COST

Domain Committee "Food and Agriculture"

COST Action FA1204

Start Date (01/10/2012)

FA1204 Vegetable Grafting to Improve Yield and Fruit Quality under Biotic and Abiotic Stress Conditions

MONITORING PROGRESS REPORT

Reporting Period: *from 05/18/2012 to 03/25/2013*

This Report is presented to the relevant Domain Committee.
It contains three parts:

I. Management Report *prepared by the COST Office/Grant Holder*
II. Scientific Report *prepared by the Chair of the Management Committee of the Action*
III. Previous versions of the Scientific Report*; i.e., part II of past reporting periods*

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.D. Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary:

The COST Action network is expanding and counts more than 200 participants, of which about 30% are female and 12% ESR, representing more than 100 institutions in 21 COST countries and 4 non-COST countries. The Annual Conference, organized in Murcia from 13 to 15 November 2013, permitted to consolidate the network and to better understand the biological basis of rootstock effects on fruiting vegetable crops from different point of views. Additional innovative knowledge was also generated from the COST Action meeting held in Jerusalem from 10 to 12 February 2014. During the meeting, scientists and industry representatives discussed their advanced research results in order to define strategies for improving the quality of grafted transplants and for using grafting as integrated pest management tool in vegetable production systems. Seven STSMs are completed and 1 has been just approved by the STSM Committee. The level of inter-disciplinary seems to be sufficient to provide significant scientific and socio-economic impacts. Interactions between breeding companies/nurseries and academic researchers have enabled a greater understanding of the commercially most important traits to target in public-private research projects, and also the economic factors that drive the increasing use of rootstocks. Furthermore, these multidisciplinary expertise provides good bases for networking and creating competitive projects in the framework of H2020 R&I Programme and National Programmes.

I. Management Report prepared by the COST Office/Grant Holder

I.A. COST Action Fact Sheet

COST Action *FA1204* Vegetable Grafting to Improve Yield and Fruit Quality under Biotic and Abiotic Stress Conditions

- **Domain** *Food and Agriculture*

- **Action details:**

CSO Approval: 07/06/2012
Entry into force: 02/07/2012
End date: 30/09/2016
Extension: *(day/month/year)*

Objectives The main objective of the Action is to understand the biological basis of rootstock-mediated improvement of several vegetable crops (tomato, eggplant, pepper, watermelon, melon, and cucumber) and their compatibility by merging already existing scientific information generated in several European and non-European countries as basis for development and exploitation of new rootstocks.

- **Parties:** *list of countries and date of acceptance*

Austria *(date)*	Greece 28/08/2012	Poland *(date)*
Belgium 10/12/2012	Hungary 19/06/2012	Portugal 14/08/2012
Bulgaria 02/01/2013	Iceland *(date)*	Romania 28/11/2012
Croatia 27/08/2012	Ireland 26/06/2012	Serbia *(date)*
Cyprus 06/02/2013	Israel 26/06/2012	Slovakia *(date)*
Czech Rep. 21/05/2013	Italy 25/07/2012	Slovenia 08/11/2012
Denmark *(date)*	Latvia 13/11/2012	Spain 15/06/2012
Estonia *(date)*	Lithuania *(date)*	Sweden *(date)*
Finland *(date)*	Luxembourg *(date)*	Switzerland 18/10/2012
FYR of Macedonia *(date)*	Malta *(date)*	Turkey 11/07/2012
France 19/09/2012	Netherlands 03/09/2012	United Kingdom 21/06/2012
Germany 02/07/2012	Norway *(date)*	

- **Intentions to accept:** *list of countries and date*

- **Other participants:**

Albania	Agricultural University of Tirana
United States	North Carolina State University
United States	The Ohio State University
China	College of Horticulture & Forestry, Huazhong Agricultural University
Lebanon	Faculty of Agricultural Engineering and Veterinary Medicine, Lebanese University

Chair: University of Tuscia, Department DAFNE, via S.C. de Lellis snc01100 Viterbo, Italy
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DC Rapporteur: Prof Dov PRUSKY Agricultural Research Organization Institute of Food Technology, Department of Postharvest Science of Fresh Produce, PO Box 650250 Bet Dagan Israel
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Action Web site: http://www.vegetablegrafting.unitus.it

Grant Holder Representative*:* Prof. Leonardo Varvaro - email: direzione.dafne@unitus.it

Working Groups *(some Members are involved in more WG)*
Working Group 1: Genetic resources and rootstock breeding
Co-ordinators: Andrew Thompson (UK), Halit Yetisir (TR)

First Name	Last Name	Country
Ahmet	Balkaya	TR
Andrea	Mazzucato	IT
Andrew	Thompson	UK
Aquilino	Sánchez	ES
Beatriz	Bielsa	ES
Branko	Lovic	ES
Cédric	Camps	CH
Cemal	Fert	TR
David	Herzog	ES
Emilio	Carbonell	ES
Georgia	Ntatsi	EL
German	Anastasio-Ramón	ES
Golgen Bahar	OZTEKIN	TR
Hacer	Dokuzluoglu	TR
HALIT	YETISIR	TR
Ilknur	Solmaz	TR
Joan	Villanova Calatayud	ES
José Manuel	Zapata	ES
Liga	LEPSE	LV
Lorenzo	Barchi	IT
Marisol	Arnedo	ES
Nikolay	Velkov	BG
Noemi	Lukacs	HU
Noémi	Kappel	HU
Patricia	Irisarri	ES
Penelope	Bebeli	EL
Ronald	van Staalduinen	NL
Slomoz	Zuker	IL
Vasilis	Papasotiropoulos	EL
Victor	Lacatus	RO
Vito	Tumino	IT
Yildiz	Dasgan	TR

Working Group 2: Rootstock-scion interactions and graft compatibility
Co-ordinators: Dr Jan Henk Venema (NL) Dr Ian C. Dodd (UK)

First Name	Last Name	Country
Alessandra	Trinchera	IT
Ana	Pina	ES
Anja	Dieleman	NL
Ascensión	Martinez Perez	ES
Astrit	Balliu	AL
Cédric	Camps	CH
Colin	Turnbull	UK
Cristina	Martinez Andujar	ES
Elena	Cantero Navarro	ES
Elvira	Ferreira	PT
Emilio	Carbonell	ES
Francesco	Giuffrida	IT
Francesco	Orsini	IT
Frank	Louws	US
Giovanna	Causarano	IT
Ian C.	Dodd	UK
Jan Henk	Venema	NL
Jorge	Barmaimón Gerente	ES
Josefa	Lopez	ES
Juan	Fernandez	ES
Maria Jose	Rubio	ES

María Teresa	Estañ	ES
Nikolay	Velkov	BG
Noemi	Lukacs	HU
Noémi	Kappel	HU
Rossitza	Rodeva	BG
Salvador	Lopez-Galarza	ES
Serpil	Tangolar	TR
Shimon	Pivonia	IL
Shmuel	Wolf	IL
Tomas	Vanek	CZ
Yuan	Huang	CN
Zhilong	Bie	CN
Zsofia	Banfalvi	HU

Working Group 3: Rootstock-mediated resistance to biotic and abiotic stresses
Co-ordinators: Dr Dietmar Schwarz (DE) Dr Roni Cohen (IL)

First Name	Last Name	Country
Alberto	Battistelli	IT
Alessandra	Belisario	IT
Alfonso	Albacete Moreno	ES
Alfredo	Lacasa Plasencia	ES
amnon	koren	IL
Ana	Fita	ES
Andreas	Ropokis	EL
Andreas	Voloudakis	EL
Angeles	Calatayud	ES
Angelo	Parente	IT
Angelo	Signore	IT
Astrit	Balliu	AL
Athanasios	Koukounaras	EL
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Aviv	Dombrovsky	IL
Caridad -Ros	Ibanez	ES
Carmen Maria	Lacasa	ES
Catalina	Egea	ES
Cédric	Camps	CH
Christos	Olympios	EL
Consuelo	Penella Casan	ES
Dietmar	Schwarz	DE
Dimitrios	Savvas	EL
Dimitrios	Tsitsigiannis	EL
Dolors	Roca	ES
Dominik	Vodnik	SI
Ebrahim	Khah	EL
Elvira	Ferreira	PT
Emilio	Carbonell	ES
Farzaneh	Bekhradi	IR
Felix	Kessler	CH
Francesco	Di Gioia	IT
Francesco	Orsini	IT
Francesco	Serio	IT
Francesco Fabiano	Montesano	IT
Francisco	Borja Flores	ES
Francisco	Perez Alfocea	ES
Francisco	Sorribas	ES
François	Villeneuve	FR
Frank	Louws	US
George	Soteriou	CY
Giovanna	Causarano	IT
Giovanna	Gilardi	IT
Giuseppe	Colla	IT
Golgen Bahar	Oztekin	TR
Gvozden	Dumicic	HR
Hakan	Aktas	TR
Hakan	Fidan	TR
Hichri	Imene	BE

Isabel	Egea	ES
Jose Manuel	Perez-Perez	ES
Josefa	Lopez	ES
Juan	Fernandez	ES
Juan Manuel	Ruiz Lozano	ES
Katja	Zanic	HR
Lorenzo	Barchi	IT
Luis Miguel	Brito	PT
Maria Belen	Pico Sirvent	ES
Marian	Bogoescu	RO
Mariateresa	Cardarelli	IT
Marie	Torres	FR
Marios	Kyriacou	CY
Matthew D.	Kleinhenz	US
Menahem	Edelstein	IL
Michael	Bitterlich	DE
Paloma	Sánchez-Bel	ES
Pedro	Martinez-Gomez	ES
Petr	Soudek	CZ
Pradeep	Kumar	IT
Rana	Kurum	TR
Rita	Grosch	DE
Roni	Cohen	IL
Rossitza	Rodeva	BG
Salvador	Lopez-Galarza	ES
Selcuk	Ozmen	TR
Sevilay	Topcu	TR
Smiljana	Goreta Ban	HR
Tomas	Vanek	CZ
Yuan	Huang	CN
YUKSEL	TUZEL	TR
Zhilong	Bie	CN
Zsofia	Banfalvi	HU

Working Group 4: Rootstock-mediated improvement of fruit quality
Co-ordinators: Prof Cherubino Leonardi (IT) Dr Carmina Gisbert (ES)

First Name	Last Name	Country
Agata	Mazzaglia	IT
Alberto	San Bautista	ES
Angelo	Parente	IT
Angelo	Signore	IT
Antonella	Verzera	IT
Carmina	Gisbert	ES
Cherubino	Leonardi	IT
Ebrahim	Khah	EL
Elvira	Ferreira	PT
Fabio	D'Anna	IT
Francesco	Serio	IT
Francesco Fabiano	Montesano	IT
Frank	Louws	US
Giovanni	Iapichino	IT
Gvozden	Dumicic	HR
Ilknur	Solmaz	TR
Ioannis	Karapanos	EL
Isabel	Mourao	PT
Justine	Dewitte	BE
Katrin	Kell	DE
Leo	Sabatino	IT
Lieve	Wittemans	BE
Maria	Asins	ES
Maria	Gonnella	IT
Matthew D.	Kleinhenz	US
Nina	Kacjan Marsic	SI
Paola	Crinò	IT
Pavlos	Tsouvaltis	EL
Raigón	Jiménez	ES

Salvador	Lopez-Galarza	ES
Silvia	Stazi	IT
Spyridon	Petropoulos	EL
Tom	Beyers	BE
Tomas	Vanek	CZ
Yaakov	Tadmor	IL
Youssef	Rouphael	LB
Yuan	Huang	CN
Zehra	Guler	TR

I.B. Management Committee member list

MC Chair	Dr Giuseppe COLLA (IT)
MC Vice Chair	Dr Francisco PEREZ ALFOCEA (ES)

1. COST Participants

Country	MC Member
Belgium	Ms Lieve WITTEMANS
Belgium	Ms Justine DEWITTE
Bulgaria	Dr Nikolay VELKOV
Bulgaria	Prof Rossitza RODEVA
Croatia	Dr Smiljana GORETA BAN
Croatia	Dr Katja ZANIC
Cyprus	Dr Marios KYRIACOU
Cyprus	Mr George SOTERIOU
Czech Republic	Dr Tomas VANEK
France	Mr François VILLENEUVE
Germany	Dr Dietmar SCHWARZ
Germany	Dr Rita GROSCH
Greece	Ms Georgia NTATSI
Greece	Prof Dimitrios SAVVAS
Hungary	Dr Noémi KAPPEL
Hungary	Prof Noemi LUKACS
Israel	Dr Menahem EDELSTEIN
Israel	Dr Roni COHEN
Italy	Prof Cherubino LEONARDI
Italy	Mr Alberto BATTISTELLI
Latvia	Dr Liga LEPSE
Netherlands	Dr Jan Henk VENEMA
Netherlands	Dr Anja DIELEMAN
Portugal	Prof Isabel MOURAO
Portugal	Dr Elvira FERREIRA
Romania	Dr Marian BOGOESCU

Romania	Dr Victor LACATUS
Slovenia	Dr Nina KACJAN MARSIC
Slovenia	Dr. Dominik VODNIK
Spain	Dr Francisco PEREZ ALFOCEA
Spain	Dr Carmina GISBERT
Switzerland	Dr Cédric CAMPS
Turkey	Dr Halit YETISIR
Turkey	Prof Sevilay TOPCU
United Kingdom	Dr Andrew THOMPSON
United Kingdom	Dr Ian C. DODD

Country	MC Substitute
Belgium	Mr Tom BEYERS
Czech Republic	Dr Petr SOUDEK
France	Ms Marie TORRES
Greece	Prof Ebrahim KHAH
Greece	Prof. Andreas VOLOUDAKIS
Hungary	Dr Zsofia BANFALVI
Israel	Dr Aviv DOMBROVSKY
Italy	Dr Mariateresa CARDARELLI
Italy	Dr Giovanna GILARDI
Portugal	Prof Luis Miguel BRITO
Spain	Dr Maria Belen PICO SIRVENT
Spain	Dr Alfonso ALBACETE MORENO

2. COST Near Neighbour Countries

Institution Name	MC Observer
Agricultural University of Tirana	Prof Astrit Balliu
Faculty of Agricultural Engineering and Veterinary Medicine, Lebanese University	Dr Youssef Rouphael

3. COST International Partner Countries

Institution Name	MC Observer
North Carolina State University	Dr Frank Louws
College of Horticulture & Forestry, Huazhong Agricultural University	Prof Zhilong Bie
College of Horticulture & Forestry, Huazhong Agricultural University	Dr Yuan Huang
The Ohio State University	Dr Matthew D. Kleinhenz

I.C. Overview activities and expenditure

Total Action
Budget:190.000
Remaining Action Commitment:

Meetings

Meeting Type	Date	Place							Cost	Total
MC+WG	11-12/March/2013	Athens -Greece							40.881.50	40 881.50
MC + WG	12-14/November/2013	Murcia -Spain							58.446.52	99.328,02
SC + WG	10-12/February/2014	Jerusalem - Israel							31.842,22	131.170,24
Dissemination Meeting	17-21/March/2014	Wuhan - China							n/a	n/a

STSM

Beneficiary	Date	Place							Cost	Total
Golgen Bahar OZTEKIN	[2013-05-15] [2013-08-15]	Murcia - Spain							2.500	2.500
Mr Saruhan ARPACI	[2013-06-20] [2013-09-20]	Großbeeren - Germany							2.352	4.852
Dr Hakan AKTAS	[2013-06-30] [2013-09-16]	Großbeeren - Germany							2.500	7.352
Dr Youssef Rouphael	[2013-07-01] [2013-09-30]	Viterbo - Italy							2.500	9.852
Ms Elena Ivanova Topalova	[2013-09-15] [2013-12-15]	Izmir - Turkey							2.500	12.352
Mr Michael Bitterlich	[2013-10-07] [2014-01-07]	Murcia - Spain							2.500	14.852
Dr Almudena Ferrandez-Ayela	[2013-10-14] [2013-11-24]	Lancaster - UK							2.100	16.952

Workshops

Title	Date		Place						Cost	Total
	From	To	From	To						0
										0

General Support Grants (Financial & Scientific Administration and Coordination)

Beneficiary	Date								Cost	Total
UNITUS - DAFNE	31 January 2014								24.000	24.000

Schools

Title	Date	Place							Cost	Total
										0

Dissemination

Title	Date	Place							**Cost**	**Total**

Website	31 January 2014	Viterbo							2.500	2.500

Others

Title		Cost	Total
General expenses	Bank Fees	950	950

Action Total : **175.572,24**

II. Scientific Report

II.A. Innovative networking

Innovative knowledge resulting from COST networking through the Action.

The COST Action network is expanding and counts more than 200 participants to the activities of the WGs registered in the e-cost system. The Annual Conference, organized in Murcia (Spain) from 13 to 15 November 2013, permitted to consolidate the network and to take a picture of the broader scientific base from which started the action. In particular, some innovative knowledge elements resulted as follow:

- the understanding of some mechanisms related to the rootstock/scion interaction and rootstock-mediated resistance/tolerance to biotic and abiotic stresses;
- the identification of protocols to study root to shoot communication;
- the use of grafting in the Arabidopsis model and new biotechnological applications;
- innovative aspects of the effect of rootstocks on the nutritional quality and especially volatile aroma compounds of the fruits;
- the rootstock-traits to be improved for the different vegetable crops according to the seed companies and nurseries points of views;
- the use of grafting in new vegetable crops.

More information about the innovative findings of vegetable grafting researches presented at the Murcia Annual Conference are reported in the book of abstracts (Annex 1).

Additional innovative knowledge was also obtained from the COST Action meeting held in Jerusalem from 10 to 12 February 2014. The meeting focussed on 'Grafted-plant production chain: from healthy seeds to healthy plants in the field'. During the three-day meeting, scientists from public and private companies discussed their advanced research results in order to define strategies for improving the quality of grafted transplants and for using grafting as integrated pest management tool in vegetable production systems. The meeting also allowed to define strategies for reducing the risk of pathogen transmission by seeds and grafting (eg. Clavibacter michiganensis, viruses).

Significant scientific breakthroughs as part of the COST Action

The most important breakthroughs are reported below.

- Hormone levels in root xylem sap correlate positively with both leaf xylem sap and leaf extract. This has a direct practical application since collecting xylem sap represents a less time-consuming way to determine rootstock impacts on scion hormone status.
- Important root genes that respond to biotic and abiotic stresses were identified.
- Oxidative stress has been associated with graft incompatibility. Reduced activities of SOD, CAT and APX in incompatible cultivars may contribute to limiting graft compatibility at the early stages of development. However, it seems that posttranscriptional mechanisms are playing important roles in this biological process.
- High graft compatibility was found between globe artichoke and cardoon rootstock. This has a direct application to avoid Verticillium wilt in artichoke crops and may help to identify the underlying rootstock-scion signals.
- A method to follow the graft union process by using electric impedance measurements has been identified.
- Rootstock-mediated differences in fruit yield correlated with the concentration of two plant hormones in leaves of tomato. This knowledge can be used to develop a biomarker which supports breeders to select vigorous tomato rootstocks.
- An alternative approach for the control of Verticillium wilt in eggplant was presented through the use of different Solanum species as rootstock.
- Reciprocally grafted RILs demonstrated the dominant effect of the scion under non-stressed conditions. This support the idea that rootstock-mediated vigour on scion becomes more significant at the end (long-term) of the crop period and/or under suboptimal grow conditions.
- The different level of salinity tolerance of pepper rootstocks was not related to the capacity to maintain leaf turgor by osmotic adjustments, but primarily with a reduced uptake of toxic ions and, therefore, to a lower concentration of these ions in the grafted plants.

- Expression of a melon Aux/IAA in the phloem of tomato modifies auxin sensitivity in a tissue-specific manner, thereby altering root and shoot development. This experiment delivered new insights in the biological functions of IAA proteins in the phloem sap.
- Effect of rootstocks on the nutritional quality and especially the volatile aroma compounds and shelf life of the fruits were identified.

Tangible medium term socio-economic impacts achieved or expected

Interactions between academic researchers and breeding companies are expected to accelerate the success in breeding rootstock varieties selected to address a wide range of industry issues. Specific examples being addressed by current researchers within the action are:

- breeding of vegetable crops that improve crop growth under abiotic and biotic stress conditions would increase crop yield;
- understanding of the genetic basis of rootstock vigour would allow marker assisted selection to be used to combine vigour with diseased resistance traits and would greatly accelerate the development of new rootstock cultivars.
- development of easy to measure parameters (stress signals) would allow plant raisers and vegetable growers to monitor crop performance and provide an early warning of possible biotic or abiotic stresses of grafting incompatibility problems;
- development of guidelines for improving the quality of grafted transplants especially from phytosanitary point of view;

The COST Action results will be available for professionals and practitioners through the dedicated COST website. Moreover, a database of rootstock-scion combinations commercially applied for different crops is being implemented as a tool for supporting vegetable growers to choose the best rootstock-scion combinations for their particular growth conditions. A training school on vegetable grafting, will be organized in Catania (Sicily, Italy) on 23-26 September 2014 in cooperation with the Centro SEIA Nursery providing theoretical and practical knowledge on the production and use of grafted plants in vegetable cropping systems.

Spin off of new EC RTD Framework Programme proposals/projects.

Two

Spin off of new National Programme proposals/projects.

Seven

II.B. Inter-disciplinary networking

Additional knowledge obtained from working with other disciplines within the COST framework.

The interdisciplinary network permits a better understanding of the mechanisms behind the rootstocks resistance/tolerance against stresses, the grafting compatibility and the influence of rootstock on fruit quality. Moreover, additional knowledge on rootstock- beneficial microorganism interactions and use of grafted plants in organic farming will be generated in collaboration with the COST Action “BioGreenhouse” (FA1103).

Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts.

The members of the COST action cover all the key disciplines: breeding, genetics, physiology, molecular biology, biotechnology and agronomy and therefore the inter-disciplinarity is excellent and shows great promise to provide synergism. As an example, there have been germplasm exchanges between genetic and biotechnology labs and physiologists within the COST action.

Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts.

The level of inter-disciplinary seems sufficient to potentially provide socio-economic impacts. Interactions between breeding companies/nurseries and academic researchers have enabled a greater understanding of the commercially most important traits to target in public-private research projects, and also the economic factors that drive the increasing use of rootstocks. There was evidence in discussions at the Murcia and Jerusalem meeting that

the goals of breeders and academic researchers were often poorly aligned, and much more progress could be made by very close interactions and discussions leading to joint research proposals.

II.C. New networking

Additional new members joining the Action during its life.

Belgium, Romania, Bulgaria, Cyprus, Latvia, Slovenia, Switzerland, USA, Lebanon, China, Czech Rep.

Total number of individual participants involved in the Action work.

207 participants, 12% ESR, 30% of female.

Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools.

7 STSM are completed and 1 has been just approved by the STSM Committee. 6 STSMs are from ESRs.

Involvement of researchers from outside of COST Countries.

Six researchers from non-COST Countries are involved in the Cost Action; 1 from Lebanon, 2 from China, 2 from US, 1 from Albania.

Advancement and promotion of scientific knowledge through publications and other outreach activities.

Book of abstract of Murcia meeting (Annex 1)
EPSO News N° 32 / September 2013 (Annex 2)
Several publications in national and international journals (Annex 3)
An industry-facing questionnaire was sent to private grafting-related companies throughout Europe to promote the activities of this COST action. The list of European private companies that have a link with vegetable grafting is under construction to be disseminated on the website.
The Chair and WG2 leader of COST action FA1204 attended the 2nd ISHS International Symposium for Organic Greenhouse Horticulture, held 28-31 October 2013 in Avignon, France, which was organised around a meeting of COST action FA1105 “BioGreenhouse”. During this meeting, the activities of COST action FA1204 and WG2 were presented and promoted.
The Chair of COST action FA1204 will promote the activities of this COST action during the ISHS International Symposium on Vegetable Grafting (17-21/03/2014) in Wuhan, China.

Activities and projects with COST network colleagues.

FP7-KBBE ‘ROOTOPOWER’; PLANT-KBBE ‘Rootom’; 5 Bilateral Research Projects, Several National Research Projects on different aspects of vegetable grafting. ISHS Working group on Vegetable Grafting.

The capacity of the Action members to raise research funds.

There is wide involvement of industry representatives and academic researchers in this COST action, and the emphasis of national and EU Horizon 2020 funding schemes is clearly on academic-industry partnerships and the involvement of SMEs leading to clear impacts. Therefore, the action members will be in an excellent position to bid for and win additional research funding. In addition, there are examples and expectation for industry to provide direct funding to academics to perform research that meets their commercial requirements. The high capacity of the Action members to raise research funds is demonstrated by several ongoing inter(national) projects.

III. Previous scientific report

II.A. Innovative networking

Innovative knowledge resulting from COST networking through the Action.

Thanks to the activity of disseminating information and promoting the objectives of FA1204 started from the beginning of Action and carried out by MC members and WG leaders and co-leaders at COST Countries level, the network is expanding and collected more than 100 expressions of interest by researchers. At present the FA1204 database collects 146 contacts for the activities of the WGs and they are already registered in the e-cost system.
This data base is also enriched by a short CV of the researchers containing information on the activities undertaken in the field of vegetable grafting and a preference to participate in a specific WG.
This action has also allowed us to expand the number of COST Countries that have joined the action COST. In December 2012 the MC has made a selection of participants in the first WG meeting which was held in Athens 11-12 March 2013.
The 11 to 12 March 2013 the first WG meeting and the second MC meeting has been held in Athens with the participation of 80 WG Members (52 invited persons eligible to reimbursement). At the WG meeting was explicitly asked everyone to send an abstract on the activities of his/her research group membership. The WG meeting focused on the oral sessions in which it was given a chance to all participants to present their research on the vegetable grafting.
The results have allowed us to consolidate the network and to take a picture of the broader scientific base from which started the action.
In particular, some innovative knowledge elements resulted are the following:

- the extension of the species concerned by the grafting (eg, artichoke, green beans);
- the existence of several ongoing projects addressed to screen Solanaceous species and Cucurbits for resistance to biotic and abiotic stresses aimed at the development of new rootstocks;
- the understanding of some mechanisms related to the rootstock/scion interaction and rootstock-mediated resistance/tolerance to biotic and abiotic stresses;
- the use of grafting in the Arabidopsis model and new biotechnological applications;
- innovative aspects of the effect of rootstocks on the nutritional quality and especially volatile aroma compounds of the fruits of Cucurbitaceae and Solanaceous crops.

New advanced knowledge should came out about the understanding of the mechanisms of graft compatibility and tolerance to some abiotic stress (eg heavy metals).
More information about the innovative findings of vegetable grafting researches presented at the Athens Meeting are reported in the attached ‘book of abstracts’ (Annex 1).
All of this information have been taken as the basis for defining the activities of the various WGs.

Significant scientific breakthroughs as part of the COST Action.

The most important breakthroughs emerged during this first analysis of the ongoing research even at interdisciplinary level are:

- the identification of germplasm available in COST Countries germplasm banks (eg, in Greece, Turkey, Spain) potentially interesting for developing new rootstocks;
- the understanding of some biochemical and physiological mechanisms related to biotic/abiotic stress tolerance of rootstocks and scion-rootstock interaction;
- the knowledge of the influence of rootstocks on nutritional quality and especially aroma volatile compounds;
- the application of grafting in new crops (eg. artichoke, faba bean).

Tangible medium term socio-economic impacts achieved or expected.

With respect to these first findings all the medium term impacts expected by FA1204 are confirmed:

- establishing links between public research institutions and private sector (seed companies, nursery companies, vegetable growers) through the organization of meetings (eg. round table that will be organised in the next WG Meeting in Murcia) and through the website;
- making resources available for professionals and practitioners (eg. website);
- identification of the utility of grafted plants in different European vegetable

production areas with particular emphasis on how grafted plants can ameliorate the efficiency of resource use, yield stability under changing environmental conditions, the quality of rural life reducing the needs of chemical applications (eg. pesticides), and improve the food quality and safety from the consumer/citizen perspective;
- development of new rootstocks which minimize negative impacts of biotic/abiotic stresses on yield, increase resource use efficiency thus reducing agriculture's environmental footprint, and significantly improve commercial and nutritional quality of the product, thus opening new market opportunities.

Spin off of new EC RTD Framework Programme proposals/projects.

None

Spin off of new National Programme proposals/projects.

None

II.B. Inter-disciplinary networking

Additional knowledge obtained from working with other disciplines within the COST framework.

Additional knowledge will be generated by the interdisciplinary network: i.e. the use of advanced tools like genomic, metabolomic and proteomic and systems biology will permits to better understand the mechanisms behind the rootstocks resistance/tolerance against stresses, the grafting compatibility and the influence of rootstock on fruit quality. Moreover, the use of the Arabidopsis (grafted) model will provide all the –omics tools available in this species, while the 'graft' system will facilitate the transfer of knowledge to the crop species.

Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts.

The level of inter-disciplinary seems sufficient to potentially provide a strong scientific impacts of the COST action. The presence in the network of breeders, agronomists, plant molecular biologists, plant physiologists, plant pathologists, experts on food science will permit to understand the biological basis of rootstock effects on fruiting vegetable crops from different point of views (resistance/tolerance to biotic/abiotic stresses, resource use efficiency, fruit quality, etc.). These information will be the starting point of new breeding programs aiming to develop new rootstocks.

Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts.

The level of inter-disciplinary seems sufficient to give a positive socio-economic impact of the COST action. We expect that the interdisciplinary knowledge generated during the COST action would have a positive economic impact increasing the market value of rootstocks, grafted plants and farmer income (high productivity and fruit quality due to the use of grafted plants). The increasing of the use of grafted plants will improve the sustainability of cropping systems through the reduction of the needs of pesticides and the increasing of resource use efficiency, thus contributing to a sustainable and secure food production.

II.C. New networking

Additional new members joining the Action during its life.

Belgium, Romania, Bulgaria, Cyprus, Latvia, Slovenia, Switzerland, USA, Lebanon, China.

Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)

146 participants, 14% ESR, 33% of female.

Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if less than 4 STSMs were carried out during the year.

Currently 2 of the 2 STSMs approved are from ESRs; 3 STSM applications of ESRs are under evaluation by the STSM Committee.

Involvement of researchers from outside of COST Countries.

5 participants from non-COST Countries approved by the CSO; 25% from Lebanon, 50% from China; 50% from US. The involvement of 2 participants Huazhong Agricultural University is useful to know the current status of vegetable grating in China including the

ongoing breeding programs for selection of new rootstocks. Prof. Zhilong Bie and Dr Yuan Huang have a great experience on vegetable grafting, and rootstock effects on abiotic stress tolerance (WGs 1 and 3). The involvement of Dr. Youssef Rouphael from Lebanese University will permit to gain additional information on the vegetable grafted plants responses to semi-arid climate conditions and on genetic variability of selected vegetable crops. Moreover, Dr. Youssef Rouphael is contributing to the COST Action sharing his great experience on the effects of rootstocks on fruit quality of several vegetable (WG4). The benefits from the involvement of Dr Frank J. Louws from North Carolina State University and Dr Matthew D. Kleinhenz from The Ohio State University is to gain information on current status of vegetable grating in US and on-going breeding programs for selection of new rootstocks. Dr Frank J. Louws and Dr Matthew D. Kleinhenz contribute to the activity of WG3 and in particular to the identification of resistance rootstocks to biotic stresses.

Advancement and promotion of scientific knowledge through publications and other outreach activities.

Book of abstract of Athens meeting (Annex 1)

Activities and projects with COST network colleagues.

EU-ROOTPOWER (coordinator Dr. Francisco Perez Alfocea) involving different research groups from Spain, UK, etc. With the aim of develop new tolerant tomato rootstocks against salinity and other abiotic stresses.

VIGONI Bilateral Research Project between Italian and German Research group addressed to select rootstocks for tolerance against heavy metals.

Bilateral Research Project between Greece and Germany aiming to select rootstocks tolerant to abiotic stresses.

Bilateral Research Project between Croatia and Germany on vegetable grafting

Several National Research Projects on different aspects of vegetable grafting: germplasm characterization, study of mechanisms of rootstock-scion interaction, selection of rootstocks resistant to biotic/abiotic stresses, impact of rootstock on fruit quality.

Workgroup Vegetable Grafting of the International Society for Horticultural Science (ISHS). ISHS- I International Symposium on Vegetable Grafting organized in Wuhan, Hubei Province (China) from 17-20 March, 2014.

The capacity of the Action members to raise research funds.

At the moment the Action members show an high capacity to raise research funds at National level while at International levels the capacity to raise research funds is limited. However, I expect that the interdisciplinary network will increase the capacity to raise research funds at International level.