Brussels, 13 March 1997

COST 230/97

Memorandum of Understanding

for the implementation of a European Concerted Research Action designated as COST Action 829

"**Fundamental, agronomical and environmental aspects of sulphur nutrition and assimilation in plants**"

The Signatories 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 400/94 "Rules and Procedures for Implementing COST Actions", the contents of which are fully known to the Signatories.

2. The main objective of the Action is to initiate and coordinate European multidisciplinary research on the fundamental, agronomical and environmental aspects of sulphur metabolism in plants.

3. The overall cost of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at ECU 48 million at 1997 prices.

4. The Memorandum of Understanding will take effect on being signed by at least 5 Signatories.

5. The Memorandum of Understanding will remain in force for a period of 6 years, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1.

COST ACTION 829

Fundamental, agronomical and environmental aspects of sulphur nutrition and assimilation in plants

A. BACKGROUND

Sulphur is an essential element needed for plant growth. The sulphur requirement of plants depends on the developmental stage and it varies strongly between species; its content in plants varies between 0,1 to 1,5% of dry weight. Together with nitrogen it is necessary for the synthesis of amino acids, proteins and various other cellular components, including thiol compounds and so-called secondary sulphur compounds, which play an important role in the protection of plants against stress and pests. In addition, plants may emit minute amounts of volatile sulphur compounds, as H_2S, which may project plants against e.g. fungi attack. Sulphur deficiency will result in the loss of plant production, plant resistance to environmental stress and pests and of food quality.

Under normal conditions sulphate is taken up by the roots and transported to the shoot where it has to be reduced before it can be incorporated into various essential organic sulphur compounds. Both the uptake of sulphate by the roots and its assimilation in the shoots is subject to regulatory control. Uptake and transport of sulphate is affected by the sulphur status; plants with a high sulphur status generally have a less efficient sulphate uptake by the roots than those with a low sulphate status. The sulphate uptake is regulated by negative feedback from sulphate itself and by repression of the uptake system by reduced sulphur compounds as glutathione. The activity of the assimilatory sulphate reduction pathway in leaves depends on the developmental stage and sulphur and nitrogen nutrition.

Under natural conditions sulphate in the soil which is formed by mineralization of organic material is the major sulphur source of plants. However, plants may utilize other forms and sources of sulphur for growth. Plants which grow in areas with volcanic activity or close to sulphur springs have to cope with high levels of atmospheric sulphur deposition. In industrialized areas plants may also be exposed to high levels of atmospheric sulphur deposition. Wet and dry deposition of atmospheric sulphur gases to natural and crop plants may contribute to a significant extent to the sulphur fertilization of plants. Until recently the deposited sulphur from industrial emissions appeared to be a major sulphur source of agricultural crops, since sulphur content in fertilizers was generally low. However, during the last decade there is an ongoing reduction of industrial sulphur emissions in Western Europe by legislatory regulation.

As a consequence the decreased atmospheric sulphur deposition has already resulted in widespread sulphur deficiency in soils in many parts of Europe, which has to be compensated by altered sulphur fertilizer techniques in order to prevent sulphur deficiency of crops. There are several good sulphur fertilizers and various suggestions as ammonium sulphate, ammonium thiosulphate and elemental sulphur have been proposed. Sulphur fertilization is relatively inexpensive and its use leads to substantial benefits of yield and quality. What is particularly uncertain is the timing and form of the sulphur application. Each has its own pitfalls, for example acidification of soil due to microbial oxidation of ammonia or reduced sulphur compounds. In addition, little is known about the route of uptake and metabolism of the different sulphur fertilizers applied to the soil in relation to the metabolic need for growth and in relation to the uptake of other plant nutrients e.g. nitrogen. The latter is of extraordinary importance because declining sulphur supply from the atmosphere has already caused substantial losses of nitrogen from agro-ecosystems to the environment. As political action in Europe is strongly focused on reducing nitrogen loads to aquatic environments the interaction between nitrogen and sulphur needs more clarification with a view to improved and more environmentally friendly fertilizing techniques. A better knowledge of the mechanisms involved will result in an improvement of fertilizer and soil management and will help to minimize the negative environmental aspects of fertilizer leakage. In addition, it will provide information on the consequences of an altered sulphur supply on crop resistance to environmental stress and pests. Based on the profound understanding of how the sulphur supply influences plant resistance, environmentally friendly fertilizing strategies may be evaluated which help keep plants healthy with no or much lower amounts of pesticides.

In general, research on uptake and metabolism of sulphur by plants has been restricted to elucidate the pathways and characterizing the transporters and enzymes involved in the uptake and metabolism of sulphur in excised plant parts. Conclusions on regulation have largely been based on the observed changes in levels of extractable enzymes and modulation of enzyme activity in vitro. There is a lack of information on whole plant regulation of sulphur fluxes in plants in relation to the metabolic need of the cultivar/species for growth at specific circumstances, and on the mechanisms involved, e.g. signals, shoot-root interactions. For a better understanding of the whole plant regulation of the uptake and assimilation of sulphur, a multidisciplinary research approach is needed. In the proposed project, the present knowledge on the molecular/biochemical, physiological and agronomical aspects of sulphur uptake and utilization by plants will be integrated. A close cooperation between the different European research groups, providing expertise from different disciplines in plant research, is rather unique and will surely contribute to a better knowledge and understanding on the mechanisms involved in sulphur utilization by plants in relation to the metabolic need for growth. The form of a COST Action provides an excellent framework to coordinate such a European multidisciplinary research project. The coordinated programme will specifically examine and compare plant species with low and high sulphur requirements as well as examining established model systems in relation to diverse sources of sulphur fertilizer application, including atmospheric sulphur deposition. The relation between tolerance of plants to pests and environmental stress and sulphur fertilization will be evaluated.

B. OBJECTIVES AND BENEFITS

The main objectives of this COST action are:

* To initiate and coordinate European multidisciplinary research on the fundamental, agronomical and environmental aspects of sulphur metabolism in plants.

* To strengthen European research on agrobiology.

This implies studies on:

* The regulatory aspects of sulphur uptake and assimilation in plants in relation to the metabolic need for growth.

* The interaction of pedospheric and atmospheric sulphur nutrition in plants.

* The route and efficiency of uptake and metabolism of various forms of sulphur-containing fertilizers by plants.

* The relation between the plant sulphur status and its resistance to environmental stress and pests.

* Initiating the setting up of a Plant-Sulphur-Data-Network.

Expected benefits:

Fundamental: A better understanding on the regulatory aspects of sulphur uptake and utilization by plants in relation to the requirements for growth.

Agronomical: Diagnostic parameters which are essential for an early recognition of sulphur deficiency in plants. Recommendation standards for an improved soil and fertilizer management, in order to obtain maximal crop production and food quality at minimal costs.

Environmental: Improved fertilizer practice with minimal environmental side effects and plant resistance to pest susceptibility and environmental stress.

C. SCIENTIFIC PROGRAMME

The research and knowledge on the molecular/biochemical, physiological and agronomical aspects of sulphur uptake and utilization by plants, in relation to plant resistance to pests and environmental stress, will be integrated through a close cooperation between different working groups, providing expertise from different disciplines in plant research. The different working groups will concentrate on the following Action objectives:

Working Group I: Molecular/Biochemical Aspects Regulation of expression of the sulphate transporter and enzymes of the sulphate assimilatory pathway as affected by the type of sulphur application and the sulphur status of the plant.

Working Group II: Physiological Aspects

Regulation and route of uptake of different forms of sulphur by plants, supplied both pedospheric and atmospheric, in relation to the metabolic need for growth.

Working Group III: Agronomical Aspects

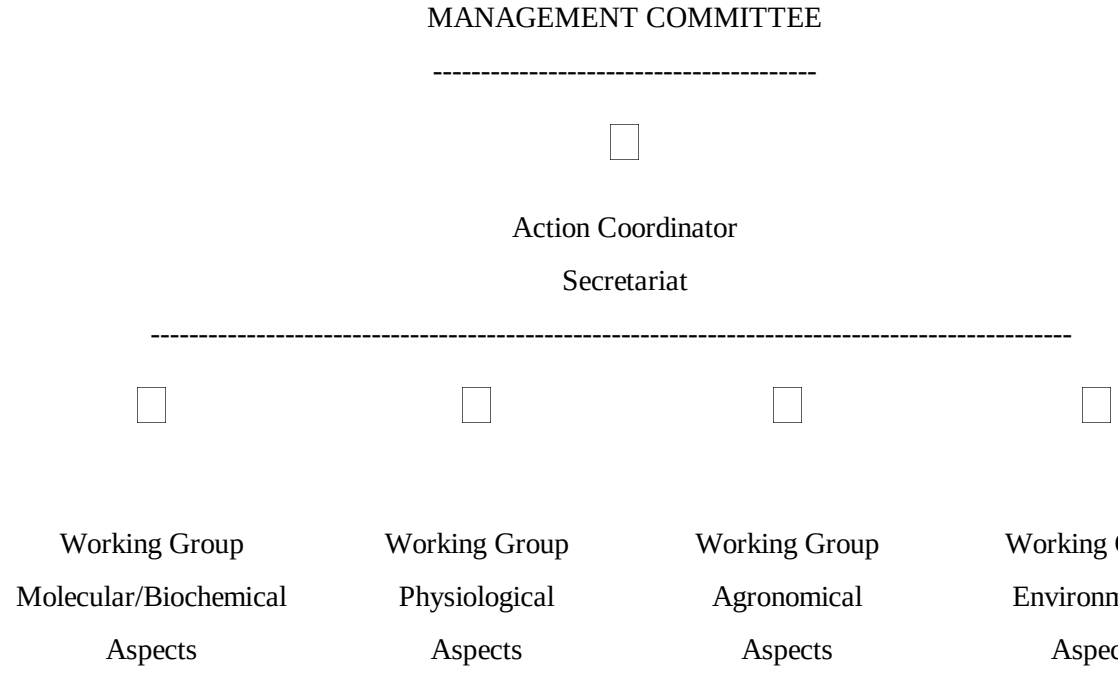
Utilization of different commercial forms of sulphur fertilizers, the significance of atmospheric sulphur deposition and the impact of sulphur fertilization on pest tolerance of crop plants.

Working Group IV: Environmental Aspects

Sulphur fertilization of crops and nitrogen leaching into the environment. Plant sulphur nutrition and resistance to environmental stress, including low temperature, drought, heavy metals and oxidative air pollutants.

D. ORGANIZATION AND TIMETABLE

Organization structure:



Tasks:

Management Committee:

* Appointment of Action Coordinator and Working Group Coordinators (WGC).

* Organization of management committee and workshop meetings twice a year.

* Assessment and report of the progress to the partners during the planning and working meetings.

* Promote cooperation and data exchange between the working groups.

* Promote the exchange of scientists within and between the working groups.

* Preparation of a yearly research report.

* Initiation of a Plant-Sulphur-Data-Network.

Working Groups:

* Coordination of the research within the working group.

* Promoting the setting up of joint research.

* Report on the research progress to the Action Coordinator.

Responsibilities of the partners:

* To attend the workshop meetings.

* To prepare a presentation of one's progress in research twice a year.

Workshop meetings:

Workshop meetings will be organized in the participating countries or in Brussels.

Joint research teams, short-term missions, exchange of scientists:

Within the different working groups, research will be integrated by the setting up of joint research teams between the participating research organizations. The research within the joint research teams will be strengthened and intensified by short term missions and exchange of scientists between the different organizations from the participating countries in the Action.

Timetable	START
	□
	PLANNING MEETING
	□
6 months	MANAGEMENT COMMITTEE MEETING 2 WORKING GROUP MEETINGS*
	□
12 months	MANAGEMENT COMMITTEE MEETING 2 WORKING GROUP MEETINGS*
	□
18 months	MANAGEMENT COMMITTEE MEETING WORKSHOP + WORKING GROUP MEETINGS*
	□
	□
	□
	□
48 months	MANAGEMENT COMMITTEE MEETING WORKSHOP + WORKING GROUP MEETINGS*
	□
	FINAL REPORT/BOOK
	□
60 months	FINAL MEETING

* All Working Groups (Molecular/Biochemical-, Physiological-, Agronomical- and Environmental Aspects) will participate in the Workshops.

** The outcome of the Action will be published in the form of a book.

E. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise have shown their interest: Austria, Germany, France, Italy, Ireland, The Netherlands, Portugal, Poland, United Kingdom, Spain, Sweden and Switzerland. On the basis of national estimates provided by the representatives of these countries and taking into account the coordination costs to be covered over the COST budget of the European Commission, the total scale of the project is estimated at 220 man-years over the five year period. The personnel considered includes senior scientists, post-graduates, PhD-students and technicians. The overall cost of the activities to be carried out under the Action has been estimated, in l997 prices, at roughly ECU 8,8 million/year. 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 costs accordingly.