



# 7<sup>th</sup> International Conference on Silicon in Agriculture

24-28 October 2017, UAS, Bengaluru, India



## PROCEEDINGS OF A B S T R A C T S

University of Agricultural Sciences, Bengaluru

Indian Society of Soil Science, Bangalore Chapter

The International Society for Silicon in Agriculture & Related Disciplines (ISSAG)



# PROCEEDINGS OF ABSTRACTS

*Published by*

**7<sup>th</sup> International Conference on Silicon in Agriculture**

24 - 28, October 2017 - University of Agricultural Sciences, Bengaluru, India

*Editors*

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**University of Agricultural Sciences, GKVK, Bengaluru**

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## Foreword

The essentiality of silicon on growth of higher plants remains debatable till now even though research has demonstrated many beneficial and functional roles of Si, especially under stressful conditions, in agriculture and horticulture crops. To unravel the secrets of silicon, the first International Conference on Silicon in Agriculture was held at Florida, the United States of America during 1999, followed by meetings at Tsuruoka, Japan (2002), Uberlandia, Brazil (2005), KwaZulu-Natal, South Africa (2008), Beijing, China (2011) and Stockholm, Sweden (2014). Since the first conference, the silicon family has grown substantially, leading to the knowledge and understanding of silicon in agriculture.

India holds the second largest agricultural land in the world and 50% of India's geographical area used for agricultural activity. Therefore, in this endeavour, the 7th International Conference on silicon in Agriculture to be held at Bengaluru, the silicon valley of India will provide a platform for scientists, policy makers, industries and students to exchange scientific knowledge, share practical experiences, motivate youngsters and prepare road map for furthering the knowledge of silicon for the benefit of mankind.

The proceedings of abstracts brought out on the occasion of the 7th International Conference on Silicon in Agriculture reflect knowledge, information and ideas of researchers studying all aspects of silicon research in the world. The major theme of the Conference is "Silicon Solution to Sustainable Agriculture". The proceedings includes seven sections: 1) Biogeochemistry of Silicon cycle in agriculture; 2) Chemistry and analysis of Silicon in soils, plants and fertilizers; 3) Mechanism of Silicon uptake and accumulation in plants; 4) Role of Silicon in abiotic stress management; 5) Role of Silicon in biotic stress management; 6) Silicon fertilizers on performance of plants; and 7) Influence of Silicon on plant growth and development.

We thank Dr. Jean Dominique Meunier and Dr. Ravin Jugdaohsingh for their plenary lectures. We also convey our wholehearted thanks to Dr. Brenda Servez Tubana, Dr. Kazuyuki Inubushi, Dr. Miroslav Nikolic, Dr. Naoki Yamaji, Dr. Richard Bélanger, Dr. Rivka Elbaum and Dr. Yongchao Liang for their keynote lectures. Special thanks to Dr. Lawrence E. Datnoff for chairing the panel discussion on "Future Scenario of Silicon in Agriculture" and his constant support and encouragement for the silicon community is highly acknowledged.

We thank the University of Agricultural Sciences, Bengaluru, and all individuals who made this conference and publication of the proceedings of abstracts possible.

We highly acknowledge all the sponsors for their financial support. We are also grateful to the members of the International and National Steering Committee for their valuable support, suggestions and guidance. We thank the delegates for their outstanding contributions to this great scientific event.

We thank all the office bearers and board members of The International Society for Silicon in Agriculture and Related Disciplines (ISSAG), Bangalore Chapter of Indian Society of Soil Science for their support and suggestion for publication of proceedings of the abstracts.

We would like to appreciate all the hard work and diligent effort that has given us fruitful result eventually provided by Meetings and More, Gurugram, Haryana, India. The efficient and hard work of Mr. Ravikumar B. A., Resolution Print Media, is gratefully acknowledged.

-The Editors



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## PROGRAMME SCHEDULE

TUESDAY 24<sup>th</sup> OCTOBER 2017

14.00 - 16.00 **Departure from Radisson Blu Atria to University of Agricultural Sciences, GKVK  
Visit to Dry Land Agriculture Farm, Visit to Pedonarium  
Visit to Field Demonstration Plots**

17.00 - 18.00 **Registration at Radisson Blu Atria**

18.00 - 18.30 **WELCOME RECEPTION**

WEDNESDAY 25<sup>th</sup> OCTOBER 2017

09.00 - 09.45 **REGISTRATION**

09.45 - 11.00 **INAUGURAL FUNCTION**

11.00 - 11.30 **INAUGURAL TEA**

11.30 - 12.00 *Plenary Speaker I : Jean Dominique Meunier* **Biogeochemistry of silicon in agriculture: a review**

12.00 - 12.30 *Plenary Speaker II : Ravin Jugdaohsingh* **Establishing the biological role of dietary silicon**

12.30 - 13.30 **LUNCH BREAK**

## SESSION I

Sub Theme I : **Biogeochemistry of silicon cycle in agriculture &**

Sub Theme II : **Chemistry and analysis of silicon in soils, plants and fertilizers**

*Chair : Jean Dominique Meunier, Co-Chair : Brenda S. Tubana*

13.30 - 14.00 **Key Note : Tubana S. Brenda** Understanding the dynamics of silicon in plant and soil are essential for establishing silicon fertilization guidelines.

14.00 - 14.15 **Jean Riotte** Origin of silica in rice plants and contribution of diatomaceous earth fertilization: insights from isotopic Si mass balance in a paddy field.

14.15 - 14.30 **Sreenivasan T. Sandhya** Alkalinity ratio and the release of extractable silicon from silicate slags in rice soil.

14.30 - 14.45 **Latha P. C.** Silicate solubilization and plant growth promoting potential of *Rhizobium sp.* isolated from rice rhizosphere

14.45 - 15.00 **Regan Crooks** Effect of silica fertiliser on dissolved silicon in soil solution based on the chemical properties of various soils.

15.00 - 15.15 **Vladimir Matichenkov** New approaches in testing active forms of silicon in soil, plants and silicon-rich materials.

15.15 - 15.30 **Zancajo Victor M. R.** Multimodal structural and functional analysis of sorghum tissues and sorghum biosilica.

15.30 - 15.45 **AryaLekshmi V.** Silicon adsorption isotherm characteristics in tropical rice soils of Kerala.

15.45 - 16.00 **Patil A. A.** Suitability of extractant for soil available silicon and silicon response toupland paddy grown on inceptisols and vertisols.

16.00 - 16.30 **TEA BREAK AND POSTER PRESENTATION**





## SESSION II

Sub Theme III : Mechanism of silicon uptake and accumulation in plants

Chair : Naoki Yamaji, Co-Chair : Maria Greger

|               |                         |   |
|---------------|-------------------------|---|
| 16.30 - 17.00 | Key Note : Yamaji Naoki | A cooperative transport system for silicon in plants.   |
| 17.00 - 17.15 | Sakurai Gen             | Analysis of the expression dynamics of silicon transporter gene using mathematical model in rice.                                 |
| 17.15 - 17.30 | Rupesh Deshmukh         | Genomics intervention to understand silicon transport in plants.  |
| 17.30 - 17.45 | Coskun Devrim           | What makes a silicon transporter? The search for key residues that confer plant silicon permeability, accumulation, and benefits. |
| 17.45 - 18.00 | Kumar Santosh           | Correlative fluorescence and electron microscopies showing programmed cell death in sorghum silica cells.                         |
| 18.00 - 18.15 | Greger Maria            | Plant uptake of silicon nanoparticles.  |
| 18.15 - 18.30 | Haijun Gong             | Isolation and characterization of silicon transporter gene <i>Lsi 1</i> in <i>Solanum lycopersicum</i> L.                         |
| 19.00 - 20.00 | CULTURAL PROGRAMME      |   |
| 20.00         | DINNER                  |   |

THURSDAY 26<sup>th</sup> OCTOBER 2017

## SESSION III

Sub Theme IV : Role of silicon in abiotic stress management

Chair : Yongchao Liang, Co-Chair : Nikolic Miroslav

|               |                               |   |
|---------------|-------------------------------|---|
| 09.00 - 09.30 | Key Note 1 : Yongchao Liang   | Silicon and abiotic stress in higher plants progress and perspectives.  |
| 09.30 - 10.00 | Key Note 2 : Nikolic Miroslav | Silicon influence on plant ionom and mineral element transporters.  |
| 10.00 - 10.15 | Camargo M. S.                 | Silicon fertilization alleviates the deleterious effects of water deficit in sugarcane cultivars.   |
| 10.15 - 10.30 | Garg Neera                    | Emerging recognition of silicon as ameliorator of abiotic stresses in legumes.  |
| 10.30 - 10.45 | Biju Sajitha                  | Silicon potentiates photosynthetic efficiency and biochemical defenceresponses of lentil against drought stress.  |
| 10.45 - 11.00 | Bosnic Predrag                | Silicon mediates sodium transport and homeostasis in maize under mild NaCl stress.  |
| 11.00 - 11.15 | GROUP PHOTOGRAPHY             |   |
| 11.30 - 11.45 | TEA BREAK                     |   |
| 11.45 - 12.00 | Vaculik Marek                 | Silicon-induced alleviation of antimonate (SbV) toxicity in maize.  |
| 12.00 - 12.15 | Zexer Nerya                   | Insights to silicon-dependent drought tolerance by testing a sorghum mutant defective in silicon uptake.  |
| 12.15 - 12.30 | Bhandari Purnima              | Silicon nutrition augments plant vigour, ionic homeostasis and defense mechanisms in mycorrhizal <i>Cicer arietinum</i> L. genotypes under salt stress. |
| 12.30 - 13.30 | LUNCH BREAK                   |   |



## SESSION IV

*Sub Theme V : Role of silicon in biotic stress management*

*Chair : Bélanger R. R., Co-Chair : Padmakumari A. P.*

|               |  |  |
|---------------|--|--|
| 13.30 - 14.00 | Key Note : <b>Bélanger R.R.</b>          | Recent progress in defining the protective role of silicon against plant diseases.   |
| 14.00 - 14.15 | <b>Cai Kunzheng</b>                      | Deciphering the role of silicon in enhancing tomato resistance to bacterial wilt <i>via</i> proteomics and transcriptome approaches.   |
| 14.15 - 14.30 | <b>Padmakumari A. P.</b>                 | Silicon in rice stem borer management - an overview.   |
| 14.30 - 14.45 | <b>Rupesh Deshmukh</b>                   | Silicon increases tolerance against powdery mildew and drought stress in transgenic tomato expressing the <i>Lsi1</i> gene from wheat.   |
| 14.45 - 15.00 | <b>Abbai Ragavendran</b>                 | Silica nanoparticles enhances the tolerance of <i>Panax ginsengmeyer</i> against the root rot causing fungus, <i>ilyonectriamors-panacis</i> by regulating sugar efflux into apoplast. |
| 15.00 - 15.15 | <b>Hou Maolin</b>                        | Improved resistance to the brown planthopper in rice plants amended with silicon and the underlying mechanisms.  |
| 15.15 - 15.30 | <b>Basdew I. H.</b>                      | The enzymatic effect of preharvest silicon applications and postharvest hot water treatments in an attempt to minimize disease development in citrus fruit.                            |
| 15.30 - 16.30 | <b>TEA BREAK AND POSTER PRESENTATION</b> |  |

## SESSION V

*Sub Theme VI : Silicon fertilizers on performance of plants*

*Chair : Prakash N. B., Co-Chair : Fabricio Rodrigues*

|               |   |  |
|---------------|---|--|
| 16.30 - 16.45 | <b>Peter Prentice</b>                           | Efficacy of silica in increasing yields in morocco.  |
| 16.45 - 17.00 | <b>Krzysztof Ambroziak</b>                      | Foliar application of pH neutral silicon product and its effect on abiotic stress mitigation in field crops.                             |
| 17.00 - 17.15 | <b>Elena Bocharnikova</b>                       | New generation silicon fertilizers – greenhouse and field tests.   |
| 17.15 - 17.30 | <b>Tubana Brenda</b>                            | Potential of Armurox®, a soluble silicon and peptides biostimulant, as a foliar source of silicon in wheat.                              |
| 17.30 - 17.45 | <b>Michel Preti</b>                             | MOSA: stabilized monosilicic acid, a new window of opportunities for efficient and effective supplementation of Silicon by root or leaf. |
| 17.45 - 18.00 | <b>Arkadiusz Artyszak</b>                       | Effect of foliar fertilization with silicon on selected physiological parameters, yield and technological quality of sugar beet.         |
| 18.00 - 18.30 | <b>INTERNATIONAL STEERING COMMITTEE MEETING</b> |  |
| 19.00         | <b>CONFERENCE DINNER</b>                        |  |



## FRIDAY 27<sup>th</sup> OCTOBER 2017

### MID CONFERENCE TOUR

|               |   |
|---------------|---|
| 07.00         | Departure from Bengaluru  |
| 09.30 - 11.00 | Visit to Experimental Plots and Jaggery Park at ZARS, VC Farm, Mandya |
| 12.30 - 13.30 | LUNCH AT MYSORE   |
| 14.00 - 16.30 | Visit to Mysore Palace  |
| 17.00         | Departure from Mysore   |

## SATURDAY 28<sup>th</sup> OCTOBER 2017

### SESSION VI

Sub Theme VII : Influence of silicon on plant growth and development

Chair : Kazuyuki Inubushi, Co-Chair : Elbaum Rivka

|               |                                    |  |
|---------------|------------------------------------|--|
| 09.00 - 09.30 | KEY NOTE 1 : Elbaum Rivka          | Silicic acid and silica biology studied in a low-silicon sorghum mutant.   |
| 09.30 - 10.00 | KEY NOTE 2 : Inubushi K.           | Effect of silicate amendment on environment and yield in Southeast Asia.   |
| 10.00 - 10.15 | Mayanglambam Homeshwari Devi       | The critical silicon dose in seedling root-dip method in acid soils dependent on rice cultivar and soil type.  |
| 10.15 - 10.30 | More R. R.                         | Bioavailability of silicon by silicate solubilizing micro-organisms for increasing yield and quality of sugarcane.   |
| 10.30 - 10.45 | Lux Alexander                      | Silicification of <i>Cocos nucifera</i> and <i>Phoenix dactylifera</i> .   |
| 10.45 - 11.00 | Valentin Kindomihou                | The tropical fodder silicification as influenced by burning: Cases of <i>Andropogon schirensis</i> , <i>Brachiaria falcifera</i> and <i>Hyparrhenia subplumosa</i> from Guinean Benin. |
| 10.00 - 11.15 | Siti Nordahliawate M. Sidiqie      | Beneficial effects of silicon on the growth and biotic stress of Melon ( <i>Cucumismelo</i> L.) var. Glamour Sakata.   |
| 11.15 - 11.45 | TEA BREAK AND POSTER PRESENTATIONS |  |
| 11.45 - 12.00 | Phonde D. B.                       | Studies on soil silicon status in vertisols and silicon nutrient management in sugarcane.  |
| 12.00 - 12.15 | Sriramachandrasekharan M.V.        | Response of Banana to Silicon Nutrition in <i>Typic Ustifluent</i> Soil.   |
| 12.15 - 12.30 | Pengbo Zhang                       | Silicon fertilizers impact on greenhouse gas emission.   |
| 12.30 - 13.30 | LUNCH BREAK                        |  |

### PANEL DISCUSSION : FUTURE SCENARIO OF SILICON IN AGRICULTURE

Chair : Datnoff E. Lawrence, Co-Chair : Lux Alexander

|               |                          |   |
|---------------|--------------------------|---|
| 13.30 - 14.00 | Datnoff E. Lawrence      | Why is silicon still not used routinely for managing plant health and enhancing plant growth under greenhouse and field conditions?   |
| 14.00 - 14.08 | Bruce Cairns             | Future scenarios of silicon in agriculture: An Australian perspective   |
| 14.08 - 14.16 | Henk Marten Laane        | Silicon in agriculture: The future  |
| 14.16 - 14.24 | Nagabovanalli B. Prakash | Status and prospects of utilization of different silicon sources: An overview of the results from seven international conferences on silicon in agriculture and future thrust |
| 14.24 - 14.32 | Tania Raugewitz          | Proven performance, economic incentive, and consistent terminology required for long-term grower adoption   |
| 14.32 - 14.40 | Tewatia R. K.            | Silicon in Indian agriculture: Policy and promotional issues  |
| 14.40 - 15.30 | GENERAL GROUP DISCUSSION |   |
| 15.30 - 16.00 | TEA BREAK                |   |
| 16.30 - 17.30 | VALEDICTORY FUNCTION     |   |



## C O N T E N T S

Page #s

### PLENARY LECTURES

- Biogeochemistry of silicon in agriculture: a review** 03  
Jean Dominique Meunier
- Establishing the biological role of dietary silicon** 04  
Jugdaohsingh Ravin

### SESSION I

- Sub Theme : I Biogeochemistry of silicon cycle in agriculture &**  
**Sub Theme : II Chemistry and analysis of silicon in soil, plants and fertilizers**

### KEY NOTE

- Understanding the dynamics of silicon in plant and soil are essential for establishing silicon fertilization guidelines.** 10  
Tubana Brenda, Babu Tapasya, White Brandon, Agostinho Flavia, Paye Wooiklee and Datnoff Lawrence

### SHORT ORAL

- Silicon adsorption isotherm characteristics in tropical rice soils of Kerala.** 12  
Arya Lekshmi V. and Jayasree Sankar S.
- Origin of silica in rice plants and contribution of diatomaceous earth fertilization: insights from isotopic Si mass balance in a paddy field.** 13  
Jean Riotte, Kollalu Sandhya, Nagabovanalli B. Prakash, Stéphane Audry and Jean-Dominique Meunier
- Silicate solubilization and plant growth promoting potential of *Rhizobium* sp. isolated from rice rhizosphere** 14  
Latha P.C., Chandrakala C., Voleti S.R., Rao P.R. and Bandeppa
- Suitability of extractant for soil available silicon and silicon response to upland paddy grown on inceptisols and vertisols.** 15  
Patil A.A., Durgude A.G., Pharande A.L. and Kadlag A.D.
- Effect of silica fertiliser on dissolved silicon in soil solution based on the chemical properties of various soils.** 16  
Regan Crooks
- Alkalinity ratio and the release of extractable silicon from silicate slags in rice soil.** 17  
Sreenivasan T. Sandhya and Nagabovanalli B. Prakash
- New approaches in testing active forms of silicon in soil, plants and silicon-rich materials.** 18  
Vladimir Matichenkov, Zhang Pengbo, Wei Xiao, Liu Yuqiao, Zhan Qiang and Elena Bocharnikova
- Multimodal structural and functional analysis of sorghum tissues and sorghum biosilica.** 19  
Zancajo Victor M.R., AdiramNurit, Soukup Milan, Goobes Gil Emmerling Franziska, Kneipp Janina and Elbaum Rivka



## POSTER PRESENTATION

**Do termites influence silicon dynamic in tropical soils? A case study in Bandipur National Park (Karnataka, South India).** 22

Jamoteau Floriane, Majumdar Sabyasachi, Jean-Dominique Meunier, Jouquet Pascal and Nagabovanalli B. Prakash

**First results of trace metals associated with silicon contents in two phenological stages of wheat (*Triticum aestivum*) in the southeast of the Pampean plains, Argentina.** 23

Frayssinet Celia, Marcovecchio E. Jorge, Osterrieth L. Margarita, Villagran Diana, La CollaNoelia, Fernandez Severini Melisa, Benvenuto M. Laura, Fernandez Honaine Mariana, Borrelli L. Natalia and Heil and Patricio

**Silicon fertilization and its role in physical and chemical soil properties in Southeastern Buenos Aires.** 24

Frayssinet Celia, Osterrieth L. Margarita, Borrelli L. Natalia, Ciarlo Esteban, Heil and Patricio

**Distribution of available silicon under different land use system in tropical soils.** 25

Laitha M., Anil Kumar K.S., Parvathy S., Shivanand K., Arti Koyal, Rajendra Hegde and Singh S.K.

**Silica production and phenological stages in soybean, wheat and maize crops developed in soils from Pampean region, Argentina.** 26

Laura Benvenuto M, Osterrieth L Margarita and Mariana Fernández Honaine,

**Estimation of amorphous silica content in tropical rice and sugarcane soils of Karnataka, India.** 27

Majumdar Sabyasachi, Nagabovanalli B. Prakash and Jean Dominique Meunier

**Silicophytoliths: their role in the degradation and silicon biogeochemical cycle of Molisols in the southeast of the pampean plains, Argentina.** 28

Osterrieth L. Margarita, Benvenuto M. Laura, Borrelli L. Natalia, Donna Roberto, Paolicchi Micaela, Altamitano Stella, Frayssinet Celia, Fernandez Honaine Mariana and Alvarez Fernanda

**Pools of Silicon in soils of Karnataka and their contribution to Rice.** 29

Thimmappa Pallavi and Nagabovanalli B. Prakash

## SESSION II

**Sub Theme III :Mechanism of silicon uptake and accumulation in plants**

### KEY NOTE

**A cooperative transport system for silicon in plants.** 36

Yamaji Naoki, Mitani-Ueno Namiki, Sakurai Gen and Ma Jian Feng

### SHORT ORAL

**What makes a silicon transporter? The search for key residues that confer plant silicon permeability, accumulation, and benefits.** 38

Coskun Devrim, Deshmukh Rupesh, Isenring Paul and Bélanger Richard R.

**Analysis of the expression dynamics of silicon transporter gene using mathematical model in rice.** 39

Sakurai Gen, Yamaji Naoki, Mitani-Ueno Namiki, Yokozawa Masayuki, Ono Keisuke and Ma Jian Feng,



## PROCEEDINGS OF ABSTRACTS

|  |    |
|--|----|
| <b>Plant uptake of silicon nanoparticles.</b>  | 40 |
| <u>Greger Maria</u> , Landberg Tommy and Nazarialian Sanam   |    |
| <b>Isolation and characterization of silicon transporter gene Lsi 1 in Solanum lycopersicum L.</b>   | 41 |
| Hao Sun, Yaoke Duan, JiaGuo and <u>Haijun Gong</u>   |    |
| <b>Correlative fluorescence and electron microscopies showing programmed cell death in sorghum silica cells.</b>   | 42 |
| <u>Kumar Santosh</u> and Elbaum Rivka  |    |
| <b>Genomics intervention to understand silicon transport in plants.</b>  | 43 |
| <u>Rupesh Deshmukh</u> , JulienVivancos, HumiraSonah, Joan Laur, Caroline Labbe, Paul Isenring, Francois J.Belzile and Richard R. Bélanger                   |    |
| <b>POSTER PRESENTATION</b>   |    |
| <b>Identification of natural variation of silicon transport in rice</b>  | 46 |
| <u>Partha Talukdar</u> , Adam H. Price and Gareth J. Norton  |    |
| <b>SESSION III</b>   |    |
| <b>Sub Theme IV:Role of silicon in abiotic stress management</b>   |    |
| <b>KEY NOTE</b>  |    |
| <b>Silicon and abiotic stress in higher plants progress and perspectives.</b>  | 52 |
| <u>Yongchao Liang</u> , Song Alin, Ping Li, Guochao Yan and Zhuoxi Xiao  |    |
| <b>Silicon influence on plant ionom and mineral element transporters.</b>  | 53 |
| <u>Nikolic Miroslav</u> , Kostic Ljiljana, Pavlovic Jelena and Bosnic Predrag  |    |
| <b>SHORT ORAL</b>  |    |
| <b>Silicon nutrition augments plant vigour, ionic homeostasis and defense mechanisms in mycorrhizal <i>Oer arietinum</i> L. genotypes under salt stress.</b> | 56 |
| <u>Bhandari Purnima</u> and Garg Neera   |    |
| <b>Silicon potentiates photosynthetic efficiency and biochemical defence responses of lentil against drought stress.</b>                                     | 57 |
| <u>Biju Sajitha</u> , Fuentes Sigfredo and Gupta Dorin   |    |
| <b>Silicon mediates sodium transport and homeostasis in maize under mild NaCl stress.</b>  | 58 |
| <u>Bosnic Predrag</u> , Bosnic Dragana and Nikolic Miroslav  |    |
| <b>Silicon fertilization alleviates the deleterious effects of water deficit in sugarcane cultivars.</b>   | 59 |
| <u>Camargo M.S.</u> , Oliveira A.L., Bezerra B.K.L. and Silva M.A.   |    |
| <b>Emerging recognition of silicon as ameliorator of abiotic stresses in legumes.</b>  | 60 |
| <u>Garg Neera</u>  |    |
| <b>Silicon-induced alleviation of antimonate (SbV) toxicity in maize.</b>  | 61 |
| <u>Vaculík Marek</u> , Vaculíková Miroslava, Tandy Susan, Luxová Miroslava and Schulín Rainer  |    |
| <b>Insights to silicon-dependent drought tolerance by testing a sorghum mutant defective in silicon uptake.</b>  | 62 |
| <u>Zexer Nerya</u> , Markovich Oshry, Seligmann Ron, Moshelion Menachem and Elbaum Rivka   |    |



## POSTER PRESENTATION

- Silicon improves the quality of fruits of *Solanum lycopersicum* Mill. subjected to saline stress.** 64  
Carballo-Méndez F.J., Olivares-Saenz E, Vázquez-Alvarado R.E., Zavala-García F, Bolívar-Duarte M. and Benavides-Mendoza A.
- Effect of silicon on tolerance of wheat (*Triticum aestivum* L.) at different growth stages to salt stress: Case study for management of irrigation water.** 65  
Daoud A.M., Hemada M.M., Saber N, El-Araby A.A.M. and Moussa L.
- Effect of silicon in the initial stages of Zn-deficiency in rice plants.** 66  
Juan José Lucena, Alexandra Martín-Esquinas, Sandra Carrasco-Gil and Lourdes Hernández-Apaolaza
- Role of silicon in modulating growth, mycorrhizal and rhizobial symbiosis as well as yield in *Cajanus cajan* genotypes under arsenate and arsenite stress.** 67  
Kashyap Lakita and Garg Neera
- Silicon nanoparticle effects on arsenic and cadmium plant uptake.** 68  
Landberg Tommy and Greger Maria
- Silicon effect on micronutrients localization in rice roots grown in Fe deficient and control conditions at two different pH values.** 69  
Lourdes Hernández-Apaolaza, Sandra Carrasco-Gil, Sara Rodríguez-Menéndez, Rosario Pereiro and Beatriz Fernández
- Effect of silicon on drought tolerance of wheat (*Triticum aestivum* L., cv. Venturero).** 70  
Lux Alexander, Kohanová Jana and Švec Miroslav
- Effect of Silicon and Potassium on performance of *Sesamia inferens* (Walker) in wheat under field conditions.** 71  
Mallikarjuna Jeer K.C., Sharma Yogesh Yele and Nagabovanalli B. Prakash
- Fighting Arsenic Toxicity in Rice Grains using Ortho Silicic acid: A Case Study.** 72  
Sanjay Dwivedi, Seema Mishra, Amit Kumar, Amit Pal Singh, Vinod Goyal, Neeru Jain and Tripathi R.D.
- Silicon nutrition alleviates cadmium and zinc induced toxic responses by modulating proline biosynthesis in mycorrhizal *Cajanus cajan* (L.) Millsp. Genotypes.** 73  
Singh Sandeep and Garg Neera
- Effect of Si fertilizers on productivity and quality of rice grown on polluted areas, field tests in the Xiangjiang River Basin.** 74  
Xiao Wei, Pengbo Zhang, Yuqiao Liu, Qiang Zhan, Elena Bocharnikova, and Vladimir Matichenkov

## SESSION IV

Sub Theme V : Role of silicon in biotic stress management

### KEY NOTE

- Recent progress in defining the protective role of silicon against plant diseases.** 80  
Bélanger R.R., Deshmukh Rupesh, Razoolizadeh A., Belzile F. and Menzies J.G.

### SHORT ORAL

- Silica nanoparticles enhances the tolerance of *Panax ginseng* meyer against the root rot causing fungus, *Illyonectria amors-panacis* by regulating sugar efflux into apoplast.** 82  
Abbai Ragavendran, Kim Yeon-Ju, Kim Yu-Jin, Mohanan Padmanaban, Mathiyalagan Ramya, Farh El-Agamy Mohamed, Sukweenadhi Johan, Rangaraj Suriyaprabha, Venkatachalam Rajendran and Yang Deok Chun



# PROCEEDINGS OF ABSTRACTS

- The enzymatic effect of preharvest silicon applications and postharvest hot water treatments in an attempt to minimize disease development in citrus fruit.** 83  
Basdew I.H. and Laing M.D.
- Deciphering the role of silicon in enhancing tomato resistance to bacterial wilt via proteomics and transcriptome approaches.** 84  
Cai Kunzheng, Lin Weipeng, Chen Yuting and Jiang Nihao
- Improved resistance to the brown planthopper in rice plants amended with silicon and the underlying mechanisms.** 85  
Hou Maolin, Yang Lang, Han Yong Qiang and Li Pei
- Silicon in rice stem borer management - an overview.** 86  
Padmakumari A.P. and Voleti S.R.
- Silicon increases tolerance against powdery mildew and drought stress in transgenic tomato expressing the Lsi1 gene from wheat.** 87  
Rupesh Deshmukh, Julien Vivancos, Humira Sonah, Caroline Labbe, Steeve Pepin, James G. Menzies and Richard R. Bélanger

## POSTER PRESENTATION

- Foliar spray of a source of soluble silicon to control asian soybean rust on soybean.** 90  
Caroline Hawerth, João Augusto C. Marques, Carla S. Dias, Leandro C. Silva, Jonas A. Rios, Rubens K. Nagata, Fabrcio A. Rodrigues
- Foliar spray of soluble silicon to control blast on rice.** 91  
Isaias Severino Cacique, Áysla Tereza Horta Oliveira, Luiz Felipe Castro Carmo Pinto, Cristiano Veloso, Rodrigo Estevam O. Mac Leod and Fabrcio Ávila Rodrigues
- Efficacy of foliar application of silicon (OSAB) on powdery mildew (Oidium neolycoopersici) disease reduction in tomato** 92  
Kedarnath, Rangaswamy K.T., Nagabovanalli B. Prakash and Raghavendra Achari
- Abrasion of midgut epithelial tissues of yellow stem borer larvae upon feeding on Silicon treated rice plants.** 93  
Mallikarjuna Jeer, Padmakumari A.P., Umamaheswari T and Voleti S.R.
- Influence of silicon on purple blotch disease (Alternaria porri (Ellis) Cif.) in onion (Allium cepaL.).** 94  
Mohammad Haroon, Amruta S. Bhat, Nagabovanalli B. Prakash, Rangaswamy K.T. and Lingaiah H.B.
- Efficacy of foliar application of silicic acid on yellow mite Oligonychussacchari McGregor (Acari: Tetranychidae) on two sugarcane commercial varieties.** 95  
Nikpay Amin and Laane Henk-Maarten
- Effectiveness of silicon application on mycotoxins reduction in maize.** 96  
Wieslaw Ciecierski, Marek Korbas and Joanna Horoszkiewicz-Janka

## SESSION V

Sub Theme VI : Silicon fertilizers on performance of plants

## SHORT ORAL

- Effect of foliar fertilization with silicon on selected physiological parameters, yield and technological quality of sugar beet.** 102  
Arkadiusz Artyszak, Dariusz Gozdowski and Katarzyna Kucińska





## PROCEEDINGS OF ABSTRACTS

**Potential of Armurox<sup>®</sup>, a soluble silicon and peptides biostimulant, as a foliar source of silicon in wheat.** 103

Botta Anna, Tubana Brenda, Sierras Núria, MarínCándido, Price Paul and Datnoff Lawrence

**New generation silicon fertilizers – greenhouse and field tests.** 104

Elena Bocharnikova and Tor S. Hansen

**Foliar application of pH neutral silicon product and its effect on abiotic stress mitigation in field crops.** 105

Krzysztof Ambroziak

**MOSA: stabilized monosilicic acid, a new window of opportunities for efficient and effective supplementation of Silicon by root or leaf.** 106

Michel Preti

**Efficacy of silica in increasing yields in morocco.** 107

Peter Prentice

### SESSION VI

**Sub Theme VII : Influence of silicon on plant growth and development**

#### KEY NOTE

**Silicic acid and silica biology studied in a low-silicon sorghum mutant.** 114

Elbaum Rivka

**Effect of silicate amendment on environment and yield in Southeast Asia.** 115

Inubushi K., Siratori Y., Ito K, Arai H., Yoshioka N., Iswandi A., Citraresmini A., Niguyen H.T., Tran T.L.H. and Pham Q.H.

#### SHORT ORAL

**Silicification of *Cocos nucifera* and *Phoenix dactylifera*.** 118

Lux Alexander, Bokor Boris, Nagabovanalli B. Prakash, Hamsa Nagaraju, Vaculík Marek, Kohanová Jana, Weidinger Marieluise, Lichtscheidl Irene and Maheswarappa H.P.

**The critical silicon dose in seedling root-dip method in acid soils dependent on rice cultivar and soil type.** 119

Mayanglambam Homeshwari Devi and Thakuria Dwipendra

**Bioavailability of silicon by silicate solubilizing micro-organisms for increasing yield and quality of sugarcane.** 120

More R.R. and Phonde D.B.

**Silicon fertilizers impact on greenhouse gas emission.** 121

Pengbo Zhang, Wei Xiao, Yuqiao Liu, QiangZhan, and Vladimir Matichenkov

**Studies on soil silicon status in vertisols and silicon nutrient management in sugarcane.** 122

Phonde D.B., Deshmukh P.S., More R.R. and Banerjee Kaushik

**Response of Banana to Silicon Nutrition in Typic Ustifluvent Soil.** 123

Sriramachandrasekharan M.V., Arthi V. and Manivannan R.

**Beneficial effects of silicon on the growth and biotic stress of Melon (*Cucumis melo L.*) var. *Glamour Sakata*.** 124

Siti Nordahliawate M. Sidique, Nur AAzhari, Andrew A. Ngadin, Nurul F. Ibrahim, Suhaizan Lob and Xiaolei Jin



## PROCEEDINGS OF ABSTRACTS

- The tropical fodder silicification as influenced by burning: Cases of *Andropogon schirensis*, *Brachiaria falcifera* and *Hyparrhenia subplumosa* from Guinean Benin.** 126  
Valentin Kindomihou, Brice Sinsin, Roland Holou and Pierre Meerts

### POSTER PRESENTATION

- Diatomaceous earth as source of silicon in tomato crop.** 128  
Ashok L.B., Swamy G.S.K. and Nagabovanalli B. Prakash

- Applying silicate fertilizer increases both yield and quality of table grape (*Vitis vinifera* L.) grown on calcareous grey desert soil.** 129  
Chu Guixin, Zhang Mei and Liang Yongchao

- Silicon and phosphorus fertilization in aerobic rice-wheat system.** 130  
Dinesh Jinger, Shiva Dhar, Anchal Dass and Sharma V.K.

- Diatomaceous earth as silicon nutrition to onion.** 131  
Durgude A.G., Kadlag A.D. and Pharande A.L.

- Effect of orthosilicic acid formulations on growth and yield of maize in different soils.** 132  
Jawahar S., Kalaiyarasan C., Sriramachandrasekharan M.V., Neeru Jain and Naveenkumar M.

- Impact of silicates on the growth of coconut seedlings grown in a tropical Entisol** 133  
Jeena Mathew, Krishnakumar V., Abdul Haris A. and Narayanan Nampoothiri C.K.

- Research progress in the positive influence of silicon fertilizer on the quality of crops.** 134  
Jianxin Jia, Zhaojun Li, Delong Cai, Xiujie Hu, Guangnian Gu, Zhifeng Bu and Guoqing Liu

- Bio-active silicon for improving phosphorus uptake and reduction in fixation in soils by mineralization.** 135  
Joshi Milind D., Syed Shakir Ali, Mahamuni S.V., Nayar Vasudev, Indurkar Udayan and Lature Prakash

- Effect of diatomite as a silicon source on growth, yield and quality of potato.** 136  
Kadalli Gundappa G., Rudresha B. Asha and Nagabovanalli B. Prakash

- Impact of ortho silicic acid formulation on yield and disease incidence of potatoes.** 137  
Khan M.A., Goyal Vinod and Jain Neeru

- Bioavailability and budgeting of different sources of silicon and their effect on growth and yield of rice in acidic, neutral and alkaline soils of Karnataka, South India.** 138  
Kollalu Sandhya, Nagabovanalli B. Prakash and Jean Dominique Meunier

- Silica content, anatomical traits and herbivory damage in leaves with different age and solar radiation exposition of invasive tree, *Ligustrum lucidum*.** 139  
Mariana Fernández Honaine, Lía F Montti,, Weilong Qi and Osterrieth L. Margarita

- Comparison of different sources of silica on the yield and quality of "Alphonso" mango in Kokan Region of Maharashtra.** 140  
More S.S., Gokhale N.B., Kasture M.C., Shinde S.E. and Jain Neeru

- Effect of sources and levels of silicon on soil properties, uptake, yield and quality of kharif onion.** 141  
Nazirkar R.B., Narale Balaji and Durgude A.G.



## PROCEEDINGS OF ABSTRACTS

|  |     |
|--|-----|
| <b>Effect of varied levels of diatomite on growth and yield of sugarcane in Karnataka.</b>   | 142 |
| Nagabovanalli B. Prakash, Chandravamshi P., <u>Mallikarjuna L.</u> , Yogesh T.C., Srinivasa D.K., Vijayamahantesh, Suchitra C.K. and Saravanakumar                                   |     |
| <b>Agronomic performances and chemical responses of rice to silicon nutrition through diatomaceous earth in two different soils.</b>   | 143 |
| Ravichandran M. and <u>Sriramachandrasekharan M.V.</u>   |     |
| <b>Effect of silicon and micronutrients on plant growth, yield and disease incidence in chilli (<i>Capsicum annuum</i> L).</b>   | 144 |
| <u>Satisha G.C.</u> , Saxena A.K. and Ganeshamurthy A.N.   |     |
| <b>Influence of diatomaceous earth (as a source of silicon) on flowering, yield and quality of pomegranate cv. Kesar.</b>  | 145 |
| <u>Swamy G.S.K.</u> , Nagabovanalli B. Prakash and Anand Kalatippi   |     |
| <b>Effect of foliar application of silicic acid on growth, yield and quality of soybean [<i>Glycine max.</i> (L)].</b>   | 146 |
| <u>Uppalige Shwethakumari</u> , Nagabovanalli B. Prakash, Jayarame Gowda and Munivenkatappa Chandrappa   |     |
| <b>Effect of foliar spray of stabilized ortho silicic acid (OSA) on the fruit quality and quantity of Kinnow mandarin.</b>   | 147 |
| <u>Vikram Verma</u> , Vinod Goyal, Prem Bubber and Neeru Jain  |     |
| <b>Rate and application time of plant available silicon on winter wheat yield and quality</b>  | 148 |
| <u>Walsh Olga</u> , Mc Clintick-Chess Jordan and Blanscet Steven   |     |
| <b>PANEL DISCUSSION : FUTURE SCENARIO OF SILICON IN AGRICULTURE</b>  |     |
| <b>Why is silicon still not used routinely for managing plant health and enhancing plant growth under greenhouse and field conditions?</b>   | 150 |
| Datnoff E. Lawrence and Tubana S. Brenda   |     |
| <b>Future scenarios of silicon in agriculture: An Australian perspective</b>   | 151 |
| Bruce Cairns, Peter Prentice and Regan Crooks  |     |
| <b>Silicon in agriculture: The future</b>  | 152 |
| Henk-Maarten Laane   |     |
| <b>Status and prospects of utilization of different silicon sources: An overview of the results from seven international conferences on silicon in agriculture and future thrust</b> | 153 |
| Nagabovanalli B. Prakash, Sandhya Kollalu, Majumdar Sabyasachi and Thoppil S. Sandhya  |     |
| <b>Proven performance, economic incentive, and consistent terminology required for long-term grower adoption</b>   | 154 |
| Tania Raugewitz  |     |
| <b>Silicon in Indian agriculture: Policy and promotional issues</b>  | 155 |
| Tewatia R.K.   |     |
| <b>INDEX</b>   | 156 |



## Silicon influence on plant ionom and mineral element transporters

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### ABSTRACT

The plant ionomics is the study of essential and nonessential mineral element composition of plants (the ionom) at cellular, tissue or organismal level. The plant ionomic profile is affected by various factors, including plant (e.g. species, genotypes, organ, developmental change) and environment (e.g. soil, fertilizers, stress conditions). Over the past decade rapid progress has been made in understanding the mechanisms through which silicon (Si) mediates mineral excess and/or toxicity stress. However, the effect of Si on the mineral element uptake and consequently the plant ionome is still unclear, in particular under conditions of limited nutrient availability.

Firstly, I will present recent results of my research group demonstrating that Si application modulates the ionomic profile of various plant species (e.g. rice, barley, wheat, maize, cucumber, sunflower, soybean, grapevine and tomato) grown under both normal and stress conditions. In the second part of my talk I will review the current knowledge of Si influence on the expression of (a) root and shoot metal transporter genes under excess of cadmium (Cd), manganese (Mn) and copper (Cu) (Li *et al.*, 2018; Kim *et al.* 2014; Che *et al.*, 2016; Farooq *et al.*, 2016); (b) transporter genes involved in the uptake, long-distance transport and homeostasis of iron (Fe) under low Fe conditions (Pavlovic *et al.*, 2013, 2016); (c) transporter genes for inorganic phosphorus (Pi) root uptake under low P conditions (Kostic *et al.*, manuscript submitted); and (d) transporter genes involved in shoot homeostasis of sodium (Na<sup>+</sup>) (see Bosnic *et al.*, this proceedings) and B (Akçay & Erkan, 2016) under saline stress.

In conclusion, the role of Si in modulation of plant ionome, including also nutrient and other mineral element uptake and utilization, appears to be more indirect by transcriptional regulation of genes responsible for both root acquisition and tissue homeostasis. Further understanding of how exactly Si regulates the expression of mineral element transporter genes will help to improve crop productivity, yield quality and food safety in stress conditions.

**Keywords:** Environmental stress, Ionomics; Mineral element transporters; Silicon

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