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NEW INDIGO Science brings Europe and India closer

SEVENTH FRAMEWORK PROGRAMME

Thursday 5 November
EU-India PARTNERING EVENT

PROFILE FORM

ORGANISATION DETAILS					
Organisation name	University of Münster				
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Employees	☐ 1-10	☐ 11-50	☐ 51 - 250	☒ 250 +	
Organisation type	☒University	☐ Research Center	☐ Industry	☐ SME	☐ Other
Department	Department of Plant Biochemistry and Biotechnology				
Short description of your company/organization	The Department of Plant Biochemistry and Biotechnology (IBBP) is one of the strongest Departments of the School of Biology of the University of Münster (WWU), one of the largest universities of Germany. Three research groups are engaged both in fundamental research in plant genetics, genomics, biochemistry, cell biology, and physiology, and in applied research in plant biotechnology and nanobiotechnology, involving projects in agriculture, biomedicine and pharmacology, and material sciences. Prof. Moerschbacher - the initiator and co-ordinator of the European research projects CARAPAX (2000-2005), NanoBioSaccharides (2005-2008) with its international satellite project NBS-TTC including partners from India and Thailand (2006-2008), and PolyModE (2009-2012), and the German spokes-person of the first Indo German International Research Training Group in Molecular and Cellular Glyco-Sciences MCGS (2009-2014) - heads a group of ca. 15 undergraduate, graduate, and postgraduate students, post-doctoral scientists and technicians. The group focuses on an understanding of the molecular basis of cell-cell recognition of cereal plants and their fungal pathogens. In particular, we have over twenty years of experience in				

	analysing on a molecular level the interaction between wheat and its potentially most devastating pathogen, the wheat stem rust fungus. One unique speciality is our ability to grow a pathogenic mycelium of this obligately biotrophic pathogen in axenic culture, including the in vitro induction of infection structure differentiation as well as sporulation (uredinio- and teliospores). The insights gained by this fundamental research is used for the knowledge-based development of plant protection strategies, typically using bio-active polysaccharides isolated e.g. from shrimp shell wastes (chitosans) or marine algae (ulvan). One current research focus is on the development of strategies and tools for the enzymatic bio-engineering of polysaccharides to exploit the potential of renewable resources for the generation of novel, environment-friendly and consumer-safe biomaterials, e.g. for plant disease protection, drug, gene, and vaccine delivery, or medical cell and tissue engineering. Most projects are pursued in international collaborations with partners from Academia and Industry from Europe and beyond, most notably with India, Brazil, and South Africa.

PARTICIPANT			
Gender	☒ Mr	☐ Ms	Title Prof. Dr.
First name	Bruno		
Last name	Moerschbacher		
Position	Professor of Plant Biochemistry		

PARTNERSHIP PROPOSAL

EU-India partnering event session participation:

☒ Sustainable production and management of biological resources from land, forest and aquatic environment

☐ Fork to farm: Food (including seafood), health and well being

☒ Life sciences, biotechnology and biochemistry for sustainable

☐ Health

Areas of activity *(Free keywords)* molecular plant pathology, renewable resources, bio-active polysaccharides, enzyme engineering, nanobiotechnology

PROJECT DESCRIPTION	
Title of your research project in one sentence	SWOT-analysis (Strengths, Weaknesses, Opportunities, Threats) of the new wheat stem rust race Ug99 threatening world wheat production for the development of knowledge-based strategies for plant protection
Short description of project	In 1999, a new race of the wheat stem rust fungus has evolved in Uganda (Ug99) which has broken the Sr31-gene for stem rust resistance that had been stable for more than 30 years. As all major wheat cultivars in the world rely on Sr31 for stem rust resistance, a potentially dangerous and de-stabilising situation is about to arise. Ug99 has already more than halved the wheat yield in Ethiopia and Kenya,

	and it has now been found in Iran and, possibly, Pakistan. Carried eastwards by the jet stream, Ug99 poses an imminent threat to Pakistani, Indian, Chinese and, consequently, world wheat production. The recently launched Borlaug Global Rust Initiative, financially supported by the Bill and Melinda Gates Foundation, is heading a US-led consortium of researchers trying to identify new sources of resistant germplasms for the breeding of durable stem rust resistance in wheat. "Rust SWOT - Know Your Enemy" I would like to suggest to complement this host plant targeted strategy by the establishment of a EU/India led consortium of researchers focusing on the stem rust fungus itself, to provide a knowledge-base for the development of efficient counter-actions. We need to know the Strengths and Weaknesses of Ug99, the Obstacles we encounter in combatting it, and the real Threat it poses to wheat production in the world. Such a strategy requires an intimate knowledge of rust biology which is all but lost in the US and elsewhere due to the immense problems in handling an obligately biotrophic pathogen and the in-attractiveness of working with an organism that is not amenable to molecular genetic techniques. However, such knowledge is still existing in a very few labs e.g. in Europe and Israel (and, hopefully, elsewhere, e.g. in India). This knowledge needs to be combined with modern and highly efficient genetic and genomic techniques available in many labs worldwide, but used on rust fungi in very few. To be successul, this approach necessarily needs to include partners with experience and expertise in wheat rust protection in the area and climate of the next crucial step in Ug99 spread, namely India.
Description of expertise offered	We have over twenty years of experience in wheat stem rust research, both on the pathogen side and on the side of the host plant. We have developed a unique protocol to grow the wheat stem rust fungus in liquid axenic culture, yielding a pathogenic mycelium that closely resembles the mycelium grown in planta. We are able to induce the differentiation of almost the complete series of infection structures rust fungi produce, i.e. germ tube, appressorium, substomatal vesicle, infection hyphae, and haustorial mother cells in vitro. We are also able to induce sporulation in vitro, both for urediniospores and teliospores. This allows us to study the molecular biology, biochemistry, and physiology of the fungus away from its host plant. Currently, we are developing a transformation system based on this axenic culture. In a collaboration with Prof. Pretorius from South Africa, who had first described the appearance of Ug99, we have recently succeeded in growing this race and its presumed progenitor race UV55 in axenic culture, allowing us to isolate pure DNA of both strains. We are currently analysing and comparing these DNAs in an attempt to isolate the Avr31 gene and to understand, how Ug99 has managed to escape Sr31 recognition. We have also begun a histological study of fungal growth of both races in susceptible and near-isogenic, Sr31-resistant wheat lines in order to understand fungal growth and successful or failing plant defense responses. This needs be followed by a molecular analysis of induced resistance reactions, their elicitation and suppression in the infected plants. For these studies, we have ample experience from former work concerning other resistance genes, including both hypersensitive and non-hypersensitive type major gene based resistances and QTL-based adult plant resistance.
Description of requested partner expertise	We need partners from Academia and Industry with expertise and experience in other aspects of rust biology. Most importantly, we need a partner able to grow all stages of the complex life cycle of the fungus, including teliospore germination and barberry infection. This is a prerequisite for genetic crossing studies which would be highly desirable for pinpointing the events that led to the evolution of Ug99. (The only expert in this area I know is Prof. Anikster from Israel who is still active and willing to contribute, but already retired). We will also need a partner with access to Ug99 and the descendant races which have already developed, picking up additional virulences. As Prof. Pretorius in South Africa is no longer allowed to work with Ug99 due to quarantine reasons, such a partner will have to come from Ethiopia or Kenya; first contacts to potential partners in the area exist. Then, we will need a partner with the required class 3

	safety facilities to work with such a potentially devastating pathogen. Currently, I only know of two labs in the US and Canada that are allowed to handle Ug99 in the winter months, but such partners can probably be identified in Europe as well. And we will need partners with the expertise and infrastructure required to perform e.g. large scale next-generation sequencing which can also easily be found in Europe (we have very good contacts to colleagues in Germany, the Netherlands, and UK). Lastly, we will need partners in India who are experts in stem rust of wheat, its biology and epidemiology under tropical and sub-tropical agricultural conditions. Just as an example, while the rust fungus faces the problem of over-wintering in Europe where the uredospores cannot tolerate sub-zero temperatures, the problem in India is over-summering. Consequently, successful strategies for rust prevention and combat will require local knowledge. Then, partners experienced in developing low cost, adapted and sustainable protection strategies for wheat against rust fungi in collaboration with local farmers will be important. Finally, I also hope that in India, we will find mycologists and plant pathologists who still have good knowledge and expertise in this equally complex, fascinating and threatening biotrophic pathogens.