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RESEARCH INTEREST

My research focuses on deciphering the molecular and functional responses of plants to biotic and abiotic stress using advanced genomics and physiological methods. Through a multidisciplinary approach, I aim to provide comprehensive insights to enhance plant stress tolerance and address pressing issues in global agriculture.

EDUCATION:

2018: Ph.D. in Biotechnology with a specialization in Plant Biotechnology, Kurukshetra University, Kurukshetra, India (Research work performed at Indian Institute of Wheat and Barley Research, Karnal, India)
2012: M.Tech. in Biotechnology, Kurukshetra University, Kurukshetra, India.
2009: B.Tech. in Biotechnology, Kurukshetra University, Kurukshetra, India.

PROFESSIONAL EXPERIENCE:

2024-Present: Postdoctoral Fellow at USDA-ARS, WRRC, Crop Improvement and Genetics Research Unit, Albany, CA, USA with PI **Dr. Matthew Milner**

This project focuses on studying brassinosteroids' regulated pathways and signaling mechanisms. Brassinosteroids (BRs) are known to be involved in plant development and adaptation under multiple environmental stresses. Biotechnological intervention in the brassinosteroids' pathways and signaling will help improve nutrient utilization and adaptation under stresses, eventually leading to an improved final yield. DWF4 genes are involved in regulating the BRs levels. In the Milner lab, I am developing DWF4 overexpressing transgenic and knockout lines in elite wheat varieties. A combined study of all these edited and overexpressing materials will provide a better understanding of BR signaling and different agronomical traits. I am also improving the transformation and genome-editing systems to enhance overall system efficiency.

2024-Present: Research Affiliate at Plant and Microbial Biology, UC Berkeley, CA, USA
2023-2024: Assistant Project Scientist at Plant and Microbial Biology, UC Berkeley, CA, USA
2022-2023: Postdoctoral Fellow at Plant and Microbial Biology, UC Berkeley, CA, USA
Project: USDA-funded project "Genes and pathways that boost wheat resistance to stripe rust" with PI **Prof. Ksenia Krasileva**.

I have developed transgenic Kronos and autoactive mutants expressing PR1: RUBY to understand plant immunity. I am delving into single-cell transcriptomics to reveal specific molecular players of the host at a cellular-level resolution. To identify stripe-rust resistance genes/alleles with a reverse genetics approach, I am also working on validating the enhanced-disease-resistance (EDR) genes (DND; 'defense, no death' and NAC21/22) using CRISPR-based genome editing. The characterization of the homozygous knockout mutants is currently underway. Ultimately, the information gained through these experiments will better understand the plant's defensive pathways. Recently, we published a long-read sequencing-based reference-quality Kronos genome, which will be helpful for gene identification and the whole wheat research community.

2019-2022: Postdoc Fellow at the Institute for Cereal Crops Research, Tel Aviv University, Israel.
Project: Development of Durable Rust Resistant Agronomical Superior Wheat with PI **Prof. Amir Sharon**

This project involved cloning a novel rust resistance gene from wild wheat, designing constructs, and performing *Agrobacterium*-mediated transformation in bread wheat. My work involved designing various leaf rust gene constructs using different promoters and *Yr87/Lr85* gDNA and cDNA regions, revealing the large impact of promoter and intron regions on rust resistance gene ectopic expression in bread wheat. We

also applied for a patent (U.S. Provisional Patent Application No. 63/213,222) for the novel rust-resistance gene from wild wheat (*Aegilops longissima*). Additionally, I worked on CRISPR-edited wheat mutants for spike length-related gene, *TaTFB3* and study of aquaporins in *Setaria viridis* in collaboration with **Dr. Nir Sade**.

2015-2019: Senior Research Fellow at ICAR-Indian Institute of Wheat and Barley Research (ICAR-IIWBR), Karnal, India
Project: ICAR sponsored "Network project on Functional Genomics and Genetic Modification in Crops" with PI **Dr. Mamrutha HM**

As a Senior Research Fellow at the Indian Institute of Wheat and Barley Research Karnal, India, I dedicated my efforts to deepening our understanding of the intricate relationships between various genes and abiotic stresses in wheat. My primary focus has been utilizing transgenesis and genome editing approaches to enhance gain yield and quality, especially under changing climate scenarios. For the first time here, I gained knowledge and hands-on experience with CRISPR-based genome editing in bread wheat, having targeted the yield and abiotic stress-responsive genes. Additionally, I have validated the combined effect of *Arabidopsis DREB2a* and *SHN1* genes in wheat using transgenes.

2013-2018: Ph.D. Scholar at University Institute of Engineering and Technology, Kurukshetra University, Kurukshetra, and ICAR-IIWBR, Karnal, India
Thesis Title: **Cloning and transformation of abiotic stress-responsive gene in Indian wheat genotypes**. (http://shodhganga.inflibnet.ac.in/handle/10603/219952) under **Dr. Anita Grewal** and **Dr. Mamrutha HM**

This study aimed to develop an efficient regeneration and transformation system to produce abiotic stress-tolerant wheat using *Agrobacterium*-mediated transformation. I studied different abiotic stress-responsive genes and conducted their expression profiles. The study's second objective was to develop a robust, reproducible regeneration and transformation system in wheat. The effect of different plant growth regulators on callus induction (mature and immature embryos as explant sources), regeneration, and root induction was analyzed on recently released high-yielding Indian wheat genotypes. Several parameters were extensively investigated and optimized for *Agrobacterium*-mediated transformation using binary vector pCAMBIA3301 through callus co-cultivation. The standardized transformation system achieved higher efficiency than existing protocols. For the functional validation of abiotic stress-tolerant genes, *Pennisetum glaucum NHX1* and *Arabidopsis SHN1* genes were transformed using the above-standardized transformation protocol in Indian wheat. The characterization of transgenic plants expressing *PgNHX1* and *AtSHN1* showed improved salt and drought tolerance, respectively.

TEACHING and MENTORSHIP EXPERIENCE:

2013-2015: Teaching Assistant under TEQIP Teaching Assistantship at University Institute of Engineering and Technology, Kurukshetra University, Kurukshetra, India.
I taught undergraduate biotechnological courses (Introduction to Biotechnology, Environmental Biotechnology, Stem Cells in Healthcare, Bioinformatics) for more than two years, including bioinformatics laboratory classes.

2010-2010: Teaching Associate at University Institute of Engineering and Technology, Kurukshetra University (UIET), Kurukshetra, India.
I taught undergraduate students courses titled Introduction to Biotechnology and Environmental Biotechnology and participated in departmental administrative tasks.

Mentorship and Guest Lectures: Furthermore, I mentored students and trainees for their respective thesis and dissertation works with Dr. Mamrutha H.M. at IIWBR, Karnal. I also delivered guest lectures to UC Berkeley undergraduates and high school students. I mentored one undergraduate student and one international Master's student from Italy for their research credits in the Krasileva lab.

FELLOWSHIPS:

- TEQIP Teaching Assistant Fellowship at UIET, Kurukshetra University, India
- CSIR-UGC Junior Research Fellowship and National Eligibility Test for University Lectureship
- ICAR National Eligibility Test, India
- Graduate Aptitude test in Engineering (GATE) in Biotechnology conducted by IITs in collaboration with MHRD, New Delhi, India

CONTRIBUTION TO THE ESTABLISHMENT OF FACILITIES:

- Plant Transformation and Plant Physiology facilities at ICAR-Indian Institute of Wheat and Barley Research, Karnal, India
- Plant Transformation facility at Institute for Cereal Crops Research, Tel Aviv University, Israel
- Wheat Transformation setup in the Krasileva''s Lab, PMB, UC Berkeley
- Wheat Transformation setup in the Milner's Lab, USDA-ARS, WRRC, Albany, CA

DEVELOPED SYSTEMS:

- Development of a robust and reproducible regeneration system in bread wheat
- Development of an efficient *Agrobacterium*-mediated transformation system in bread wheat

PATENT: Rust disease resistance genes and use thereof. U.S. Provisional Patent Application No. 63/354,703 filed 23 June 2022

PUBLICATIONS:

1. **Kumar R**, et al. Unveiling the interplay: stripe rust and wheat mRNA profiles under drought and salt stress interactions. **Manuscript in preparation**
2. **Kumar R**, et al. Assessment of NAC21/22 edited mutants under multiple pathogens of wheat. **Manuscript in preparation**
3. **Kumar R**, et al. DND (defense, no death) modulates immunity to pathogens in wheat mutants. **Manuscript in preparation**
4. **Kumar R**, et al. Tracking transgenes with color: evaluating RUBY as a visual marker in CRISPR-edited mutant plants. **Manuscript in preparation**
5. Sharma D, Parpar T, Prusty MR, Brotman Y, Cohen AS, **Kumar R**, Leah R, Minz-Dub A, Sharon A, Nir Sade. Population genomic analysis of *Aegilops longissima* identifies targets for bread wheat improvement. **Manuscript in preparation**
6. Sharma D, Haber Z, Brotman Y, Cohen AS, **Kumar R**, Prusty MR, Leah R, Minz-Dub A, Nir Sade. Wild wheat allele of B3 transcription factor regulates wheat yield tradeoff. **Manuscript in preparation**
7. Seong K, **Kumar R**, Prigozhin DM, Lunde C, et al. (2025) The Annotated Blueprint: Integrated functional genomic resources for a model tetraploid wheat *Triticum turgidum* cv. Kronos. PREPRINT (Version 1) available at bioRxiv. https://doi.org/10.1101/2025.09.12.675711 (under revision in *New Phytologist)*
8. Seong K, Wei W, Vega B, Dee A, Ramirez-Bernardino G, **Kumar R**, Parra L, Krasilva K (2025) Engineering the plant intracellular immune receptor Sr50 to restore recognition 2 of the AvrSr50 escape mutant. PREPRINT (Version 1) available at bioRxiv. https://doi.org/10.1101/2024.08.07.607039
9. Singh T, Mamrutha HM, Singh R, Jaiswal JP, Wadhwa Z, **Kumar R**, Singh O, Ahlawat OP, Tiwari R (2025) Comprehensive approaches to design efficient gRNA for SDN1-CRISPR/Cas9 genome editing in wheat. Front Genome Ed. https://doi.org/10.3389/fgeed.2025.1579165
10. Lunde C, Seong K, **Kumar R**, Deatker A, Chhabra B, et al. (2024) Durum wheat mutants with enhanced disease resistance to stripe rust show differential responses to other fungal diseases. Mol Breeding. https://doi.org/10.1007/s11032-025-01576-y

11. Prusty MR, Shatil-Cohen A, **Kumar R**, Sharma D, Minz-Dub A, Ezrati S, Hihinashvili A, Sharon A. (2025) Pigments to precision: RUBY aiding genetic transformation and genome editing in wheat and barley. Physiol Mol Biol Plants. https://doi.org/10.1007/s12298-025-01591-5
12. Sharma D, Avni R, Gutierrez-Gonzalez J, **Kumar R**, Sela H, et al. (2024) A single NLR gene confers resistance to leaf and stripe rust in wheat. *Nat Commun* **15**, 9925 (2024). https://doi.org/10.1038/s41467-024-54068-6
13. Seong K, **Kumar R**, Lunde C, Krasileva, K (2023) Chromosome-level genome assembly of *Triticum turgidum* var 'Kronos' [Data set]. Zenodo. https://doi.org/10.5281/zenodo.10215402
14. Mamrutha HM, Wadhwa Z, Deswal K, Budhagatapalli N, **Kumar R**, Tikaniya D, Krishnappa G, Singh G and Singh GP (2023) Evidences and opportunities for developing non-transgenic genome edited crops using the site-directed nuclease-1 approach. Crit Rev Biotechnol https://doi.org/10.1080/07388551.2023.2270581
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19. **Kumar R**, Mamrutha HM, Kaur A, Bhusal N, Pandey A, Kumar S, Mishra CN, Singh G, Singh GP (2020) Identification and characterization of multiple abiotic stress tolerance genes in wheat. Mol Biol Rep 47: 8629-8643. https://doi.org/10.1007/s11033-020-05906-5
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26. Suman, Kaur A, **Rakesh,** Grewal A (2014) An assessment of genetic fidelity in *Lepidium sativum* regenerants using RAPD markers. Eco Env Cons 20(1): 341-347.

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2. Mamrutha H.M., Rinki, **Kumar R.,** Pandey A., Kaur A., Gopalareddy K., Pandey G.C. (2021) Current Understanding of Thermotolerance in Wheat. In: Wani S.H., Mohan A., Singh G.P. (eds) Physiological, Molecular, and Genetic Perspectives of Wheat Improvement. Springer, Cham. https://doi.org/10.1007/978-3-030-59577-7_7
3. **Kumar R**, Singh V, Pawar SK, Singh PK, Kaur A, Sharma D (2019) Abiotic Stress and Wheat Grain Quality: A Comprehensive Review. In: Hasanuzzaman M., Nahar K., Hossain M. (eds) Wheat Production in Changing Environments. Springer, Singapore. https://doi.org/10.1007/978-981-13-6883-7_3.
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5. Mamrutha HM, Singh R, Sharma D, Venkatesh K, Pandey GC, **Kumar R**, Tiwari R, Sharma I (2019) Physiological and Molecular Basis of Abiotic Stress Tolerance in Wheat. In: Rajpal V, Sehgal D, Kumar A, Raina S (eds) Genetic Enhancement of Crops for Tolerance to Abiotic Stress: Mechanisms and Approaches, Vol. I. Sustainable Development and Biodiversity, vol 20. Springer, Cham. https://doi.org/10.1007/978-3-319-91956-0_5.
6. Singhal P, Gill AR, Sharma PK, **Kumar R**, Bhusal N, Kaur A, Sharma P (2019) Aptamers: Novel therapeutic and diagnostic molecules. In: Yadav GS, Kumar V, Kumar N (eds) Aptamers-Biotechnological applications of a next generation tool. Springer, Singapore. https://doi.org/10.1007/978-981-13-8836-1_5.
7. **Kumar R**, Mamrutha HM, Venkatesh K, Tiwari KN, Kumar S (2018) Application and achievements of Recombinant DNA in crop improvement. In: Bharadwaj DN (ed). Advanced molecular plant breeding. Apple Academic Press, Inc., New Jersey, USA, pp: 299-318. Hard ISBN: 9781771886642, e-book ISBN: 9780203710654. https://doi.org/10.1201/b22473.

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1. **Kumar R**, Palayur A, Lunde C, Milner M, Krasileva K (2024) Assessment of the RUBY gene as a visual marker to screen CRISPR-Cas9 mutants. **Invited talk** at Plant and Animal Genomics (PAG)-32, San Diego, CA, USA. Jan. 10-15, 2025
2. **Kumar R**, Lunde C, Seong K, Palayur A, Denora G, Song S, Hegarty J, Mundt C, Krasileva K (2024) Durum wheat, a new genetic model for forward and reverse disease resistance breeding. **Invited talk** at Plant and Animal Genomics (PAG)-31, San Diego, CA, USA. Jan. 12-17, 2024
3. **Kumar R**, Lunde C, Seong K, Hegarty J, Song S, Mundt C, Krasileva K (2023) Identification and engineering of broad-spectrum enhanced disease resistance alleles in wheat. **Invited talk** at Plant Health 2023 (APS), Denver, Colorado, USA. Aug. 12-16, 2023
4. **Kumar R**, Lunde C, Hegarty J, Song S, Mundt C, Krasileva K (2023) Exploring genetic elements and strategies for the improvement of rust resistance in wheat. **Invited talk** at Plant and Animal Genomics (PAG)-30, San Diego, CA, USA. Jan. 13-18, 2023
5. Mamrutha HM, Rinki, **Kumar R**, Pandey A, Kumar Y, Chatrath R and Singh GP (2019) Deciphering photosynthesis associated traits for improving yield in wheat. In 4th International Group meeting at CSK HPKV Palampur, Himachal Pradesh, India. Feb. 14 -16, 2019. Page no. 18
6. **Kumar R**, Mamrutha HM, Kaur A and Pandey A (2018) Expressional analysis of abiotic stress responsive genes in wheat genotypes under heat, drought and salt stresses. Poster presentation at 4th International Plant Physiology Congress 2018 at CSIR-NBRI, Lucknow, India. Dec. 2-5th 2018. Page no. 126

7. Mamrutha HM, Rinki, **Kumar R,** Singh R, Venkatesh K, Tiwari R, Chatrath and Singh GP (2018) Opportunities to explore photosynthesis associated traits for wheat yield improvement. In 4th International Plant Physiology Congress 2018 at CSIR-NBRI, Lucknow, India. Dec. 2-5th 2018. Page no. 296
8. Mamrutha HM, **Kumar R**, Kaur A, Tiwari V and Singh GP (2017) Enhancement of abiotic stress tolerance in wheat using *AtSHN1* gene. In National conference on Basic Biology is the Core of Biotechnology at Banasthali Vidyapith, Banasthali, Rajasthan, India. Oct. 30-31, 2017. Page no. 26
9. **Kumar R**, Kaur A, Mamrutha HM, Venkatesh K, Kumar R, Sharma P, Tiwari V and Sharma I (2016) Standardization of an efficient transformation protocol in Indian wheat genotypes. **Invited talk** at 6th International conference on "Technology Innovation and Management for Sustainable Development" at Gwalior, India. Feb. 11-13th, 2016 Page no. CP-135
10. **Kumar R**, Mamrutha H.M., Grewal A, Venkatesh K, Kumar R, Sharma P, Tiwari V and Sharma I (2015) Wheat recalcitrant nature breaks off in terms of tissue culture. Presented at: "XII Agricultural Science Congress *Sustainable Livelihood Security for Samllholder Farmers"* held at ICAR-National Dairy Research Institute (NDRI), Karnal. Feb. 3-6th, 2015. Page no. 56
11. **Kumar R**, Kaur A, Suman and Punia A (2012) Genetic diversity analysis of genotypes of *Lepidium sativum* (Garden Cress), a medicinal plant, using electrophoretic protein banding pattern. Presented at: National conference on "NexGen Biotechnology Amalgamating Science and Technology" organized by UIET, Kurukshetra University, Kurukshetra, Haryana. Nov. 23-24th, 2012. Page no. 42

Technical/Popular article

1. Pandey A, Mamrutha HM, **Kumar R**, Singh G and Singh GP (2020) Co-expression of regulatory genes to improve abiotic stress tolerance in wheat. Wheat & Barley Newsletter.14(2): 2
2. Pandey A, Mamrutha HM, **Kumar R**, Rinki, Gopalareddy K, Singh G and Singh GP (2020) Physio-biochemical characterization of NWPZ wheat varieties for temperature stress tolerance. Wheat & Barley Newsletter.14(2): 9
3. Mamrutha HM, **Kumar R**, Wadhwa Z, Mishra S, Pandey A, Singh G and Singh GP (2019) Improving grain weight in wheat through CRISPR/Cas9 mediated genome editing. Wheat & Barley Newsletter. 13 (2): 1
4. Pandey A, Mamrutha HM, **Kumar R**, Rinki, Singh G and Singh GP (2019) Functional validation of BTF3, NF-YA7 and SAP-ZF multigene construct for imparting multiple abiotic stress tolerance in wheat. Wheat & Barley Newsletter. 13 (2): 5
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6. Mamrutha HM, Rinki, **Kumar R**, Singh R, Venkatesh K and Narwal S (2017) Opportunities to explore photosynthesis associated traits for wheat yield improvement. Wheat Barley News lett 11(1): 4
7. Rinki, Mamrutha HM, **Kumar R** and Tiwari V (2016) Comparison of seedling and adult stage heat stress tolerance in wheat. Wheat Barley News lett 10(1**)**: 9
8. **Kumar R**, Mamrutha HM, Kaur A, Bhusal N and Venkatesh K (2017) Elucidating the cellular thermal stress tolerance mechanism in Raj 3765. Wheat Barley News lett 10(2): 8
9. **Kumar R**, Kaur A, Mamrutha HM, K Venkatesh, Kumar R, Sharma P, Tiwari V and Sharma I (2015) Standardization of an efficient genotype independent transformation system in Indian wheat genotype. Wheat Barley News lett 9(1&2): 13
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JOURNAL REVIEWER: BMC Plant Biology, BMC Genomics, Gene Reports, Physiology and Molecular Biology of Plants, Journal of Agriculture and Food Research, Plant Physiology and Biochemistry, Genetic Resources and Crop Evolution, 3 Biotech, Frontiers in Plant Science, Plants, Genes, Agronomy, International Journal of Plant Biology, Journal of Cotton Research, ORYZA - An International Journal on Rice, International Journal of Molecular Sciences, Biochemical Genetics.

REFERENCES:

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