Puyam Tondonba Singh

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Research Interests

Molecular plant pathology, plant–microbe interactions, and functional genomics of disease resistance in crops. Current focus on the molecular basis of resistance to *Fusarium oxysporum* f. sp. *cubense* tropical race 4 (TR4) in Cavendish banana somaclonal variants, including chromosomal deletions, susceptibility genes, calcium signaling, and salicylic acid (SA) mediated immunity.

Education

National Taiwan University **2020 – Expected 2026**
Ph.D. in Biotechnology *Taipei, Taiwan*

- Dissertation: *Reduced expression of calcium pumps augments banana resistance to* Fusarium *wilt tropical race 4.*
- Advisor: Dr. Ho-Ming Chen.
- Scholarships: MOE Scholarship (2019–2023); NTU Outstanding Scholarship (2023–2024).
- GPA: 4.15 / 4.30.

College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University **2016 – 2018**
M.Sc. (Genetics and Plant Breeding) *Barapani, Meghalaya, India*

- Thesis: *Crossability studies and genetic diversity analysis in blackgram (*Vigna mungo *L. Hepper) using molecular markers.*
- Advisor: Dr. V. K. Khanna.
- Grade: 8.00 / 10; CAU Merit Scholarship (2016–2018).

Assam Agricultural University **2012 – 2016**
B.Sc. in Agriculture *Jorhat, Assam, India*

- Grade: 7.60 / 10; NEC Scholarship (2012–2016), Government of India.

Academic Experience

EMBO Visiting Tour 2023 **Nov 2023**
Trainee *Academia Sinica, Taipei, Taiwan*

- Participated in scientific talks, career discussions, and training in academic writing and communication.

ICAR Research Complex for NEH Region **Oct 2018 – Aug 2019**
Junior Research Fellow (JRF) *Umiam, Meghalaya, India*

- Development of DUS (Distinctiveness, Uniformity and Stability) guidelines for jackfruit from the North-Eastern region.
- Association mapping for yield and yield-related traits in rice bean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi).

ICAR Research Complex for NEH Region **Mar 2019**
Research Intern, Bioinvid Training 2019 *Umiam, Meghalaya, India*

- Hands-on training in genome assembly, annotation, and sequence analysis.

Krishi Vigyan Kendra (KVK) **Aug 2015 – Jan 2016**
Research Intern, Rural Agricultural Work Experience Programme *Mangaldai, Assam, India*

- Field-based exposure to farmer-participatory research, on-farm demonstrations, and agricultural extension activities.

Publications

- [1] **P. T. Singh**, B.-H. Hou, Y.-H. Tsai, Y. Tzean, C.-P. Chao, P.-X. Zheng, Y.-C. Lin, W.-C. Shen, H.-H. Yeh, H.-M. Chen. *Chromosomal deletions in banana somaclonal variants reveal negative regulators of immunity underlying* Fusarium *wilt resistance. Proc. Natl. Acad. Sci. USA (PNAS)*, 2025. (In press).
- [2] T.-C. Chen, Y. Tzean, B.-H. Hou, **P. T. Singh**, S.-M. Tsao, M.-C. Lee, S. Rai, C.-P. Chao, C.-C. Chen, W.-C. Shen, H.-M. Chen, H.-H. Yeh. *Functional characterization of MaSAP6 conferring resistance to* Fusarium *of banana*. (Under communication).
- [3] S. R. Assumi, **P. T. Singh**, A. K. Jha (2021). Pineapple (*Ananas comosus* L. Merr.). In S. N. Ghosh & R. R. Sharma (Eds.), *Tropical Fruit Crops: Theory to Practical*, pp. 487–541, Jaya Publishing House, New Delhi.
- [4] W. S. Philanim, **P. T. Singh**, S. Sachdeva, C. Bhardwaj, V. S. Hegde, B. S. Patil, A. Sarker (2019). Correlation study and path coefficient analysis for seed yield and its contributing traits in chickpea (*Cicer arietinum* L.). *International Journal of Chemical Studies*, 7(4), 1492–1494.
- [5] W. S. Phalinim, U. Pant, R. Bhajan, **P. T. Singh** (2019).Gene action for quantitative traits through generation mean analysis in Indian mustard (*Brassica juncea* L.). *International Journal of Current Microbiology and Applied Sciences*, 8(8), 260–266.
- [6] **P. T. Singh**, V. K. Khanna, V. U. Tejaswini (2018). Crossability studies and genetic diversity analysis in blackgram (*Vigna mungo* L. Hepper) using molecular markers. *Agrotechnology*, 7:179. (doi:10.4172/2168-9881.1000179)

Conferences, Workshops and Talks

- [1] **Oral Presentation.** "Chromosomal deletions in banana somaclonal variants reveal negative regulators of immunity underlying *Fusarium* wilt resistance." Plant Science Shapes the Future of Agriculture, Taiwan Society of Plant Biologists, Taiwan 2025
- [2] **Oral Presentation.** "Chromosomal deletions in banana somaclonal variants reveal negative regulators of immunity underlying *Fusarium* wilt resistance." IOB Mini Symposium, Institute of Biotechnology, National Taiwan University, Taiwan 2025
- [3] **Oral Presentation.** "Reduced expression of calcium pumps augments banana resistance to *Fusarium* wilt tropical race 4." Plant & Animal Genome Conference (PAG 32), San Diego, USA 2024
- [4] **Oral Presentation.** "Reduced expression of calcium pumps augments banana resistance to *Fusarium* wilt tropical race 4."11th Asian Crop Science Association Conference, Taipei, Taiwan 2024
- [5] **Oral Presentation.** "Reduced expression of calcium pumps augments banana resistance to *Fusarium* wilt tropical race 4."IOB Mini Symposium, National Taiwan University, Taiwan 2024
- [6] **Poster Presentation.** "Copy number variation and *Fusarium* wilt TR4 resistance in Cavendish banana somaclonal variants." ABRC 24th Annual Poster Competition, Academia Sinica, Taipei, Taiwan 2023
- [7] **Poster Presentation.** "Copy number variation and *Fusarium* wilt TR4 resistance in Cavendish banana somaclonal variants." Taiwan–Japan Plant Biology 2023, Academia Sinica, Taiwan 2023
- [8] **Participant.** International Plant Phenotyping Symposium – PhenoVeg 2023, World Vegetable Center, Shanhua, Tainan, Taiwan 2023
- [9] **Oral Presentation.** "Exploring the molecular basis of resistance to *Fusarium* wilt TR4 in Cavendish banana somaclonal variants." IOB Mini Symposium, National Taiwan University, Taiwan 2023
- [10] **Poster Presentation.** "Chromosomal deletion and aerenchyma development of *Fusarium* wilt resistant TBRI banana clones." ABRC 23rd Annual Poster Competition, Academia Sinica, Taipei, Taiwan (virtual) 2022
- [11] **Poster Presentation.** "Chromosomal deletion and aerenchyma development in *Fusarium* wilt resistant TBRI banana clones." Post-pandemic Era for Frontier Plant Science and Sustainable Agriculture Conference, TSPB, Hushan, Nantou, Taiwan 2022
- [12] **Oral Presentation.** "Chromosomal deletion and aerenchyma development in *Fusarium* wilt resistant TBRI banana clones." IOB Mini Symposium, National Taiwan University, Taiwan 2022

- [13] **Poster Presentation.** "Development of allele-specific SNV markers and identification of 3′ negative regulatory elements in Foc TR4 resistant TBRI banana clones." IOB Mini Symposium, National Taiwan University, Taiwan 2021
- [14] **Oral Presentation.** "Development of nutraceutical enriched beverage from underutilized crops of North-East hill region." International Conference on Technological Innovations for Integration of Food and Health: A Focus on North East India, Tezpur University, India 2019
- [15] **Poster Presentation.** "Different blackgram accessions evaluated for yield and intervarietal hybridization." National Seminar of the Indian Society of Seed Technology, ICAR, Lamphelpat, India 2019
- [16] **Participant.** "Role of Plant Pathology in Empowering and Doubling Farmer's Income." Indian Society of Plant Pathologists, ICAR-NEH Region, Umiam, Meghalaya, India 2018
- [17] **Poster Presentation.** "Crossability studies and genetic diversity in blackgram using molecular markers." International Conference on Climate Change, Biodiversity and Sustainable Agriculture, Assam Agricultural University, Jorhat, India 2018

Awards and Honors

- [1] Selected Abstract Oral Presentation Winner, "Plant Science Shapes the Future of Agriculture", Taiwan Society of Plant Biologists 2025
- [2] Outstanding Oral Presentation Award, IOB Mini Symposium, National Taiwan University 2025
- [3] Best Oral Presentation,Taiwan Biodiversity Genomics, Evolution, and Biodiversity 2025
- [4] Travel Grant Winner, Plant & Animal Genome Conference (PAG 32), San Diego, USA 2024
- [5] ABRC Travel Grant, ABRC 25th Annual Poster Competition, Academia Sinica 2024
- [6] Outstanding Oral Presentation Award, IOB Mini Symposium, National Taiwan University 2024
- [7] Outstanding Poster Award, ABRC 24th Annual Poster Competition, Academia Sinica 2023
- [8] Outstanding Poster Award, ABRC 23rd Annual Poster Competition, Academia Sinica 2022
- [9] Outstanding Oral Presentation Award, IOB Mini Symposium, National Taiwan University 2022
- [10] Outstanding Poster Award, IOB Mini Symposium, National Taiwan University 2021
- [11] Best Article Award, *Agriculture and Food: e-Newsletter*, 1:11 2019

Research Techniques and Skills

- **Wet Lab:** Gel electrophoresis; RT-PCR; 3′ RACE; molecular cloning; real-time PCR (qPCR); transient expression assays in tobacco; virus-induced gene silencing (VIGS); plant crossing techniques; hydroponics; pathogen inoculation; microscopy (upright, inverted, confocal).
- **Bioinformatics:** SNP calling from RNA-seq and whole-genome sequencing (WGS) data; transcriptome and differential gene expression analysis; WGS coverage analysis; basic scripting and data processing in R, Linux and Python.
- **Software:** Microsoft Office (Word, Excel, PowerPoint); Google Workspace; Adobe Photoshop and Illustrator; Benchling; Primer3; MEGA 11 and ModelTest-NG; GraphPad Prism; SnapGene; Vector NTI; EndNote; Zen microscopy software.
- **Research organisms:** Banana, tobacco, *Arabidopsis*, jackfruit, rice bean, blackgram, rice.
- **Other:** Badminton; photography.

Referees

- **Dr. Ho-Ming Chen**
  Associate Research Fellow,
  Agricultural Biotechnology Research Center (ABRC), Academia Sinica, Taiwan.
  E-mail: homing@gate.sinica.edu.tw
- **Dr. Yao-Cheng Lin**
  Associate Research Fellow, Agricultural Biotechnology Research Center (ABRC) & Biotechnology Center in Southern Taiwan, Academia Sinica, Taiwan.
  E-mail: yalin@sinica.edu.tw

Current Research

The global cultivation of Cavendish bananas is severely threatened by Fusarium wilt caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *cubense* tropical race 4 (TR4). Although breeding TR4-resistant cultivars is constrained by triploidy and sterility, the Taiwan Banana Research Institute (TBRI) has developed several somaclonal variants exhibiting stable TR4 resistance. However, the precise mutations and molecular mechanisms underlying this resistance remain unclear. Our research aims to elucidate the genetic basis of TR4 resistance in TBRI somaclonal variants by identifying causal somatic mutations and key regulatory genes. We discovered that highly resistant variants share common chromosomal deletions that reduce gene copy number and expression. Within these deletion regions, we identified two candidate susceptibility genes belonging to the *Autoinhibited* Ca^{2+}*-ATPase* (*ACA*) family. Using a virus-induced gene silencing (VIGS) system, we demonstrated that silencing these *ACA* genes in susceptible bananas elevates salicylic acid (SA) marker gene expression and attenuates TR4 disease symptoms. These findings indicate that reduced *ACA* expression enhances SA-mediated immunity, conferring durable resistance to Fusarium wilt. We are currently developing CRISPR-edited lines targeting these two *ACA* genes for stable modification and generating transgenic *Arabidopsis* lines to investigate their subcellular localization. Future work will evaluate whether silencing or knockout of these genes in other susceptible banana cultivars can similarly confer resistance to TR4.