European Cooperation in the field of Scientific and Technical Research
- COST -

Secretariat

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COST 263/09

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FA0906: UV-B radiation: A specific regulator of plant growth and food quality in a changing climate (acronym: UV4growth)

Delegations will find attached the Memorandum of Understanding for COST Action FA0906 as approved by the COST Committee of Senior Officials (CSO) at its 176th meeting on 1 December 2009.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action FA0906
UV-B RADIATION: A SPECIFIC REGULATOR OF PLANT GROWTH AND FOOD QUALITY IN A CHANGING CLIMATE (ACRONYM: UV4GROWTH)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 270/07 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to bring together, coordinate, and enhance the performance of nationally-funded research activities by forming a coherent, interdisciplinary research & training Network that will develop an integrated vision on the regulatory role of UV-B in plant growth and development at cell, organism and ecosystem level.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 60 million in 2009 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Significant new understanding of UV-B mediated processes in plants has been gained during the last decade. Rather than being a damaging agent, it is now recognised that UV-B radiation is a specific regulator of gene expression, metabolite profiles, and responses to climate change parameters. This COST-Action will generate knowledge on the fundamentals of plant growth, food quality, and plant-environment interactions by integrating nationally and internationally funded research on UV-B mediated regulation of molecular, physiological, metabolic and ecological processes. Benefits of this Action include the creation of a stimulating research environment that leads to scientific breakthroughs, further research collaborations and funding applications, an interdisciplinary, international training environment for Early Stage Researchers (ESR) and Experienced Researchers (ER), coordinated uptake of novel technological applications, and development of standardised experimental routines. Outcomes include development of an integrated vision of the role of UV-B in plant growth across a range of organisational levels and natural and agricultural systems, as well as a consolidated, transnational Network of experts and the strengthening of ties with potential stakeholders, including researchers, food and feed industries, horticultural and agricultural enterprises, and policy-makers involved in environmental and agronomic management.

Keywords: UV-B radiation, Signalling and gene-expression, Food and feed quality, Pest and disease tolerance, Climate change.

B. BACKGROUND

B.1 General background

Concerns about world food supply have risen sharply in the last few years. Imbalances between food supply and demand, combined with ecosystem degradation and the threat of global climate change, emphasise the importance of understanding fundamental processes that control plant growth and food quality in natural and agricultural ecosystems.

Plants are sedentary, and therefore can not avoid contact with agents that target their metabolism, physiology and genome integrity. Few environmental parameters have such a profound effect on plant growth and development as UV-B radiation (280-315nm). This type of radiation has the highest energy per photon of any part of the solar spectrum, and has the potential to damage macromolecules, including DNA and protein-complexes such as the photosynthetic machinery. Indeed, UV-B radiation has traditionally been considered a stressor that negatively impacts plant growth. This "narrow perspective", associated with concerns about depletion of the ozone layer, dominated the field of UV-B research for decades. A novel vision has now emerged, emphasising the regulatory properties of low, ecologically-relevant doses of UV-B radiation, and the important role that these play at the cell, organism and vegetation levels. Thus, rather than a damaging agent, UV-B appears to play similar role in coordinating plant growth and development as Blue and Red/Far-red wavelengths. UV-B induces changes in the morphology, metabolic make-up and anti-oxidative capability of plants. This in turn has consequences for plant/crop productivity, food/feed quality, pathogen/pest sensitivity and food web integrity, abiotic stress susceptibility and plant performance under increasing climate change conditions. "Normal" regulatory UV-B control of plant growth is modulated by increased ambient UV-B and climate change conditions. It is predicted that UV-B levels will remain high for most of the coming century, especially at higher latitudes, since ozone layer recovery is a particularly slow and uncertain process. This will result in on-going interactions between climate change parameters and UV-B at the molecular, organism, vegetation and climatic levels.

UV-B mediated regulation has not been studied in detail, despite its relevance to plant growth and development. Progress is hampered by lack of communication between disciplines (i.e. molecular, organismal and agri-/horticultural, ecological, photobiological and climatological disciplines), and across national borders. This problem is aggravated by the use of non-standardised experimental protocols. There is a need to establish a coherent, multi-disciplinary, research network to (1) increase knowledge about, and explore biotechnological potential of, newly discovered UV-B-dependent regulatory processes across different organisational levels and to (2) fully capitalise on advances in novel UV-irradiation, spectroradiometry and UV-cladding technologies. This Action provides a cost-effective programme to stimulate basic science, train ESR, disseminate UV-B related issues, and has clearly defined relevance in terms of developing pre-competitive research.

This COST-Action will elucidate UV-B mediated regulation of:

- Fundamental, nuclear-based processes that control growth
- Metabolic processes that determine quality of plant-based food and/or feed nutritional benefits and biotic interactions
- Organismal processes that determine stress tolerance, biomass accumulation, competitive interactions and vegetation composition
- Responses to climate change

B.2 Current state of knowledge

This Action brings together nationally funded researchers studying newly discovered regulatory UV-dependent processes. A specific UV-B photoreceptor, associated with UV-induced metabolic changes, was predicted in the early 1970s. However, it is only in the last few years that substantial progress has been made in identifying this UV-B photoreceptor and of specific, regulatory UV-B-mediated processes. Recent genetic studies have revealed that two different UV-specific signalling pathways operate in plants. Under low UV doses, UVR8 and COP1 induce expression of the HY5 transcription factor which, in turn, regulates target genes involved in (amongst others) photomorphogenic UV-B responses and metabolite accumulation. HY5 operates downstream from auxin-signalling pathways, and controls plant architecture, an important parameter in agriculture. Additional, non-specific UV-B signalling, typically associated with high UV doses, involves DNA damage signalling components, reactive oxygen species, and wound/defence signalling molecules such as jasmonic acid, salicylic acid nitric oxide, ethylene, and ABA. Regulatory, UV-B-mediated processes do not necessarily occur immediately. Excitingly, some UV-B mediated responses accumulate through the life of a perennial plant, or even from generation to generation in annual plants, involving epigenetic changes in the genome. However, the precise mode of action of these specific, non-specific and epigenetic signalling pathways, and the potential for regulatory cross-talk between them, remains poorly understood. Nevertheless, it is clear that molecular UV-B research in plants has substantially progressed during the last decade, and that research is now yielding novel understanding of the mechanisms underlying growth and phenotypic plasticity. This research domain is now at a stage that integration and cooperation will trigger important innovative, pre-competitive research on plant UV-B responses at the metabolite, organism and ecosystem level.

Many UV-induced plant compounds provide protection against potential UV damage, including UV-B absorbing anthocyanins and flavonoids, anti-oxidants such as ascorbate (vitamin C) and glutathione and a broad range of further metabolites including carotenoids (vitamin A), polyamines, tocopherols (vitamin D), glucosinolates and specific alkaloids. Many of these metabolites are of nutritional and/or pharmacological importance, and are determinants of food quality, safety, colour, smell, firmness and flavour. For example, dietary polyamines control human cell growth and proliferation. Polyamine accumulation in the plant is regulated by UV-B involving a complex dose-response relationship. Similarly, the phenylpropanoid methyleugenol is of nutritional concern. The EU Health and Consumer Protection DG has reported on its carcinogenic and teratogenic properties, and the lack of a safe exposure limit. This compound is present in basil (and derived products such as pesto) where its levels are strongly regulated by UV-B radiation. Thus, a better understanding of UV-B-induced changes in plant metabolite profiles, addresses the fundamental question of regulation of plant metabolism, but also offers opportunities to improve food quality, and to exploit UV-B in sustainable crop production. The regulatory effects of UV-B on pest and disease tolerance are still poorly understood, but offer substantial potential for exploitation in conjunction with UV-manipulation technologies, including novel cladding materials and post-harvest UV-applications. Currently, reductions in insect damage (and a consequent decrease in viral disease) in UV-poor glasshouses constitute one of the best practical examples of exploiting environmental control by UV-B. This will benefit farmers, growers, food/feed processors, and consumers. There is an urgent need to integrate (current) disparate studies on UV-induced metabolites by developing standardised protocols, and by analysing a greater range of metabolites. Both needs will be addressed through this COST Action.

Plants raised under ambient UV-levels are typically well protected from such radiation due to the activation of a battery of protective responses. However, these protective responses may directly alter relationships of plants with their abiotic environment. UV-induced changes in anti-oxidant status can potentially mediate crosstalk between different stressors, either via cellular and/or intercellular molecular signalling or by altering anti-oxidant stress defences. However, the link between UV tolerance, ROS and anti-oxidant systems is currently not sufficiently clear, especially not under realistic UV levels. This Action will improve understanding of the roles of ROS and ROS

scavengers in regulation and defence by developing exposure protocols, and investigating UV-responses of transgenic plants with altered ROS-scavenging capacity. In parallel, sophisticated ROS-detecting spin-trap methods will be developed, and used in newly developed UV-B exposure routines**.**

A ubiquitous, regulatory UV-B-driven process is the decrease in stem and leaf size of UV-B exposed plants. During the last years, substantial progress has been made in elucidating the mechanism underpinning the UV-induced, small-plant phenotype. The transcription factor HY5 appears to play a central role in inducing this phenotype, involving changes in redistribution of the plant hormone auxin. However, there are still big gaps in our understanding of the mechanism by which UV alters morphology, the benefits for the plant in terms of UV-B protection and the cost of this response in terms of a potential trade-off. Biotechnological applications of UV-mediated morphogenesis include the production of stocky plants that are less easily damaged during transport and handling. Transfer of plants, sometimes over long distances, is a normal aspect of modern horticulture. Regulatory processes that yield more robust, stocky plants have substantial potential for the horticultural trade. The annual added value of the trade in cut flower and pot plants for the Netherlands alone is in excess of €4.5 billion.

There is now significant evidence to suggest that UV-B radiation interacts with other environmental variables when impacting on plants and their communities. Climate change has a major impact on how plants respond to UV-B, and vice versa. Recent studies indicate that UV-B exposure can moderate some effects of climate change at the organism level. For example, pre-exposure to UV-B will promote plant xerophytic characteristics, resulting in increased tolerance to drought episodes as a consequence of global change. At the same time, UV-B slows recovery of plants following exposure to other environmental stresses associated with climate change, including frost recovery and heat-shock recovery. Understanding these mitigating and/or aggravating phenomena will require better understanding of the (seasonal) role of UV-B at organism, plant community and landscape level. Increased knowledge will have pan-European relevance in terms of identifying threats to natural ecosystems, forage crops, and agriculture, but also present significant opportunities for improved food-/feed-chain and ecosystem management.

B.3 Reasons for the Action

Novel understanding of UV-mediated processes has emerged over the last few years. It is now realised that low, ecologically-relevant doses of UV-B radiation specifically regulate plant metabolism (as opposed to earlier stress dominated-views). This Action focuses on the basic mechanisms underlying regulation of growth, metabolite profiles, stress defence and interactions of plants with their environment, including development of pre-competitive research on new biotechnological applications in food/feed quality, pest/pathogen sensitivity, and modulation of plant architecture.

A major impediment for the UV-research community is that data from different studies can mostly not be compared due to the use of different UV-sources, spectral doses and measurement techniques. Therefore, this Action will work towards the development of standardised UV exposure routines. Technical advances have been made in spectroradiometry (CCD), UV-irradiation equipment (LED), and development of UV-weighting factors and cladding materials. Some of these have improved the quality and environmental relevance of work on UV-responses, but for other technological advances the biological suitability remains to be established. The concerted assessment and exploitation of novel UV-technologies, in conjunction with relevant industries, is a major aim of this Action.

It is virtually impossible for any individual researcher or research group to synthesise a conceptual model encompassing the many molecular signalling routes, protection and repair responses that control growth of an individual plant, or, ultimately, vegetation, exposed to a changing climate. Yet, such a conceptual model is required to stimulate new applied research for the food/feed and agri-/horticultural industries, and to underpin crop and ecosystem management, as well as policy decisions. This Action provides a unique pan-European platform of expertise, study sites, and approaches for the study of UV-B and its interaction with plants. Indeed, involved in this Action are most key UV-researchers from within Europe, giving access to state-of-the-art laboratories, an established, experimental field site (Abisko) and highly specialised phytotrons with sun-simulators. This Action will, through “cross-pollination” of research ideas and approaches, develop an interdisciplinary vision by integrating a range of sciences from plant biology, to meteorology and

nutritional sciences, as well as scales from molecule to organism, ecosystem and climate. It is this bridging of expertises that will create a robust, broad perspective on the regulatory role of UV-B, incorporating laboratory or field work on different plant species and spatial or temporal scales.

A pan-European, interdisciplinary platform of expertise and study sites, and a wealth of ideas and approaches guarantee that associated ESR and ER receive the highest possible quality of training in a stimulating environment. ESR will be able to present ideas and or data to various experts through Network meetings or a dedicated Action Website, and can avail of an exchange program to gain experience in a range of techniques, approaches and concepts, across the different groups included in this Action.

A COST Action is particularly appropriate to coordinate work of such a broad ranging consortium of scientific groups, as are present in this Action. Actions improve international contact between laboratories, enhance the training experience of ESR and ER and encourage scientific collaboration between laboratories, disciplines and industries. This Action encompasses a very large proportion of the European and International experts working on different aspects of UV-plant biology, including cellular, metabolic, organismal and ecological perspectives, as well as experts in general stress biology, human nutrition, food quality, climatology, meteorology and photobiology. Success in networking will facilitate scientific debate, stimulate innovative research, enhance the international standing of European research, and result in a platform from which to launch future research applications.

B.4 Complementarity with other research programmes

This COST Action has synergies with several programs, including:

- Cost Action 726 "Long term changes and climatology of UV radiation over Europe" (8/1/04 through to 28/3/09; two Members of COST 726 are also part of this application).
- Cost Action FA0650 “Signalling control of stress tolerance and production of stress protective compounds in plants” (21/3/07 through to 16/12/11; two Members of COST FA0650 are also part of this application).

- Activities of the UNEP Environmental Effects Panel on Ozone Depletion. This Action will closely liaise with the Panel, an interaction facilitated by the fact that three members of this panel are also involved in this Action.

This COST Action has also complementarities with several future programs, and the Action Network will be instrumental to launch further research grant applications. This includes:

- FP7 (theme 2 Food, Agriculture and Fisheries and Biotechnology) collaborative projects on plant breeding, response to climate change, induced stress and abiotic stress tolerance of plants. (KBBE.2010.3.1-01 states that research on abiotic stress tolerance of plants under climate change conditions is priority in the EU and in third countries, with biotechnology as a key tool addressing the ability of plants to cope)
- Marie Curie Initial Training Network

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The key objective of this COST Action is to bring together, coordinate, and enhance the performance of nationally-funded research activities (currently 39 academic groups and 2 SME in 18 countries) by forming a coherent, interdisciplinary research and training Network that will develop an integrated vision on the regulatory role of UV-B in plant growth and development at cell, organism and ecosystem level.

C.2 Secondary objectives

1. Support training and enhance the research experience of ESR and ER in order to prepare a cadre of highly skilled researchers with the interdisciplinary skills needed to ensure that Europe can meet future research challenges.
2. Develop new experimental guidelines and standards based on new biological insights as well as technological advances in UV irradiation technology and spectroradiometry applications, and summarise these in a “best-practice” report.

3. Develop understanding of the molecular mechanisms underlying the regulatory UV-B-mediated control of growth, morphology and metabolite accumulation, and report this in a vision document.
4. Assess prospects for commercial production of produce with improved quality including better flavour, colour, firmness and/or aroma, and higher contents of nutritionally and/or pharmacologically relevant metabolites, including tocopherols, anthocyanins, flavonoids, polyamines, isoprenoids, and glucosinolates, as well as lower contents of potentially toxic compounds (i.e. methyleugenol) and report this in a stakeholder document.
5. Develop understanding of how UV-B interacts with regulatory pathways and metabolites involved in pest and disease resistance and assess potential for sustainable pest and disease control and report this in a vision document.
6. Develop understanding of the role of ROS and anti-oxidants in UV-B-mediated signalling and protection and report this in a vision document.
7. Expand knowledge regarding the mechanism of UV-B-induced morphogenesis, its role in UV-B protection and assess potential for commercial production of more stocky plants and report this in a stake-holder document.
8. Comprehend how UV-B radiation interacts with and also moderates the impacts of climate change factors (e.g. increased temperature, drought, and N deposition) at plant and community level and report this in a vision document.
9. Identify UV-B mitigation and adaptation processes and explore their value to breeding and management of crops and natural vegetation and report this in a vision document.

C.3 How will the objectives be achieved?

The relevant research community is currently fragmented across disciplines and national borders, impeding scientific and pre-competitive progress. This Action brings together most of the key UV-B plant researchers in Europe and beyond, thus providing access to a broad range of skills, techniques and facilities, including laboratories for molecular studies, metabolomic facilities and

field stations including an established experimental field site (Abisko). The main tools to achieve the primary and secondary objectives are:

- Regular Network meetings to discuss and coordinate research and network activities (twice a year for the MC, and once or twice a year for the WG and TG)
- A substantial number of research exchanges for ESR and ER to enhance ideas, research experience, and career prospects
- Several (>4) workshops and/or summer schools in topical, methodological and complementary skills, with invited international experts
- Five specific dissemination sessions to liaise and transfer knowledge to stakeholders including agri- and horticultural industries, food and feed industries and policymakers
- One major international conference on regulatory UV-B interactions with plants
- A Website which will enable Members of this COST Action to access data, publications and/or presentations, and serve as a forum to discuss technical and scientific issues.

C.4 Benefits of the Action

European groups are currently at the forefront of research on newly discovered, regulatory UV-B processes, but joint action is necessary to decipher the regulatory, UV-dependent events that control growth and plant-interactions at the cellular, organismal and vegetation levels, and to develop biotechnological applications.

This Action will strengthen Europe's leading role in UV-B research, meet a major objective of FP7, the creation of a "European Knowledge-Based Bio-Economy", and address FP7 thematic priorities in "Health", "Food, Agriculture, and Fisheries-Biotechnology", and "Environment".

Specific benefits of this Action include:

- Optimised use of facilities and funding.
- Novel interdisciplinary research and learning by bringing together molecular biologists, plant physiologists, agronomists and ecologists in a Network.
- Platform for exploitation novel technological advances in UV-weighting factors, UV irradiation, filtering and spectroradiometry.

- Platform for development of standardised exposure technologies.
- Launching platform for future proposals seeking national and international funding.
- Enhanced training environment for ESR and ER.
- Improved knowledge-base and generation of integrated summary reports on interactions of UV-B with plants, to support policy-makers concerned with environmental change.
- Generation of relevant knowledge that forms a basis for pre-competitive collaboration with food and agricultural enterprises (SME) that develop biotechnological applications.
- Forum for North-South collaboration with partners in New Zealand and Argentina.
- Better understanding of potential health benefits or toxicological concerns due to UV-B-induced changes in the plant metabolome (developed UV-applications could add value to crops).

C.5 Target groups/end users

The primary target group for this COST Action are university and research laboratories, throughout Europe, working on complementary aspects of UV-B plant biology. Currently, UV-B research is fragmented across disciplines and countries. This COST Action will bring together, coordinate and enhance the performance of these nationally-funded groups. This Action will be inclusive, within limits set by main and secondary aims. Contact with further scientists, not involved in this Action, will be maintained through published papers, contributions at conferences and individual networking. In this respect, success of this Action will be demonstrated by the quality of the networking, increases in collaborative research, development of new knowledge, enhanced liaising with food/feed and agri-/horticultural industries and policy makers, and success of consortium Members to attract additional funding.

A second target group of this COST Action are ESR and ER in the participating groups. This Action provides a stimulating, exciting environment for study and learning, offering possibilities to present and discuss data at Network meetings, contact experts for advice (directly or via Website forum), and take part in scientific exchanges to learn new techniques and/or ideas.

A third target group of this interdisciplinary COST Action are agricultural and horticultural industries, food/feed industries and policy makers. The development of pre-competitive research, in association with industries, is an important aim of this Action. Two SME are full Members of this Action, while Action Members are in regular contact with a range of agri/horticultural organisations, food/feed industries, and governmental organisations (see H1). These contacts will be further developed during the course of this Action. Stakeholders will be invited to specific stakeholder sessions (see H3), linked to Network meetings, in order to match research and developmental agendas. The final output of this Action is a summary report that integrates insights developed at Network meetings and workshops, and that addresses issues related to fundamentals of growth, food quality, pest and disease tolerance, and environmental and agronomic management. Targeted end-users of this report are food and feed industries, horticultural and agricultural enterprises, and policy-makers concerned with environmental policies.

A final Target Group are educational institutions. To reach out to the latter, this Action will develop an on-line educational information package (TG Dissemination, See E.1.) that integrates across all work-packages of the Action and that reaches out to primary and secondary schools. UV-B and climate change will have the most significant effects on the younger generation. Therefore, there is a need to inform, educate and prepare this generation for future challenges to food security and European habitats. Research outputs will be used to inform young European citizens to help them make the connection between the environment and the:

- Food ("From our planet to our plate").
- European habitats, the ecosystem services that they supply and our responsibility in terms of conservation.
- Future threats, challenges and opportunities of global environmental change.

This addresses the increasing concern about our European "packaged food mentality" and helps young people to appreciate and connect with the origins of their food. There will also be a section on the Website where the public (and private sector) can ask questions to the scientists.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

Scientific focus is on the objectives listed in section C1 and C2. The key steps, for reaching our main objective of creating a coherent, interdisciplinary research & training Network focussed on the regulatory role of UV-B in plant growth and development, are:

- Development of strong communication channels, enabling discussion, exchange of ideas and people across disciplines and borders.
- Development of an interdisciplinary vision on new perspectives in plant UV-B research, across organisms, organisational and time scales.
- Development of standardised experimental protocols and increased uptake of novel exposure technologies, enabling comparison of data between laboratories.
- Development of an effective training environment for ESR and ER
- Using this COST Action as leverage to obtain further support for research through EU and other funding bodies.

D.2 Scientific work plan methods and means

The scientific program of this Action focuses on coordination and stimulation of research in four complementary themes, each represented by a Working Group (WG). Most Action Members are involved in multiple WG, ascertaining exchange of information. Technical Groups (TG) will address specific issues relevant to all consortium Members, and these will operate across the four work packages.

Nuclear regulation by UV-B radiation (WG1)

This WG will produce a coherent vision of the molecular mechanisms underlying regulatory, UV-B-mediated control of growth. The emerging picture indicates that UV-B responses are controlled at two levels, at the level of gene expression and via a number of different regulatory circuits. This WG will generate better understanding of UV-B perception, signal transduction, cell cycle adjustments, DNA and histone modification and transcription regulation, and will create opportunities to adjust growth, yield, and quality and stress tolerance of crops.

WG1 will coordinate and enhance nationally-funded research on:

- WG1.1 A coherent vision of UV-B regulated gene expression will be developed through a range of approaches. Promoter elements required for UV-B regulation will be defined through meta-analysis of microarray data in combination with computational techniques (such as phylogenetic foot-printing). Transcription factors binding to these promoter elements will be identified through the latest generation of yeast 1 hybrid (Y1H) assays. Novel signaling components, including putative UV-B receptors, will be isolated using appropriate UV-B-responsive reporter lines. Moreover, interactions will be analysed between UV-B signaling pathways and other important regulatory cascades (i.e. the UV-B-induced MAP, and other protein kinase pathways, antioxidant-activating and nitrotyrosination systems, and the circadian clock).
- WG1.2 The interaction between UV-B exposure, epigenetics, and gene expression will be analyzed by assessing changes in the level of histone modification in UV-B-exposed *Arabidopsis thaliana*. UV-induced histone modifications will be analysed using chromatin immunoprecipitation (ChIP) assays and ChIP-on-chip to investigate the link between gene-expression and UV-B-exposure. Purified histones will be analysed using sensitive high-performance mass spectrometry and *in vitro* stable isotope labelling techniques (e.g. iTRAQ) linked to tandem mass spectrometry will be applied to quantify histone modification. Methylation of CpG islands linked to the genes shown to be differentially expressed during UV-B-exposure will be identified by using Methylation-Specific PCR (MSP-PCR).
- WG1.3 The activation of targets and the epigenetic modifications identified in WG1.1 and WG1.2 will be analyzed at the cellular level using a state-of-the-art high-resolution (0.4 nm) tunable UV laser, both in wild type and UV-B signaling mutant backgrounds. The involvement of these components in the regulation of a number of different UV-B response genes, as well as the wavelength dependencies of these regulatory events, will be determined. In parallel, UV-B responses will be studied at the tissue level. UV-B radiation is readily absorbed by the outer cell layers of plant organs; however, it is unclear how UV-B responses are orchestrated at the whole plant body level. To assess whether UV-B signaling is manifested in cell-to-cell and/or cell autonomous fashion, transgenic plants producing the

UVR8 protein in a cell-specific fashion will be generated, driving *UVR8* expression exclusively in the epidermal, mesophyll or vascular bundle sheet cells in an *uvr8* null background. The efficiency of UV-B signaling will be determined by analyzing HY5/HY5/YFP and CHS/CHS/YFP reporter activation.

The outputs from WG1 will include a positional report on the current state of knowledge on UV-B regulated nuclear events (possibly published as a peer reviewed paper), a vision document identifying areas requiring further research or having pre-competitive potential, a Network meeting/summer school as well as a program of research exchanges, especially targeted towards ESR.

UV-B-induced metabolic changes (WG2)

Recent data indicate that UV-B alters accumulation of a broad range of metabolites, in a coordinated manner. This WG will generate knowledge on the regulatory, UV-B-mediated control of nutritionally and/or pharmacologically relevant metabolites, including polyamines, tocopherols, and isoprenoids and glucosinolates. The profiles of metabolite accumulation, dose-response curves and accumulation kinetics, as well as consequences for food and feed quality, food safety, colour and flavour will be analysed. Optimizing phytochemical concentrations by targeted post-harvest UV-B applications can add health value, and generate new opportunities for growers and processors. UV-induced metabolites can modulate pest and/or pathogen sensitivity, and, therefore, offers potential for reducing pesticide applications.

This WG will integrate research into a series of focussed sub-packages that address the effects of UV on metabolism across a range of organisational scales, from gene-expression, via metabolites to food quality. Work will focus on model (incl. *Arabidopsis thaliana*) and horticulturally important target species. All sub-packages share a common foundation of UV methodologies. Of particular importance for this WG is the involvement of nutritional scientists, who will give feedback and advice on the dietary relevance of changes in plant metabolome.

WG2 will coordinate and enhance nationally-funded research on:

- WG2.1 UV-dependent regulation of metabolic pathways, focussing on (i) the phenylpropanoid pathway, (ii) the shikimic acid pathway and (iii) the lipoxygenase pathway. There will be strong links here to WP1 (nuclear events including translation) and there will be a shared approach to experimentation, including the use of mutants and transgenic plants in specific biosynthetic or regulatory pathways, and real-time PCR to characterise UV-mediated control of expression of genes for enzymes in specific pathways (including spatial and temporal patterns of expression).
- WG2.2 UV-dependent regulation of the concentration and balance of major groups of plant metabolites, including pigments. Focus is on the products of the pathways studied in WG2.1 and those with roles pertinent to WG2.3 and WG2.4. Methods used within the consortium include metabolomic fingerprinting (FT-IR and NMR), GC-MS, LC-MS for quantification of specific compounds, and UV-visible spectrophotometry for pigments and antioxidant systems.
- WG2.3 The influence of UV-induced changes in metabolite profiles on crop quality. WG2.3 will consider how UV-induced changes studied in WG2.1 & WG2.2 influence crop quality; this refers to nutritional quality, or toxic properties, but also potentially to the pharmaceutical value of medicinal plants. This sub-package links the biochemical measurements of WG2.2 with agronomic and commercial elements of quality, including pigmentation and taste, contribution to stress tolerance (see WG2.4) and contribution to human dietary needs, the latter involving close links with colleagues working in the role of plant phytochemicals in health and well-being.
- WG2.4 The influence of UV-induced changes in metabolite profiles on the responses to abiotic and biotic cues. WG2.4 will consider how UV influences responses to environmental stimuli such as high light and extreme temperatures using a range of ecophysiological tools (e.g. chlorophyll fluorescence, in situ gas exchange) linked “down” to the measurement of plant chemistry from WG2.2 and linked “up” to wider assessments of UV regulation of growth in WP3. Similarly, this group will study the importance of UV-induced changes in chemistry on biotic interactions such as with plant pests (insects) and pathogens (fungi), but also plant litter degradation in the soil.

- WG2.5. Delivery systems for the practical and commercial exploitation of the understanding obtained in WG2.1 and 2.2. This will form part of the wider knowledge transfer element delivered through integrating WG2 with the "UV technology" TG. WG2.5 will extend the improved knowledge on altered responses to biotic and abiotic conditions to meet the needs of crop production, for example through the use of modified cladding materials or the use of novel UV lighting technologies, and post-harvest UV-exposure which can create low, ambient or enhanced UV-environments.

Knowledge will be summarised and suitability for commercial exploitation will be investigated through communication with relevant stakeholders (and subject to IPR establishment). Outputs will include a positional report on the current state of knowledge on UV-B regulated metabolomic changes (possibly published as a peer reviewed paper), a vision document identifying areas requiring further research or having pre-competitive potential, a Network meeting/summer school as well as a program of research exchanges, especially targeted towards ESR.

Organismal responses to UV-B radiation (WG3)

This WG will generate knowledge about the regulation by UV-B of plant growth and development, mainly at the organismal level. This will include regulatory mechanisms that induce morphological changes, but also mechanisms that confer protection or accelerate repair. These data will help understand plant function in agro/natural ecosystems. Currently, a picture is emerging in which moderate irradiances of UV-B regulate, rather than inhibit growth. ROS and scavenging of ROS play an important role in these processes, through altered intercellular signalling as well as protection against oxidative conditions. Acquired knowledge will be considered in the context of potential for a more sustainable and environmentally friendly agriculture and horticulture, taking advantage of more stocky phenotypes (use of chemical growth regulators is increasingly restricted), and/or cross-tolerance between stressors.

WG3 will coordinate and enhance research on four supplementary sub-packages across different timescales, from short term, via long term, to cross-generational UV-responses, giving a kinetic perspective of UV-B-mediated responses.

- WG3.1 Characterisation of responses of plants to short term UV-B exposure (hours to days). Plants will be exposed to short term, regulatory doses of UV-B and consequences for plant growth, photosynthesis, stomatal function, cytoskeletal architecture and gene-expression (jointly with WG1) will be analysed. This will include eco-geographic analysis of ecotypes and/or species that have evolved under different UV-regimes. UV-B-mediated changes in oxidative redox states will be quantified and characterised using novel (spin trap) ROS monitoring methods, under moderate UV doses, while the functional (protection and signalling) role of ROS and ROS scavengers in UV-B responses will be tested in transgenic plants with modified levels of ROS scavenging enzymes.
- WG3.2 Characterisation of UV-B acclimation responses to medium-term UV-B exposure (weeks to months). Regulatory UV-B responses will be investigated at the level of gene-expression, physiology and plant performance (with WG1, and WG2.4). The transmission of systemic signals, from irradiated plant parts to non-irradiated plant parts will be analysed, as this is especially relevant to acclimation of large plants such as trees, in which different branches experience contrasting UV-B conditions. The role of phytohormones in UV-induced morphogenesis will be analyzed and the consequences of the altered phenotype for light capture, photosynthesis, competitiveness, and ecosystem function will be established. The possibility to commercially modulate plant architecture using UV-B (alternative to chemical growth regulation) will also be investigated. Where growth regulation by UV-B is undesirable (e.g. leafy vegetable crops), the potential of commercial biostimulators (e.g. based on seaweed extracts or synthetic mixtures of phenolics) to moderate UV-B responses will be investigated.
- WG3.3 Characterisation of cross-generational UV-B acclimation responses. Recent studies have indicated cross-generational induction of UV-B tolerance. This exciting finding needs much further study, and this will be done in conjunction with WP1 (epigenetics). Memory effects will be characterised in terms of induction conditions and thresholds, duration and the ecophysiological role in the acclimation to temporal variation of the UV-B environment.

Outputs from WG3 will include a positional report on the current state of knowledge on UV-B regulated organismal responses (possibly published as a peer reviewed paper), a vision document identifying areas requiring further research or having pre-competitive potential (for example in crop breeding or plant architecture modification), a Network meeting/summer school as well as a program of research exchanges, especially targeted towards ESR.

UV-B and climate change (WG4)

This WG will generate knowledge about the interaction between UV-B regulated processes and effects of climate change. Most UV responses change dramatically (some synergistically) with alterations in other environmental parameters. On a global scale, such interactions are of key importance for agricultural and ecosystem productivity (food security, food web integrity). This work group will study UV-B plant photobiology in the context of climate change, and develop a vision on the importance of these interactions for agronomic practice, plant breeding, (protected)-crop management as well as habitat and conservation management. These studies will link organismal responses with those at the community and ecosystem level.

Research in this WG has been organised to concentrate on three systems, the aquatic environment, foraging-dominated systems and communities of berry-carrying shrubs and trees.

WG4 will coordinate and enhance nationally-funded research on:

- WG4.1 Aquatic and semi-aquatic systems. Research targets aquatic and intermittent aquatic systems, colonized by plants, bacteria, ciliates and zooplankton of different growth forms and strategies. Some species have amphibious characteristics and are exposed to variable hydrological and consequently differing light (UV-B and PAR) conditions. Climate change and consequent changes in temperatures and precipitation will influence water level fluctuations in riparian systems selecting against certain species but offering opportunities for competitive native and alien invasive species. Ecophysiological and biochemical response mechanisms to UV-B and submersion will be analysed in different aquatic species, the habitats of which range from the fully aquatic to the aquatic-terrestrial interface.

- WG4.2 Foraging dominated systems. Research will focus on the impact of UV and seasonal changes in temperature on foraging grasses and foraging quality. The metabolic composition of foraging grasses exposed to UV-B and/or high temperatures will be analysed in conjunction with WP2. The use of UV induced pigments as a proxy for drought tolerance in plants will be investigated, enabling selection for drought stress in breeding. The initial work will focus on using the model species *Lolium perenne* which is widely exploited as an agriculturally important forage grass throughout the EU. This species also offers the potential to investigate protective pigments at the eco-geographic scale using the COST Network to look at variation with latitude and altitude. Grazing, including food conversion efficiencies will be determined for reindeer (in conjunction with Fennoscandian reindeer industry) in the context of UV-B and/or temperature changes. This work will develop into a full EU research programme dealing with forage quality and climate change and its impact on sheep and cattle grazing systems.
- WG4.3 Berry-carrying shrubs and trees. This WG will focus on the question how interactions between UV-B and climate change parameters control fruit quality in natural and agro-ecosystems. Berries represents an important food source for humans, frugivorous small mammals and passerines. Many berries are high in flavonols and antioxidants and it is hypothesised that UV-B will enhance this health benefitting capacity. Interactions between UV radiation and climate change factors (e.g. temperature, precipitation and elevated CO2) on berry metabolite profiles will be investigated on a wide range of fruits (in close collaboration with WG2). Fruit quality traits include amino acid composition, flavonoids, C/N ratios, and aromatic compounds such as methoxypyrazines. These traits are important determinants of wine quality (flavour, aroma, mouth feel, ageing). This COST-Action will closely interact (existing contacts) with the wine industry, which represents a multi billion Euro market within EU alone.

Outputs from WG4 include a positional report on the current state of knowledge on interactions between UV-B and climate change effects (possibly published as a peer reviewed paper), a vision document identifying areas requiring further research, a Network meeting/summer school as well as a program of research exchanges, especially targeted towards ESR.

TG UV-technology

Technical Groups (TG), spanning across all four WG, are key components of this Action, and are defined in section E. The TG "UV-technology" coordinates activities related to UV spectroradiometry, UV- radiation technology, UV filtering, and UV manipulation in order to:

- Ascertain standardisation of technical approaches across the COST Action,
- Contribute to establishing a common basis of "best practice" across all Members.
- To encourage uptake of novel technological advances.

UV manipulations are solidly established in the participating laboratories. Treatments use either UV lamps (in glasshouses, growth rooms, sun simulators or in the field) or manipulation of solar UV radiation and plastic or glass filters that specifically attenuate UV radiation. However, the correct use of action spectra to calculate biologically-effective UV-B (UV_{BE}) is of paramount importance to obtain environmentally relevant regulatory effects that can be compared between laboratories (an area where this COST-Action will strongly contribute). Currently, there are discrepancies in the use of UV-measurements, and doses, particularly between "laboratory" scientists and "field" scientists. The TG 'UV-technology' will develop experimental protocols, and advise the Action on the use of action spectra ("Generalized Plant Action Spectrum [Caldwell]" or "Plant Damage Spectrum [Flint]") for weighting radiation. With increasing knowledge about plant responses to UV radiation, and a shift of focus from inhibition to regulatory effects, new weighting functions, based on action spectroscopy must be developed, and this Action will play a coordinating role in this process.

The availability of irradiation sources to deliver either a chosen spectral composition, or monochromatic UV of a selected wavelength band, has long been a real problem. However, technological advances are creating great opportunities. LED can now be obtained for any wavelength, the problem is only cost, life-span and output of radiated watts, but technology is rapidly improving. TG "UV-technology" will liaise with technology-suppliers to facilitate uptake of novel measurement (CCD), filtering (plastics) and lighting (LED, narrow-band UV-B lasers) technologies. Thus, TG "UV-technology" catalyses technological innovation across the Network.

The output of TG "UV-technology" is a report on good practice and standard procedures, and this will be available at the end of year one, in order to maximize its impact on research in this Action. This report is an important output of this COST-Action and will be published in a peer reviewed paper as procedural aspects have relevance for a much wider audience than this COST Network (i.e. medical and veterinary work). The advice of TG "UV-technology on best practice will also be presented at a Network meeting/summer school early in this COST-Action, followed by annual updates at Network meetings.

E. ORGANISATION

E.1 Coordination and organisation

The key objective of this COST Action is to bring together, coordinate and enhance the performance of nationally-funded research activities (currently 39 academic groups and 2 SME in 18 countries) by forming a coherent research Network.

The organisational structure reflects the need to improve communication across disciplines and national borders, and comprises a Management Committee (MC), four Working Groups (WG) and three Technical Groups (TG).

An MC, assembled when the Action is formally approved, will oversee the overall functioning of the COST Action, take responsibility for the budget, coordinate activities of WG, and TG, organise an international conference, and report to relevant COST-domain committees. The MC is composed of the MC Chair and Deputy-Chair, WG-leaders, TG-leaders and representatives from all (currently 18) signatory countries. The MC Chair and Deputy-Chair, together with WG-, and TG-leaders will all be appointed at the kick-off meeting of the MC. The MC Chair and Deputy-Chair, together with WG-, and TG-leaders will form the Core Group (CG) of the MC. This CG will prepare meetings, agendas and minutes, and will work closely together on coordinating all network-activities. The MC Chair will be the formal point of contact person between the Action and the COST-office and the Domain Committee. The MC will meet every 6 months to evaluate progress, and plan ahead. The CG will meet once between each MC meeting.

The WG-leaders will be tasked with coordinating activities within the respective work-packages. This includes ensuring that timetables are adhered to, prepare reports for WG and MC meetings, and coordinate the organisation of topical workshops and/or summer schools. The topics of the specific work-packages are found in section D2, and E2 Each WG-leader will also interact with other WG and relevant TG.

TG are an important aspect of this COST-Action. The TG will interlink all our work-packages, and coordinate specific activities that are vital for the whole Network. TG involve one or more scientists with expertise and interests in specific aspects of the Action. TG-coordinators are part of both the MC and the CG, and report directly to these.

The "TG dissemination" will coordinate all dissemination activities. This will include updating the COST-Action Website, establishing a register of Network output (i.e. publications and other reports), and maintaining and establishing contacts with relevant stakeholders, including organization of stakeholder-sessions (H3) in collaboration with WG. Two SME are Members of this Action, and their extensive network of contacts in the agro-/horticultural industries will further facilitate dissemination.

The "TG training & education" will coordinate all exchange activities (STMS), establishing (in conjunction with the MC) guidelines to assure optimal use of funding. The scientific exchange programme will act as a tool to optimise interactions within the Network and across disciplines and borders, to optimise exchange of technical expertise, to make new equipment and methods available, to improve the research and learning experience of ESR, and to assist development of future funding applications by Network Members. At least two ESR from different countries will be members of this TG. The "TG training and development" also contributes by co-organizing summer training schools together with the WG.

The "TG UV-technology" has specific responsibility for training and advice on all health and safety aspects of work with UV-radiation. This TG also advices on all technical aspects related to UV-measurements, UV-irradiation equipment, UV-filtering and UV-manipulation to ascertain

standardisation of technical approaches across the COST Network. The "TG UV-technology" will also liaise with manufacturers to facilitate uptake of novel measurement (CCD), filtering (plastics) and irradiation (LED) technologies. Two relevant SME are Members of this Action, and these companies will actively contribute to this TG. Thus, this TG plays an important role in technological innovation across the Network. The tasks of "TG UV-technology" also include contacts and co-action with the UNEP Environmental Effects Panel on Ozone Depletion. Three members of this panel are also Members of this COST Action.

Financial support of this COST Action will provide a firm basis for the organisation of meetings, conferences, workshops, exchange visits, and production of other deliverables.

E.2 Working Groups

Four interactive Working Groups will be constituted to supervise a programme of activities in each of the following domains:

- Nuclear regulation by UV-B radiation
- UV-B-induced metabolic changes
- Organismal responses to UV-B radiation
- UV-B and climate change

The focus of WG ranges from nuclear responses, via metabolic/physiological changes, to organismal and ecological/environmental aspects, thus emphasising the cross-disciplinary character of this Action, including the potential for cross-domain fertilisation. The WG will organise group meetings, specialised workshops, summer schools and/or exchange visits. The four Working Groups report back to the MC on activities and budgetary issues.

Specific details of the scientific programmes will, too some extent, evolve during the course of this Action, and this may be reflected in changes in the delineation of WG.

E.3 Liaison and interaction with other research programmes

This COST Action has synergies (i.e. cross-membership) with several EU-programs, including:

- Cost Action (COST 726) titled "Long term changes and climatology of UV radiation over Europe"
- Cost Action (COST FA0650) entitled “Signalling control of stress tolerance and production of stress protective compounds in plants”
- EU-Network of excellence on Ubiquitin regulation (Rubicon LSHG)
- FWO-International Network on phytohormones
- Italian National Network for UV-monitoring
- Arctic Monitoring and Assessment Programme
- WWF Arctic Programme

Where appropriate, either the MC or specific Members of this COST Action will liaise with other EU-programmes. This COST Action will also serve as an incubator that will likely lead to the establishment of future EU-funded research activities (as indicated under B4).

E.4 Gender balance and involvement of early-stage researchers

The COST Action will adhere to an appropriate gender balance in its activities and this issue will be a standard discussion and decision point on all MC agendas. Overall 159 researchers, ESR and ER are involved in this application, 49% of which are female. Some 40% of principal investigators (PIs) are female.

Large numbers of ESR are involved in this Action (currently 130 out of a total of 159). Active involvement of early-stage researchers will be a major issue of the Action and their research and learning processes are highly important. ESR will be encouraged to take leading roles in WG and TG, and to actively participate in organisation of, and scientific debate during workshops and summerschools. All WG will organise 1 or 2 workshops and/or summer schools, thus creating a stimulating environment of knowledge exchange and learning. A specific TG will coordinate training and educational activities (see section E1), in conjunction with the MC and the WG. ESR participation in this TG is particularly encouraged.

F. TIMETABLE

The Action will last four years. During this time there will be a series of MC, WG, TG, and CG meetings, exchange visits (STSM), workshops, and/or summer schools. MC-meetings take place every 6 months. The CG will meet once between each MC meeting. The organisers of each WG and/or TG will report on their activities to the MG. In addition, other deliverables, such as establishment of a Website, dissemination meetings for stakeholders, and annual reports will also be produced.

Timetable UV*4*growth (X, scheduled activity; v,optional meeting)

UV4Growth	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
MC activities																
Kick-off meeting	X															
Web site			X													
MC meetings		X		X		X		X		X		X		X		X
CG meetings			X		X		X		X		X		X		X	
Organisation international conference																
Progress report				X				X				X				
Final report															X	
WG activities																
Formal establishment WGs	X															
WG meeting		v		X		v		X		v		X		v	X	
WG Workshop / summer school by one WGl				X				X				X			X	
Stakeholder sessions								X				X			X	
TG activities																
Formal establishment TGs	X															
TG-meeting		v		X		v		X		v		X		v	X	
TG-Workshop by TG UV-technology				X												
STSMs		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Stakeholder sessions				X								X				

The first MC meeting (kick-off) will take place within 3 months after the Action has been approved. Each year, there will be annual MC meeting, coinciding in time and place with meetings of all WG and TG. This maximizes interactions across WG and TG domains, and ensures efficient use of time and resources. The MC has a further, second meeting every year. WG and TG also have the option to organise a second meeting each year. Some of the WG and/or TP meetings will take shape as a workshop and/or summer school, and these are preferentially associated with the combined, annual meeting of MC, WG and TG. Each WG will organise at least one workshop or summer school. Also, between MC meetings, the CG will meet twice a year. At the kick-off meeting, the MC Chair and Deputy-Chair, and WG- and TG-leaders will be appointed.

A large topical conference (open to non-Action participants) will be organised by the MC, in conjunction with the WG in year 4 of this Action. This international conference will underpin the final output of this Action; that is a summary report that integrates insights developed at Network meetings, workshops and the international conference, and that addresses issues related to fundamentals of growth, food quality, and environmental and agronomic management. Also, a summary of the educational and visiting programme for the ESR will be included. Targeted end-users are food and feed industries, horticultural and agricultural enterprises, and policy-makers concerned with environmental policies. There will also be a section on the Website where the public and private sector can ask questions to the scientists.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, FI, FR, DE, HU, IE, IL, IT, NL, PL, SI, ES, SE, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 60 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The aim of this Action is to study key UV-B induced regulatory processes underpinning growth, UV-induced morphogenesis, UV-B-induced changes in metabolite profiles and UV-B responses in the context of climate change. The greatest bottleneck facing researchers associated with this COST-Action is a lack of targeted communication channels with colleagues active in this scientific field. It is expected that improved communication with colleagues will enhance scientific and technical progress, innovation and exploitation. Effective communication with industry, regulatory bodies, policy makers, and public organizations will bring an important problem-orientating element into the research of the different research groups leading to the development of pre-competitive research.

Internal communication among the research community, as well as external dissemination of research findings, experimental approaches and technical advances are key targets of this COST Action. The target audience is diverse and can be grouped along the WG:

- Research scientists with an interest in fundamentals of plant growth and development (WG 1−3)
- Horticultural and agricultural organisations (WG 1-2-3)
- Governmental, regulatory agencies and industrial organisations with an interest in food quality (WG 2)
- Governmental and non-governmental policy makers with interest in climate change (WG 3−4)
- Producers of UV cladding and UV measuring equipment (TG UV-technology).

Internal interactions: This Action includes most key players in UV-B research in Europe, which, together with our associates in Argentina and New Zealand, is almost synonymous with the world leading researchers in this field. The groups have excellent scientific and publication records when it comes to UV-B-related research and some are already involved in EU-funded research projects. All have agreed to collaborate and share expertise, knowledge and facilities with the aim to form a strongly competitive UV-B research Network that has no comparison anywhere else in the world.

External interactions: Interactions with external stakeholders are considered that important that a dedicated TG-dissemination has been created to coordinate external dissemination activities. Members of this COST-Action are already in frequent contact with a broad range of these stakeholders, whilst two SME are full Members of this Action. Currently, Network partners are closely interacting with governmental organisations including the IPCC (Intergovernmental Panel on Climate Change), Arctic council, IASC (International Arctic Science Committee) and UNEP (United Nations Environment Programme) as well as agricultural, horticultural and forestry organisations throughout Europe, wine-industry in several European countries and New Zealand, Food-industries in several European countries, UV-equipment producers and a large biotech company. An attractive feature of this Action is the connection to the United Nations Environment Programme's (UNEP) Environmental Effects Panel on Ozone Depletion, where three Members of this Action are also members. Exchange of research results and development of recommendations for policy makers is a synergistic outcome of this collaboration, as are joint plans for dissemination.

H.2 What?

Dissemination of research findings, experimental approaches and technical advances and recommendations are a priority of this COST Network, and this is reflected in the establishment of a dissemination-TG, whose Chair is a Member of the MC Core Group.

Internal research exchanges are centred on regular MC, WG, and TG meetings, exchanges of staff (STMT), and the COST Action Website. A mailing list has already been established during the writing of this proposal. The Website will consist of a publicly accessible part, with information and general details on the COST Action, as well as selected presentations in the form of texts and videos. There will also be links to related websites and a special forum enabling questions from the public to the scientists, as well as material in different European languages that can be used in teaching in schools and at universities. A password-protected domain for internal use will contain more detailed information on research, research reports, and scientific updates, as well as administrative documents for distribution to the Action Members.

External communication will be based on a variety of strands whereby the Action Website will play a pivotal role in our communication (see above), presenting the background of the Action, contact details, selected research results etc. Additionally, scientific results will be disseminated in annual reports, scientific publications, pamphlets, and lectures at conferences, thus reaching out to the wider research community. However, most of our external dissemination activities will be pro-active, by inviting agencies, SME and other interested partners to WG and/or TG meetings, specialized stakeholder dissemination sessions, and the large, international conference. This will encourage two-way traffic of ideas, and guarantee long-term advantages (beyond 4-year term of this Action) for Network Members. Various Members of the consortium have extensive contacts with stakeholders (see H1), and these contacts will be fostered by inviting stakeholders to one topic-focused stakeholder sessions organized by WG and TG. At least four such stakeholder sessions will be organised during the four years (see also the time table in section F).

H.3 How?

Specifically, the major forms of dissemination are as follows:
Website: An Action Website will be operated through the COST Website containing an open part and a password protected part. The content of the Website is as elaborated previously in this section (H2).

Workshops and summer schools: These will enable internal communication and/or dissemination of research findings, experimental approaches and technical advances. There will time dedicated to networking and discussions on joint research grant proposals. One or more workshops will be arranged together with other organisations such as UNEP.

Stakeholder Sessions: Stakeholders (H1), including interested administrators, policy makers, industry representatives, organizations and the general public, will be invited to open specialized sessions that are part of workshops and/or summer schools. These sessions will be organized by each of the WG and TG together with the dissemination TG.

The Final International Research Conference: This topical conference will be open to non-Action participants. It will deal with all aspects of UV-B photobiology research as well as the role of UV-B in climate change. It will also produce a summary report of the COST Action that integrates insights learnt and addresses issues related to fundamentals of growth, food quality, and environmental and agronomic management, and that will be distributed among all interested stakeholders, and displayed on the Website

Annual Reports: Each year of the Action, an Annual Report for open publication will be produced. The report will contain a summary of the results and outcomes of the Action and its role in the progress of UV-B-related research

Pamphlets: General information about the Action and its outcomes will be published in pamphlet form.

Scientific Publications: Results obtained within the collaboration will be presented at scientific symposia or meetings other than those organised by this COST-Action. The Action will also strongly motivate participants to publish joint research results in peer reviewed scientific journals and encourage dissemination of such results in media reaching a broader audience. Results of the Action are of particular interest for the agriculture, horticulture, silviculture and food/feed sector, as well as enterprises in the UV irradiation and measurement fields. The connection between UV-B and climate change should also be of interest to the general public.

Prizes for Best Action Publication by an ESR: The MC will each year, upon nomination from any Action Member PI, award prizes for the three best scientific publications produced by Action ESR as first author. The prizes will be 1500, 1000, and 500 € each for the best, the second best and the third best scientific papers, respectively, to be used by the ESR for travel to an international research congress or for a visit to a scientific laboratory following standard COST rules. Also, a diploma/certificate will be presented to the three best papers. These prizes will be awarded each of the four years of the Action.

Direct contacts with other organisations: Joint organisation of workshops with other COST Actions or the UNEP Environmental Effects Panel on Ozone Depletion will be strongly considered. Also, it is aimed to contribute to decision-making by UNEP, by developing improved datasets on regulatory UV-mediated control of plant growth and development.