	0.021562828	0.008397152	0.004028814	0.002096936	0.00037312	0.001623375	0.089820731	0.434304909	0.016020939	0.061492413
P34	0.014405746	0.184758193	0.006229933	0.010889604	0.002967712	0.001953626	0.001628994	0.000839273	0.001751005	0.061526975	0.260455107	0.013793473	0.032283519
P35	0.011087139	0.154446792	0.007031752	0.006795798	0.001509416	0.001559804	0.001742744	0.000768633	0.001172595	0.046174004	0.208919001	0.015726823	0.030973158
P45	0.014009154	0.213429143	0.007330287	0.017831087	0.005840404	0.002398574	0.002284194	0.000935625	0.002232856	0.072794124	0.364013312	0.013347157	0.03856246
P46	0.010471843	0.18087024	0.00707753	0.017343081	0.008765455	0.001892122	0.002439304	0.000953999	0.002495189	0.052817435	0.272059525	0.013260237	0.045652231
P47	0.0108311	0.186953885	0.009727108	0.031450154	0.011616521	0.002349072	0.004348228	0.001005955	0.004617453	0.054773877	0.258463981	0.014792335	0.084454356
P54	0.01849515	0.257223204	0.010252303	0.014832938	0.005417934	0.000352532	0.001896824	0.000535377	0.000996055	0.072510223	0.43860774	0.025052276	0.05742109
P55	0.014003432	0.208594409	0.008501264	0.007072952	0.002095393	0.001293725	0.00144349	0.000710173	0.001140433	0.07363574	0.277288828	0.01789512	0.037354772
P56	0.021824538	0.268020454	0.007444806	0.010306499	0.003516293	0.004839747	0.003029482	0.000735739	0.001700714	0.100988826	0.395451679	0.019804472	0.056536238
P61	0.014601397	0.231752028	0.007478103	0.007112788	0.00142107	0.003389715	0.001631461	0.001070311	0.001519148	0.060168965	0.27331637	0.01451127	0.03435201
P72	0.021694072	0.246935982	0.008689351	0.009182297	0.003423454	0.003246131	0.001700707	0.000694686	0.001076793	0.108838967	0.349983576	0.022433264	0.046062753
P73	0.011768155	0.208946986	0.004490196	0.023125062	0.007967665	0.002360995	0.005918129	0.000697127	0.003078107	0.076160865	0.364161166	0.013644286	0.054623178
P79	0.013300416	0.189762962	0.008241209	0.012028249	0.004559718	0.000320627	0.001809744	0.000503609	0.000925881	0.056742779	0.368365749	0.019199414	0.050225725
P85	0.013285468	0.171562582	0.006714782	0.029117294	0.010683855	0.00196479	0.002825772	0.001033042	0.003263972	0.095592954	0.390314835	0.011398727	0.045441006
P91	0.015216432	0.224241044	0.006447608	0.022894317	0.00757031	0.002385957	0.002743099	0.000879991	0.00319561	0.088880773	0.370241966	0.01310403	0.047486427
P96	0.017955923	0.242192471	0.00805754	0.025968008	0.007111145	0.004020309	0.002925585	0.000785542	0.002589164	0.080231981	0.372396194	0.019487169	0.065075991
P99	0.016331145	0.1820598	0.008251615	0.00920648	0.003704548	0.002373175	0.001720693	0.000882729	0.001390791	0.078195619	0.281953204	0.019664649	0.042509402

Continuation of the Suppl. Table 6: Metabolite data for roots, first column describes the individual, further columns show individual compounds.

	FA26.0.1ME_2930_143_FA_I2	Hexacosanol.1tms	beta.peltatin.tms_2979_486_OTHER_I4	X2.OH.FA25.0.ME.1tms_2998_425_OH.FA_I2	Campesterol.acetate_3022_382_STEROL_I2	X3.5.7.Trihydroxy.2..4.hydroxyphenyl..4H.chro	w.OH.FA24.0.ME.tms_3065_455_OH.FA_I1	X2.OH.FA26.1.ME.tms_3074_437_OH.FA_I2	X2.OH.FA26.0.ME.1tms_3099_439_OH.FA_I4	Stigmasta.3.5.diene_3117_147_STEROL_I3	FA28.0.ME_3132_438_FA_I3	Octacosanol.1tms_3137_467_F.OL_I2	Cholesterol.1tms_3160_129_STEROL_I2
P100	0.004345622	0.00117029	0.043082403	0.004856358	0.004036808	0.144598479	0.004986714	0.001304123	0.008671472	0.035110083	0.000275353	0.002259787	0.005307076
P113	0.007674665	0.002654614	0.057469237	0.00253493	0.00364194	0.026519327	0.005981371	0.00132408	0.007108895	0.026767477	0.000664087	0.005054512	0.003141337
P115	0.003599159	0.00127552	0.016185417	0.003176695	0.003399104	0.000190962	0.003829397	0.001321003	0.0058707	0.022718604	0.000331004	0.002124278	0.001667868
P116	0.006016699	0.002075794	0.032820903	0.003603504	0.005456942	0.062543392	0.005769896	0.001149015	0.008266893	0.042673425	0.000454711	0.002660996	0.002245518
P120	0.008561136	0.004759043	0.043683494	0.003714356	0.006014485	0.006087292	0.005601591	0.001678856	0.010132544	0.037707041	0.000830402	0.007952634	0.001143281
P121	0.004023134	0.00154743	0.024498979	0.006163002	0.004247162	0.000540562	0.007253952	0.00109302	0.007756767	0.030895705	0.000326885	0.002247505	0.001533138
P136	0.004090968	0.001739492	0.015903873	0.003532037	0.004629696	0.003107631	0.004071382	0.001538746	0.00699927	0.02553719	0.000328434	0.002026931	0.001387201
P150	0.006344814	0.002478182	0.020998556	0.002210798	0.004663027	0.000431498	0.003087419	0.001601003	0.007113771	0.030885314	0.000725503	0.004027976	0.002367579
P151	0.003624419	0.001258394	0.01530942	0.003036788	0.003324285	0.000292638	0.007353855	0.001188949	0.005417064	0.029680752	0.000395666	0.002555595	0.001017522
P152	0.007061611	0.001205489	0.015661467	0.004037576	0.003390029	0.000523543	0.014419204	0.001354707	0.008427512	0.03422729	0.000622379	0.001497597	0.001479628
P159	0.003458634	0.000988664	0.100472679	0.004555112	0.005599587	0.141860825	0.005372586	0.001274442	0.007425893	0.029518193	0.000326982	0.001379118	0.000829415
P161	0.004869947	0.001827939	0.084090059	0.002022394	0.005967878	0.053770012	0.005079828	0.001398548	0.005742602	0.033992403	0.00037528	0.002036013	0.000877982
P172	0.009762062	0.002582995	0.026790968	0.004891746	0.004142066	0.000277514	0.006709164	0.001929141	0.013274806	0.038568818	0.000781059	0.00326353	0.00179634
P175	0.009113879	0.005044081	0.010797343	0.003475195	0.002916877	0.000172601	0.008521357	0.000961391	0.00653656	0.028964162	0.001154356	0.00859236	0.001508448
P181	0.007270011	0.004000172	0.021002122	0.005611816	0.004050095	NA	0.005364735	0.001164721	0.007660784	0.027899189	0.000892465	0.006964961	0.001719981
P189	0.006085449	0.002494189	0.022833749	0.004850091	0.003608066	0.003355892	0.008068689	0.00124031	0.009914454	0.046406207	0.000410573	0.002529084	0.002621604
P194	0.011573953	0.00642427	0.044527725	0.003828271	0.004336441	0.003129331	0.009763947	0.001427601	0.010232521	0.037866535	0.001472031	0.012612745	0.001732303
P199	0.004374903	0.001675531	0.002393522	0.002562857	0.004198998	0.000132859	0.003659173	0.001294072	0.006402543	0.026769281	0.000319003	0.001865617	0.001564916
P200	0.002255382	0.000724317	0.059960171	0.001991888	0.005414954	0.255997112	0.003506202	0.00138142	0.005840333	0.030816625	0.000167333	0.000876376	0.000852333
P201	0.009451474	0.002957083	0.046708734	0.004334292	0.002852201	0.000455177	0.007570868	0.0013277	0.008588088	0.024956344	0.00089637	0.003717635	0.001622966
P204	0.016292858	0.007824667	0.041794353	0.005353745	0.003158028	0.000251516	0.010609015	0.000940221	0.010061853	0.03435811	0.002307626	0.011601883	0.002270467
P209	0.006289964	0.001985436	0.039016443	0.003240282	0.003632847	0.000569066	0.00687951	0.001100509	0.006557443	0.030276035	0.000693999	0.003562295	0.001142722
P211	0.003847629	0.001311347	0.041179338	0.002111756	0.00601074	0.048773063	0.002881496	0.001486758	0.005961523	0.031619132	0.000408697	0.001978061	0.001268393
P222	0.015025199	0.011886511	0.014663994	0.004684091	0.003631249	0.000192254	0.013158795	0.00141535	0.009148002	0.024465276	0.002574066	0.020725558	0.001187648
P223	0.009930508	0.00475162	0.00229958	0.002945875	0.004050068	0.0000861	0.008487665	0.002381058	0.013607047	0.027734431	0.00223431	0.01299411	0.001009614
P227	0.010823963	0.004063204	0.059875292	0.00390959	0.003648024	0.001159973	0.009155705	0.001054336	0.007959376	0.038479107	0.001331386	0.00967459	0.001855232
P229	0.015009377	0.006061642	0.067994487	0.004014588	0.005014798	0.009828113	0.007815896	0.001423806	0.009523274	0.039585873	0.001470811	0.011027259	0.002288165
P230	0.012685802	0.011020689	0.066087685	0.003908699	0.005447615	0.014418334	0.010224702	0.001550984	0.009940483	0.033133938	0.001732683	0.016095259	0.002808374
P241	0.002013656	0.00082282	0.021153677	0.002330543	0.00617962	0.007091812	0.002714146	0.001550559	0.005103397	0.031822898	0.00012727	0.000852969	0.001521438
P246	0.007652714	0.004152831	0.062544267	0.002878534	0.008237944	0.014349121	0.004463574	0.001954094	0.007846993	0.042165223	0.000672799	0.005956415	0.001703728
P249	0.005214879	0.002084385	0.09798961	0.006197002	0.004839187	0.118675742	0.005153187	0.001257417	0.008284625	0.028195944	0.000225822	0.002403919	0.001610359
P258	0.006417262	0.003191378	0.015933438	0.002408007	0.004608384	0.000205758	0.006113952	0.001471806	0.006153205	0.030426366	0.00047452	0.003621015	0.002092899
P261	0.003371241	0.00095756	0.016270658	0.003423707	0.00473132	0.012114913	0.004638414	0.00214386	0.008584986	0.030180885	0.000219119	0.001593622	0.001283321
P264	0.003897871	0.001203355	0.027618563	0.002309282	0.005973163	0.005139557	0.003023719	0.00144369	0.005448883	0.037329735	0.000277489	0.001740373	0.001147513
P273	0.003168116	0.000787902	0.035505657	0.004024208	0.004899839	0.002532227	0.003565401	0.001379176	0.006675778	0.02330099	0.000194424	0.000800968	0.002046183
P28	0.010668866	0.005580513	0.039459629	0.003869159	0.005039032	0.009162111	0.006189686	0.001406605	0.009216934	0.034933977	0.0013358	0.010205727	0.001263749
P281	0.003685532	0.000750707	0.092955846	0.002211387	0.005531345	0.50159585	0.005734823	0.0012935	0.005102523	0.034014959	0.000198184	0.000994803	0.000924285
P284	0.00581397	0.000827299	0.010465403	0.003292056	0.003265064	0.0000815	0.004385576	0.001789572	0.009347047	0.026683211	0.000384008	0.001569726	0.000957071
P287	0.003996181	0.000637245	0.042690561	0.00407019	0.007196532	0.01067151	0.004156929	0.001752755	0.007167091	0.033305379	0.000327418	0.001139346	0.001387194
P289	0.00694639	0.002284566	0.043323893	0.003194656	0.005645312	0.055068819	0.008897822	0.001499041	0.007918551	0.035664144	0.000619218	0.002859221	0.001220408
P296	0.004532672	0.001550399	0.06948083	0.004131528	0.004656794	0.007733178	0.00443188	0.001598956	0.006986274	0.029879055	0.00029001	0.001325544	0.002037675
P299	0.002910246	0.000709262	0.038691544	0.002322945	0.005803798	0.035951813	0.00287756	0.001475934	0.005384894	0.029925579	0.0002148	0.000728757	0.001769269
P3	0.002658684	0.000609808	0.023278653	0.002720218	0.004464218	0.007144421	0.003598106	0.00148377	0.006720422	0.032225574	0.000136635	0.000589579	0.002746632
P301	0.006030763	0.00267725	0.136324095	0.006853401	0.00688908	0.097434052	0.0071576	0.001883764	0.008457127	0.036500946	0.000584681	0.003138237	0.002373153
P302	0.006918239	0.002533082	0.006997791	0.002594295	0.002163643	0.000203445	0.007032766	0.001307702	0.009235697	0.028524592	0.000613691	0.00445711	0.000883906
P34	0.003546516	0.001020586	0.015004355	0.002699614	0.003015251	0.000152919	0.003179866	0.001384889	0.005298767	0.023631736	0.000314596	0.001356437	0.001152494
P35	0.00212563	0.000400295	0.022421694	0.002222729	0.005031302	0.000230196	0.001505119	0.000970337	0.003452588	0.025647062	0.000120648	0.000432869	0.001156607
P45	0.004525517	0.001299076	0.013968657	0.003176798	0.003746908	0.000231776	0.005124151	0.001081707	0.005618224	0.025328679	0.000451711	0.002174425	0.00159153
P46	0.004396849	0.001723038	0.014541698	0.003550719	0.003230749	0.000952286	0.00518844	0.001064616	0.006603589	0.029381711	0.000324021	0.002461468	0.004674453
P47	0.009453709	0.002026407	0.002044755	0.006733295	0.002297938	0.000376515	0.006908116	0.001434206	0.01125868	0.042621744	0.000541052	0.001689098	0.001184212
P54	0.003999765	0.001037662	0.037677645	0.001813916	0.004974851	0.003134071	0.005308948	0.001488004	0.00642937	0.02704827	0.000288632	0.001383091	0.001846891
P55	0.002816687	0.000604759	0.022684421	0.001915125	0.005217172	0.002676451	0.002224074	0.001145561	0.004465769	0.035569772	0.000192098	0.000918875	0.001284966
P56	0.004082454	0.001769809	0.011821297	0.003142327	0.005601918	0.000194613	0.003745734	0.001537137	0.006790121	0.027183642	0.000346162	0.002140847	0.001775587
P61	0.002445787	0.000423586	0.00402453	0.002815587	0.003377194	0.0000644	0.001909109	0.001656452	0.005592505	0.024580424	0.000152538	0.000843094	0.001001675
P72	0.003528779	0.001938094	0.041888952	0.002319539	0.005938549	0.022586159	0.003341696	0.001681484	0.006390902	0.035352135	0.000315092	0.003006446	0.001297966
P73	0.007481286	0.003861729	0.09103553	0.005659218	0.003181275	0.002598874	0.007072738	0.000926682	0.006023254	0.031650038	0.000641488	0.005283144	0.00077062
P79	0.002970521	0.001080569	0.031621855	0.001771366	0.004149693	0.017705511	0.004278583	0.001203263	0.00522126	0.022498946	0.000215629	0.001363034	0.001178172
P85	0.013753686	0.008965216	0.066674138	0.00412723	0.003698266	0.000500767	0.011521284	0.000845133	0.007132535	0.028234274	0.001179204	0.010700766	0.00415286
P91	0.007410477	0.002253451	0.027230082	0.004332344	0.004376129	0.000822618	0.006347625	0.001012792	0.007322389	0.029478677	0.000592869	0.004842752	0.001752117
P96	0.005753173	0.001998839	0.035689832	0.004359546	0.004546431	0.002154731	0.009356155	0.001349638	0.008723211	0.033846165	0.000462709	0.00302269	0.002093786
P99	0.003343541	0.001867473	0.018778084	0.002164837	0.005908075	0.006833897	0.0026234	0.001319073	0.005133685	0.029197412	0.000362135	0.002628824	0.001202539

	Campesterol.1tms_3261_343_STEROL	Beta.Sitosterol.1ME_3272_396_STEROL	Stigmasterol.TMS_3285_255_STEROL	Stigmast.5.ene.1tms_3350_396_	Stigmastanol.1tms_3363_215_STEROL	Isofucosterol.1tms_3391_296_STEROL	prop16	sum	c16toc18	prop14	prop18	prop20	prop22	prop24	prop26
P100	0.031273854	0.021035409	0.002837134	0.117661318	0.006197043	0.001080825	0.008999207	0.581734129	0.009080928	0.123643787	0.519620869	0.635534852	0.983841513	0.810942044	0.341184722
P113	0.027097699	0.017671521	0.0027571	0.09147481	0.005333443	0.00097221	0.077618866	0.34766002	0.084150536	0.041946277	0.37931131	0.596976683	0.977546508	0.754010623	0.344346913
P115	0.035389071	0.015564636	0.000604516	0.087086945	0.004025152	0.000738688	0.085651705	0.666705891	0.093675141	0.017260704	0.610684662	0.652011973	0.982226261	0.746355009	0.375175262
P116	0.040274763	0.023076627	0.002607398	0.116038582	0.004973206	0.00226748	0.079661177	0.626688154	0.086556358	0.024318714	0.529107594	0.577771604	0.973729559	0.829799702	0.438227946
P120	0.052164432	0.02574545	0.001888288	0.127699101	0.005495916	0.002526951	0.066915181	0.755684568	0.071713932	0.030933819	0.630778388	0.625260638	0.974884185	0.572486179	0.374383552
P121	0.032348352	0.021034839	0.001648262	0.095482641	0.00679703	0.000683414	0.101952683	0.707151251	0.113527073	0.01477193	0.555656577	0.613966059	0.973787676	0.847430176	0.407761842
P136	0.04695108	0.018780362	0.000270299	0.104936231	0.005861813	0.001004742	0.037338869	0.555125309	0.038787137	0.042041015	0.578649567	0.534128494	0.981255768	0.788455628	0.461841896
P150	0.047872296	0.021985683	0.000884573	0.102829774	0.004236605	0.001835504	0.07694368	0.745553855	0.083357514	0.023273859	0.752374259	0.711647969	0.973669976	0.500364473	0.380897923
P151	0.030243303	0.020063436	0.001767386	0.102387529	0.004831124	0.000927658	0.086651579	0.782868411	0.094872424	0.014569298	0.567506189	0.667295686	0.971753762	0.862556275	0.329941598
P152	0.030068778	0.025485968	0.000727046	0.119896933	0.005383395	0.001356492	0.120274681	0.643994016	0.136718449	0.021947707	0.484980653	0.652971992	0.962201247	0.912430373	0.445967778
P159	0.043955065	0.020282132	0.001160646	0.090200183	0.006044035	0.000696685	0.017428386	0.608943279	0.017737522	0.083596656	0.67481849	0.62649074	0.96531014	0.862034401	0.417548419
P161	0.045018579	0.023648407	0.000856618	0.104002355	0.004921308	0.001182104	0.083530785	0.53575622	0.091144125	0.018607749	0.402656685	0.595883654	0.986098332	0.792091871	0.473074939
P172	0.036453192	0.029026954	0.003601985	0.134499098	0.005858169	0.001668827	0.082538442	0.781275357	0.089963924	0.031492598	0.724836734	0.695168511	0.960642738	0.654286413	0.441800009
P175	0.031697001	0.019297339	0.001939931	0.112384301	0.005779988	0.00104154	0.096389022	0.628756678	0.106670928	0.018693021	0.463496806	0.630985345	0.973840693	0.671936493	0.369897171
P181	0.03512696	0.02033644	0.001319	0.094432188	0.006804044	0.001099895	0.077340848	0.531912718	0.083823856	0.04606835	0.562561879	0.635262224	0.97509344	0.583174678	0.364808342
P189	0.031388065	0.023612438	0.005148315	0.123707459	0.004729518	0.002516778	0.1094831	0.589676627	0.122943316	0.078516182	0.572059136	0.539727662	0.96490076	0.830096043	0.496526633
P194	0.034943607	0.02570253	0.003424072	0.118807202	0.006198386	0.001744296	0.055109382	0.676177064	0.058323557	0.023033161	0.624155467	0.530532484	0.96682109	0.645217127	0.337462023
P199	0.040066323	0.024160653	0.001055128	0.104320845	0.003899804	0.00172177	0.070709867	0.553994785	0.076090195	0.070332585	0.633292351	0.579870715	0.97706082	0.751640003	0.473160462
P200	0.038203619	0.019157873	0.000640186	0.087921611	0.005798354	0.00068611	0.067123595	0.60394843	0.071953363	0.035168243	0.520426571	0.655359434	0.993067154	0.724635013	0.452502138
P201	0.027901421	0.01591463	0.002165676	0.104389762	0.006125399	0.001246947	0.015939822	0.60059082	0.016198016	0.114681092	0.534941081	0.650660206	0.970657574	0.738225901	0.44302743
P204	0.029648742	0.026773079	0.001004436	0.110664095	0.008256465	0.001225322	0.150319119	0.518806979	0.176912441	0.017055763	0.44643853	0.564308894	0.958444882	0.700455468	0.402782135
P209	0.031587668	0.021118321	0.001268904	0.106069625	0.006270264	0.001023296	0.101148887	0.839809894	0.112531303	0.024347265	0.642097048	0.700845904	0.972254545	0.720782543	0.357882572
P211	0.048617291	0.021556961	0.000875892	0.103791268	0.004249307	0.002064112	0.028209596	0.679922584	0.029028478	0.040203706	0.723435577	0.682243609	0.976951389	0.679136866	0.398657478
P222	0.034692242	0.01773421	0.000755268	0.086200791	0.007285928	0.000963088	0.04317498	0.389543519	0.045123172	0.067370913	0.588622369	0.424209381	0.961743009	0.541965868	0.364481976
P223	0.037804069	0.021247263	0.001209623	0.114166749	0.005927877	0.001440662	0.010011425	0.491007049	0.010112667	0.296639076	0.652679594	0.620275138	0.975570641	0.454902702	0.267761312
P227	0.027563124	0.027857913	0.001795057	0.120004222	0.008510693	0.001397414	0.096917554	0.70038571	0.107318611	0.017113664	0.553483898	0.590572922	0.969450902	0.732869785	0.295768288
P229	0.046757205	0.026292343	0.006567532	0.14246727	0.006067019	0.002639217	0.068126637	0.642347949	0.073107184	0.050495363	0.593970947	0.574535732	0.972316182	0.587337847	0.354712246
P230	0.040553278	0.020702447	0.00069568	0.092877366	0.006612723	0.001102287	0.031420963	0.576883825	0.032440268	0.144205975	0.660859482	0.52380493	0.970034424	0.422197379	0.406428325
P241	0.055683999	0.018052305	0.000634818	0.096183798	0.003985689	0.001663269	0.075594904	0.453655216	0.081776814	0.023753399	0.630887272	0.53837981	0.984616663	0.799782538	0.491004707
P246	0.057094645	0.028512841	0.001024693	0.121513537	0.005606718	0.001660396	0.052765889	0.78462622	0.055705224	0.03530318	0.601677369	0.655154981	0.981631466	0.538522388	0.410795332
P249	0.041541197	0.017223173	0.00124762	0.09689036	0.00641473	0.001166912	0.020239122	0.613391915	0.020657206	0.069489976	0.601569242	0.62190234	0.977206982	0.730310921	0.464403791
P258	0.041605684	0.023430066	0.001323874	0.110701561	0.004658653	0.002188056	0.03919038	0.759215716	0.040788913	0.031864553	0.648378493	0.65480955	0.97330717	0.641845213	0.468466547
P261	0.047376203	0.019852467	0.000682204	0.11384378	0.006411589	0.000873938	0.059992357	0.851971017	0.063821137	0.015106326	0.572727917	0.708502353	0.989351478	0.734253591	0.375339801
P264	0.043545325	0.025129028	0.000687979	0.114723679	0.004381221	0.001904811	0.038551596	0.457110925	0.040097416	0.051958628	0.629923547	0.556078579	0.98166181	0.761893094	0.408785991
P273	0.046156713	0.015864898	0.000724279	0.091517995	0.005299589	0.000987368	0.011413406	0.483935606	0.011545176	0.158147655	0.561799164	0.694880798	0.98085003	0.802379259	0.495888175
P28	0.040529923	0.021535831	0.001985668	0.113873162	0.005132386	0.001734601	0.073874345	0.662896418	0.079767087	0.017305183	0.664794395	0.607036101	0.974471483	0.484727069	0.353504907
P281	0.047688164	0.019358859	0.001197797	0.106672275	0.004776845	0.000960996	0.098769358	0.482112845	0.109593875	0.056111525	0.359005764	0.632592248	0.986589737	0.890807726	0.430078922
P284	0.032001341	0.02175136	0.001505272	0.113462851	0.005896763	0.001289243	0.009281928	0.631884736	0.009368889	0.122418095	0.593029699	0.703507878	0.976928527	0.837887186	0.345135906
P287	0.056462379	0.02104525	0.000352995	0.103741002	0.006763769	0.001240894	0.114865407	1.008020664	0.129771685	0.009431342	0.635888818	0.720694074	0.9780302	0.874679863	0.358689795
P289	0.0507689	0.022502638	0.001354558	0.129872845	0.005577493	0.003076624	0.066927636	0.872121869	0.071728238	0.014402028	0.648087534	0.670510091	0.973095456	0.724352889	0.44414086
P296	0.040908315	0.019450254	0.000759907	0.103350821	0.00665665	0.001218118	0.02387974	0.623309702	0.024463932	0.075124586	0.617830098	0.645206519	0.973760968	0.782460201	0.539092374
P299	0.056144924	0.020052081	0.000391722	0.121972056	0.004318039	0.001887548	0.097624623	0.837993952	0.108186266	0.009026972	0.610925414	0.714483341	0.984687578	0.808407125	0.493221513
P3	0.035079067	0.01746441	0.000776825	0.09483976	0.004082095	0.00128815	0.075129809	0.504459375	0.081232815	0.039156657	0.60320283	0.589694515	0.97959	0.879463201	0.508433105
P301	0.054937692	0.021289834	0.000813538	0.117767361	0.007666519	0.001675188	0.110776144	0.820392837	0.124576217	0.01726028	0.632616623	0.67496056	0.971769543	0.688840334	0.460365533
P302	0.023028468	0.019607389	0.001059889	0.091573883	0.005357122	0.000858699	0.016623464	0.496102291	0.016904474	0.258886806	0.552834114	0.590782256	0.970194334	0.768249943	0.362376653
P34	0.029919054	0.016822823	0.001288476	0.090858903	0.004489431	0.000787135	0.111689092	0.533432533	0.125731983	0.017244916	0.573673578	0.765729357	0.973192513	0.744104818	0.429354761
P35	0.045467361	0.016013168	0.000817615	0.083043017	0.003186574	0.001315675	0.037303147	0.694659572	0.038748591	0.03038643	0.708660961	0.753311687	0.983511062	0.790389982	0.480451335
P45	0.036156112	0.018383272	0.000404814	0.095320833	0.005271318	0.000719296	0.120145995	0.682950227	0.136552194	0.02182666	0.481788121	0.678632867	0.981275242	0.818043321	0.373996124
P46	0.027783443	0.020363994	0.001556637	0.104073255	0.005729779	0.000794679	0.087344415	0.931016612	0.095703589	0.009353826	0.611223457	0.680804943	0.966564528	0.835721082	0.411766172
P47	0.029642375	0.025039582	0.001284268	0.119134949	0.007296386	0.001131563	0.075739081	0.665664239	0.081945563	0.018886412	0.632529492	0.577444082	0.957475618	0.851468303	0.545392104
P54	0.048529141	0.019907407	0.001172197	0.113677114	0.005379933	0.001192008	0.067370769	0.639856934	0.072237463	0.02627901	0.489476486	0.627135269	0.985570363	0.839261668	0.428652435
P55	0.039657188	0.024050252	0.000599769	0.11010254	0.004236805	0.001499985	0.055445073	0.737320399	0.058699681	0.020515238	0.626604622	0.729566197	0.986561994	0.776027694	0.396918899
P56	0.061512624	0.020635994	0.00064082	0.109331797	0.005105709	0.002574905	0.077996889	0.584968182	0.084595039	0.019260509	0.642393201	0.608898474	0.98209297	0.665195779	0.452560738
P61	0.032842496	0.017695318	0.000627229	0.09722775	0.004864995	0.000772827	0.092003448	0.761261484	0.101325768	0.015156412	0.627379065	0.734203243	0.990529042	0.770371324	0.334406357
P72	0.043901047	0.021438917	0.000462113	0.102637415	0.003627589	0.001189091	0.034455924	0.726123636	0.035685501	0.073152864	0.68691309	0.592565928	0.984657949	0.638519679	0.391966495
P73	0.024015329	0.018364568	0.000690869	0.09472982	0.006387552	0.000902235	0.109757015	0.751974082	0.123288829	0.008204905	0.55069279	0.602121827	0.978400848	0.673548002	0.422283531
P79	0.041815753	0.015441654	0.000925432	0.088715003	0.003565051	0.000838652	0.075701104	0.46567596	0.081901108	0.031691352	0.489618468	0.622885617	0.983491396	0.808419438	0.442203251
P85	0.032703128	0.018475507	0.001900471	0.101001566	0.010103044	0.001297276	0.039358684	0.40315203	0.040971259	0.121115039	0.562778873	0.501793365	0.965470604	0.543733339	0.455874323
P91	0.034876983	0.018451472	0.000525005	0.09339016	0.006659781	0.001125832	0.110638659	0.625401383	0.124402371	0.021423569	0.54880534	0.63645938	0.971833017	0.770612169	0.317557331
P96	0.038830041	0.019994158	0.002585299	0.110459802	0.004629816	0.0010485	0.081403795	0.61357948	0.088617604	0.023115844	0.541805805	0.672805729	0.970235455	0.780588048	0.398053945
P99	0.049861196	0.01749545	0.000597837	0.1044105	0.004693629	0.001403363	0.042764922	0.53885371	0.044675465	0.033460522	0.624630558	0.582630684	0.98359043	0.664848235	0.415335714

Supplementary method 1: Sorbitol DNA extraction

Preparation of the botanic sample:

1. Take approximately 1 cm^2 of fresh leave.
2. Place the leaves in a tea filter bag.
3. Allow it to dry over 5 days in a sealed plastic bag/box with silica gel balls.

DNA Extraction:

4. Beat the tubes on the (Qiagen) TissueLyser for 2-4 minutes with 50 oscillations/s until all samples are powdered.
5. Prepare the extraction buffer (EP) for 24 samples: Mix 41.6ml Extraction buffer (EP) with 41.6µl Mercaptoethanol.
6. Add a pinch of Polyvinylpyrrolidon[1] K30 (PVP), 1300µl of the mix (EP and Mercaptoethanol) and 5µl RNase to each tube. Mix thoroughly by hand.
7. Let the samples stand for 20 minutes at room temperature.
8. (Meanwhile, prepare new 1.5ml Eppendorf tubes for the DNA washing steps and label them.)
9. Centrifuge for 5 minutes at 7000rpm.
10. Discard the supernatant.
11. Add 300µl EP and 300µl lysis buffer (LP) to each tube. Shake well to prevent pellets from settling.
12. Incubate for 15 minutes at 65°C in the thermoblock with mixing at 300rpm.
13. Add 600µl of Chloroform (Chloroform: Isoamylalcohol 1:24) and manually mix for 1 minute.
14. Centrifuge for 10 minutes at 9,000 rpm.
15. Transfer 550µl of the upper aqueous phase to the new 1.5ml tubes (from step 8).
16. Add 370µl frozen Isopropanol to each tube.
17. Gently mix and place the tubes in the freezer (-20°C) for 30 minutes.

DNA-Washing:

18. Centrifuge for 15 minutes at 13,000rpm and 4°C.
19. Carefully drain the supernatant, ensuring the pellet is not flushed out.
20. Add 700µl 80% ethanol at room temperature and mix on the Multirotator (Grant-bio) for 3 minutes.
21. Centrifuge for 2 minutes at 13,000 rpm.
22. Carefully pour out the supernatant; ensure the pellets are free of ethanol. Dry the samples in opened tubes on a 60°C heating block for 6-10 minutes.
23. Add 40-100µl nuclease-free H_2O and dissolve DNA in a heating block at 60°C for 10 minutes or overnight in the refrigerator at +4°C.
24. Before DNA concentration measurements, vortex the samples well.

[1] *Polyvinylpyrrolidon removes secondary metabolites*

How to prepare the Extraction Buffer (EP) and the Lysis Buffer (LP)

Extraction Buffer (EP)

			For 200ml	***For 250ml***
0.1M	***TRIS-HCl**, pH 7,5*	*157.64 g/mol*	*3.153 g*	*3.866 g*
0.005M	***EDTA** pH 8*	*292.25 g/mol*	*0.292 g*	*0.365 g*
0.35M	***Sorbitol***	*182.18 g/mol*	*12.753 g*	*15.94 g*
10mM	*2-Merkaptoethanol (0.1%)*		*0.2 ml*	*0.25 ml*

Calculation for 250ml Extraction Buffer:
Formula: m = c*V*M
TRIS-HCL: 0.1mol/L*0.250L*157.64g/mol = 3.9g
EDTA: 0.005 mol/L*0.250L*292.25g/mol = 0.37g
Sorbitol: 0.35 mol/l*0.250L*182.18 = 15.94g
Information: Make sure that the EP is weighed without the addition of mercaptoethanol. To adjust the water to pH 8, add NaOH. Heat Tris-HCl and EDTA slightly to facilitate dissolution. After cooling, add the mercaptoethanol.

Lysis Buffer (LP)

			For 100ml	***For 200ml***	***For 250ml***
0.2M	***TRIS-HCL**, pH 7.5*	*157.64 g/mol*	*3.15g*	*6.306g*	*7.88g*
0.05M	***EDTA** pH8*	*292.25 g/mol*	*1.46g*	*2.923g*	*3.65g*
2M	***NaCl***	*58.44 g/mol*	*11.69g*	*23.376g*	*29.22g*
2%	***CTAB***	*378,5 g/mol*	*2g*	*4g*	*5g*

Calculation for 250ml Lysis Buffer:
Formula: m = c*V*M
TRIS-HCL: 0.2mol/L*0.250L*157.64g/mol = 7.882g
EDTA: 0.05 mol/L*0.250L*292.25g/mol = 3.65g
NaCl: 2 mol/l*0.250L*58.44 = 29.22g
CTAB: 250g/100*2 = 5g
Information: Achieve a pH of 8 by adding NaOH to the water. Gently warm Tris-HCl and EDTA, not exceeding 65°C, to facilitate dissolution. It is advisable to add them sequentially for better dissolution, noting that EDTA dissolves more effectively when the pH is already close to 8.