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DESIGN AND DEVELOPMENT OF PLANT RESISTANCE GENE DATABASE

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ABSTRACT

The Plant Resistance Genes database is a comprehensive resource on resistance genes (R-genes), a major class of genes in plant genomes that impart disease resistance against various stresses including pathogens. The ultimate goal of this project is to gather reported candidate host plant resistance genes and design a user friendly Plant Resistance Gene Database. Plant Resistance Gene Database is a comprehensive searchable information system to enable effortless location of Resistance genes data of particular crops and their diseases. Plant Resistance Gene Database is an open and updated space about Pathogen Receptor Genes (PRGs), in which all information available about these genes is stored, curated and discussed. The purpose of our work is to create a user friendly tool for world community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange. The most represented group of resistance genes belong to the nucleotide binding site–leucine-rich repeat (NBS-LRR) class. These genes have been isolated from the Species of Oryza sativa, Solanum lycopersicum and Cajanus cajan crops. Information such as nucleotide and protein sequences, genomic locations and structural information were automatically retrieved and imported into the PRG database. Since these genes could have been annotated in NCBI as R-genes from other predictive tools, we will refer to them from here on as 'putative R-Genes collected from NCBI. The PRG database represents the first collection of resistance genes publicly available to the scientific community. Rice Blast, Bacterial Leaf Blight and Gall Midge disease are found in Oryza sativa crops and Leaf curl, Phytophthora Infestans disease are important diseases in Solanum lycopersicum and the Fusarium wilt, Pod borer diseases are found in the Cajanus cajan. These genes are located on various plant genomes, and they often occur at specific loci in clusters conserved on chromosomes following gene duplication and amplification events. When these NBS-LRR genes have been physically or genetically mapped, in many cases have shown co-localization between resistance loci and NBS-LRR genes. The database was designed to allow easy integration with other data types and existing and future use of databases.

KEYWORDS: Plant Resistance Genes database, nucleotide binding site–leucine-rich repeat, Pathogen Receptor Genes, Resistance gene.

INTRODUCTION

PRGDb is a web accessible open-source database that represents the first bioinformatics resource providing a comprehensive overview of resistance genes (R-genes) in plants.[8] Plant disease resistance genes (R-genes) play a key role in recognizing proteins expressed by specific avirulence (Avr) genes of pathogens. R-genes originate from a phylogenetically ancient form of immunity that is common to plants and animals. In this study we present the plant resistance gene database (PRGDb) which is the first comprehensive bioinformatics resource dedicated to known and predicted plant disease resistance genes.[5] This resource aims to provide scientists working in this field of research a comprehensive.[13] This represents the largest manually curated dataset published so far for plant disease resistance genes. These genes have been isolated from the Species of Oryza Sativa, Solanum Lycopersicum and Cajanus Cajan crops. Information such as nucleotide and protein sequences, genomic locations and structural information were automatically retrieved and imported into the PRG database. Since these genes could have been annotated in NCBI as R-genes from other predictive tools, we will refer to them from here on as 'putative R-Genes collected from NCBI'. The PRG database represents the first collection of resistance genes publicly available to the scientific community. Rice Blast,[7] Bacterial Leaf Blight[4] and Gall Midge disease,[3] are found in Oryza sativa crops, and in Leaf curl,[10] Phytophthora Infestans disease are important diseases in Solanum lycopersicum, Fusarium wilt,[9] Pod borer diseases are found in the Cajanus cajan. Hence we collected the Resistance genes of these

particular Crops Diseases and we designed and developed the Plant Resistance Gene Database of this Resistance Genes in the present work. PRGDB is an open and updated space about Pathogen Receptor Genes (PRGs), in which all information available about these genes is stored, curated and discussed,[23] The purpose of our work is creating a worldwide community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange. Hence in to this Database the Resistance genes of three crops Disease are found and they also explain about their (disease) management and functions. The presence of different domains at the N-terminal portion of the NBS-LRR proteins classifies these NBS-LRR gene products into two subgroups: the TIR-NBS-LRR (TNL) proteins that contain a Toll-like domain, and the CC-NBS-LRR (CNL) proteins that are characterized by a coiled-coil domain. The Plant Resistance Genes database is a comprehensive resource on resistance genes (R-genes), a major class of genes in plant genomes that convey disease resistance against pathogens. Plant Resistance Gene Database is an open and updated space about Pathogen Receptor Genes (PRGs), in which all information available about these genes is stored, curated and discussed. The purpose of our work is creating a worldwide community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange. We collected the raw sequence data of Plant resistance genes, using computer programming scripts designed both Front-end and back-end of the database facilitating storage user search query processing, projecting answer and created a plant Resistance Gene Database. In present work we using HTML for the developing web pages that are front-End and Back-End data in to Database and LAMP server are used to develop Schema and query coverage. We also using SMART, P-fam, and other database for the finding the genes, gene sequences and their functions and Domains. We employed gene finding tool such as August, Pub Med, and etc. The ultimate goal of this project: The Plant Resistance Gene Database a comprehensive searchable information system is to enable effortless collection of Resistance genes data of particular crops disease.

NBS-LRR- Plant proteins belonging to the nucleotide-binding site–leucine-rich repeat (NBSLRR) family are used for pathogen detection. Plant NBS-LRR proteins detect pathogenassociated proteins, most often the effectors molecules of pathogens responsible for virulence.

Many virulence proteins are detected indirectly by plant NBS-LRR proteins from modifications the virulence proteins inflict on host target proteins.[12] However, some NBS-LRR proteins directly bind pathogen proteins. Association with either a modified host protein or a pathogen protein leads to conformational changes in the amino-terminal and LRR domains of plant NBSLRR proteins. The PRG data is stored in a MySQL database and is freely accessible through a web interface at the address: http://www.prgdb.org. The PRG web site was designed to provide plant researchers with user-friendly tools to retrieve relevant information in our complete R-gene catalogue. The main aim of PRGDb is to provide tools to support research in this field. We have developed an exhaustive plant community database, providing data for extensive studies.[6] The main class of R-gene consists of a nucleotide binding domain (NB) and a leucine rich repeat (LRR) domain(s) and is often referred to as (NB-LRR) R-genes.[15] Generally, the NB domain binds either ATP/ADP or GTP/GDP. The LRR domain is often involved in protein-protein interactions as well as ligands binding. NB-LRR R-genes can be further subdivided into toll interleukin 1 receptor (TIR-NB-LRR) and coiled-coil (CC-NB-LRR). The presence of different domains at the N-terminal portion of the NBS-LRR proteins classifies these NBS-LRR gene products into two subgroups: the TIR-NBS-LRR (TNL) proteins that contain a Toll-like domain, and the CC-NBS-LRR (CNL) proteins that are characterized by a coiled-coil domain,[1] this subdivision is, however, not always precise. With several hundreds of members, the NBS-LRR genes are one of the most numerous gene families in plants, as has also been demonstrated by recent studies carried out with species with a sequenced genome.[14] Once the R protein has detected the presence of a pathogen, the plant can mount a defense against the pathogen. Because R genes confer resistance against specific pathogens, it is possible to transfer an R gene from one plant to another and make a plant resistant to a particular pathogen. Once the R protein has detected the presence of a pathogen, the plant can mount a defense against the pathogen. Because R genes confer resistance against specific pathogens, it is possible to transfer an R gene from one plant to another and make a plant resistant to a particular pathogen.[11]

The Database models are defined in the manner in which the various files of Database are linked together. In a database management system (DBMS), a group of similar information or data, which is of interest to an organization, is called an Entity. A model that represents system data by entity and relationship sets is called E-R model. The entity-relationship data model is based on a perception of a real world which consists of a set of basic objects. The E-R model was introduced by P.P. Chen.[16] An entity relationship diagram (ERD), also known as an entity relationship model, is a graphical representation of an information system that depicts the relationships among people, objects, places, concepts or events within that system. An ERD is a data modeling Technique that can help define business processes and be used as the foundation for a relational database.

MATERIAL AND METHODS

In Resistance plant Gene Database we included various Resistance genes sequences, their functional domains

and their functions using the following Tools and Databases. And we found the Resistance genes and their Functions against particular crops Disease by the help of Following Tools.

Table 1.1: List of Bioinformatics tools.

Tools used	Function performed	URL
RAP-DB	To provide access to the annotation data.[21]	http://rapdb.dna.affrc.go.jp/
PubMed	PubMed is a Good Book Shelf to search for Information You want from Various Scientific Journals.[17]	https://www.ncbi.nlm.nih.gov/pubmed/
SMART	Allows the identification and annotation of genetically mobile domains and the analysis of domain architectures.[19]	http://smart.emblheidelberg.de/
DRAGO 2	Detects LRR, Kinase, NBS and TIR domains from 60 HMM modules created for this purpose using HMMER v3 package and it is also able to detect CC and TM domains.[22]	http://www.prgdb.org/prgdb/drago2
Inter Pro Scan	Provides functional analysis of proteins by classifying them into families and predicting domains.[20]	https://www.ebi.ac.uk/interpro/search/sequence-search
NCBI	The National Center for Biotechnology Information advances science and health by providing access to biomedical and genomic information.[26]	https://www.ncbi.nlm.nih.gov/

Description

Design and development of Plant resistance Gene database based on MySQL involves two components: Front-end and Back-end of the database. Front-end comprises; Homepage, Crop disease analyzed page, Other Database page, Team Page and contact Page. Similarly the Backend consists of the Information of the Resistance genes and query coverage. Using Relational database system (RDMS) the data base is used for storing data, it's projection (facilitating userqueries on available resistance gene information), made operational and accessible to users across Intra and internet.

PRGDB is an open and updated space about Pathogen Receptor Genes (PRGs), in which all information available about these genes is stored, curated and discussed. The purpose of our work is creating a worldwide community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange. Hence in to this Database the Resistance genes of three crops disease are found and they also explain about their (disease) management and functions. The presence of different domains at the N-terminal portion of the NBS-LRR proteins classifies these NBS-LRR gene products into two subgroups: the TIR-NBS-LRR (TNL) proteins that contain a Toll-like domain, and the CC-NBS-LRR (CNL) proteins that are characterized by a coiled-coil domain. The Plant Resistance Genes database is a comprehensive resource on resistance genes (R-genes), a major class of genes in plant genomes that convey disease resistance against pathogens. Plant Resistance Gene Database is an open and updated space about Pathogen Receptor Genes (PRGs), in which all information available about these genes is stored, curated and discussed. The purpose of our work is creating a worldwide community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange.

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Home Page: The Page showing the Home page of Plant Resistance Gene Database in the present work, View of front-end of the Database.

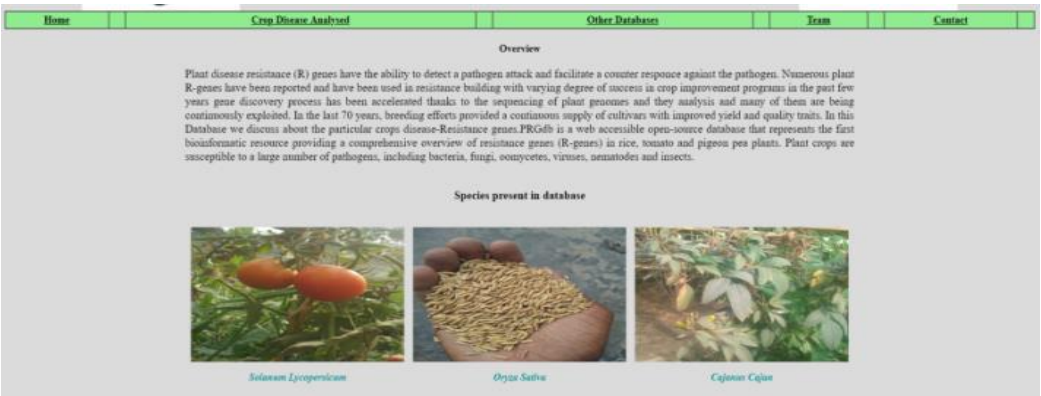

Fig 1.1: Homepage of PRGDb.

Solanum lycopersicum

Solanum lycopersicum is an important vegetable crop. It is a rich source of vitamins, minerals, and fiber, and a dietary source of antioxidants. Tomato is also a model system for studies on fruit development and functional genomics.A wide range of microbial pathogens and insect pests attack different parts of the tomato plant, causing severe losses to the crop productivity. In my work we have detail about two disease against resistance Genes, such as-

- Leaf curl
- phytophthora Infestans

Table 1.2: List of resistance genes of *Solanum lycopersicum*.

Disease	Resistant Genes	Sequence ID	NBS-LRR (Protein)
Phytophthora infestans	ARS1	NP_001340693.1	Other
Phytophthora infestans	PDK1	NP_001234519.1	LRR
Phytophthora infestans	PH-3	XP_010317978.1	CC-NBS-LRR
Phytophthora infestans	SlWRKY33A	NP_001306910.1	TIR
Phytophthora infestans	TBGIC(PH-5)	NP_001234465.1	LRR
Phytophthora infestans	TW65-03231(PH-4)	KNG49917.1	Other
Phytophthora infestans	WRKY3	ADZ15316.1	TIR
Phytophthora infestans	LOC101252668(R1)	XP_010318018.1	CC-NB-LRR
Phytophthora infestans	LOC101254530(PH-2)	XP_010326689.1	CNL
Phytophthora infestans	LOC101259759(PH-2)	XP_010323231.1	CNL
Phytophthora infestans	LOC101257478(PH-1)	XP_004241168.1	Other
Phytophthora infestans	WRKY4	ACF04193.1	TIR
Leaf Curl	AC3	YP_002124296.1	TIR
Leaf Curl	AV1	YP_002124295.1	TIR
Leaf Curl	AV2	YP_002124294.1	LTR
Leaf Curl	C1	AGL34952.1	TIR
Leaf Curl	NC1	API61733.1	TIR
Leaf Curl	TYNBS1	BBC83283.1	NB-LRR
Leaf Curl	TYNBS2	BBC83286.1	NB-LRR
Leaf Curl	TOLCV-K3	ACG49276.1	TIR
Leaf Curl	TOLCV-K3(AC4)	ACG49280.1	TIR
Leaf Curl	TOLCV-K5(AC4)	ACG49274.1	TIR

Oryza sativa

Rice is the most widely grown tropical cereal, and over 400 million tonnes of milled rice is produced each year. The importance of rice has been recognised for many centuries - in India it was once known as 'dhanya' meaning 'the sustainer of the human race'. Rice is a staple food of South Asia and a vast number of people are employed in its cultivation.[18]

In my works we discus about three disease against resistance Genes, such as-

- Rice blast
- Gall Midge & Bacterial leaf blight

Table 1.3: List of resistance genes of *Oryza satriva.*

Disease	Resistant Genes	Sequence ID	NBS-LR (Protein
Rice Blast	FAH1	Os12t0628400-01	CNL\TNL
Rice Blast	FAH2	Os03t0780800-01	CNL\TNL
Rice Blast	AAE3	Os04t0683700-01	LRR
Rice Blast	ALD1	Os03t0195100-01	TIR
Rice Blast	VAMP714	Os10t0154000-01	TIR
Rice Blast	PIT	Os01t0149500-01	NBS-LRR
Rice Blast	WAK14	Os02t0632800-01	TIR/CC
Rice Blast	WAK90	Os09t0561500-01	TIR/CC
Rice Blast	WAK92	Os09t0562600-01	TIR
Rice Blast	WAK112	Os10t0180800-01	CC
Rice Blast	WAK91	Os09t0561600-0	TIR
Bacterial leaf blight	TBL1	Os12t0106300-01	CC
Bacterial leaf blight	TBL2	Os11t0107000-01	CC
Bacterial leaf blight	Xa4	AQQ72929.1	CC/TIR
Bacterial leaf blight	Xa5	AUK50737.1	TIR & LRR
Bacterial leaf blight	Xa10	ARB16033.1	TIR
Bacterial leaf blight	Xa13	BAD13102.1	CNL\TNL
Bacterial leaf blight	Xa21	AAC49123.1	LRR
Bacterial leaf blight	pi-ta	ARB16034.1	CNL
Gall midge	Gm2(clone)	AFQ36048.1	NB-ARC
Gall midge	Gm2(clone8)	AFQ36049.1	NB-ARC
Gall midge	Gm4(2)	ALA99923.1	LRR
Gall midge	Gm4	ALA99926.1	LRR

Cajanus cajan

Pigeon pea, one of the major grain legumes of the semi-arid tropics. Due to its high protein content, pigeon pea forms a significant component of the diet of vegetarians. But the productivity are constrained by a major insect pest of pigeon pea. So development of transgenic pigeon pea has been targeted to generate pod borer resistant pigeon pea.[2] There are different types of biotic and abiotic stresses which reduce the production. In to my project work we discus about two disease against Resistance Genes. In my works we discus about two disease against resistance Genes, such as-

- Fusarium wilt
- Pod borer

Table 1.4: List of resistance genes of *Cajanus cajan.*

Disease	Resistant Genes	Sequence ID	NBS-LRR (Protein)
Fusarium wilt	BAHAR	AGW81294.1	Other
Fusarium wilt	BSMR-846	AFV93475.1	TIR
Fusarium wilt	LOC109807922	XP_020226241.1	LRR
Fusarium wilt	MAL-13	AFV93476.1	TIR
Fusarium wilt	BWR-133	XP_020208974.1	TIR
Pod Borer	LOC109807922	XP_020226241.1	LRR
Pod Borer	LOC109809676	XP_020229737.1	CC & TIR
Pod Borer	LOC1098910682	XP_020229806.1	CC & TIR
Pod Borer	C-T1-3	XP_020238339.1	LRR
Pod Borer	ICP8863	YP_009268861.1	Other
Pod Borer	ICPL 84023	ACQ99773.1	LRR

CONCLUSION

PRGDB is an open and updated space about Pathogen Receptor Genes (PRGs), in which Solanum lycopersicum, Oryza sativa, and Cajanus cajan information available in a single platform about those species genes are stored, curated and discussed in Plant Resistance gene Database. The purpose of our work is creating a worldwide community working on plant resistance genes with a constant update on all aspects of this research field and to encourage scientists to be actors of the discussion and of the data exchange. Hence in to this Database we Resistance genes of three crops Disease are found and they also explain about their (disease) management and functions. Plant Resistance Gene Database is an open and updated space about Pathogen Receptor Genes (PRGs).In present information system, user can able to find the specific and non redundant information regarding of those edible species.

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