

GEPHE SUMMARY

	Gephebase Gene		GepheID
Rgh4 (https://www.gephebase.org/search-criteria?/and+GeneGephebase=~Rgh4~#gephebase-summary-title)		GP00001049	
	Entry Status	Martin	Main curator
Published			

PHENOTYPIC CHANGE

	Trait Category		
Physiology (https://www.gephebase.org/search-criteria?/and+TraitCategory=~Physiology~#gephebase-summary-title)			
	Trait		
Pathogen resistance (cyst nematode; parasite) (https://www.gephebase.org/search-criteria?/and+Trait=~Pathogen+resistance+(cyst+nematode;+parasite)~#gephebase-summary-title)			
	Trait State in Taxon A		
Glycine max - sensitive			
	Trait State in Taxon B		
Glycine max - resistant - “Peking-type”			
	Ancestral State		
Data not curated			
	Taxonomic Status		
Domesticated (https://www.gephebase.org/search-criteria?/and+TaxonomicStatus=~Domesticated~#gephebase-summary-title)			
	Taxon A		Taxon B
	Latin Name		Latin Name
Glycine max (https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Glycine+max~#gephebase-summary-title)		Glycine max (https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Glycine+max~#gephebase-summary-title)	
	Common Name		Common Name
soybean		soybean	
	Synonyms		Synonyms
soybean; soybeans; Glycine max (L.) Merr.; Glycine max; cv. Wye		soybean; soybeans; Glycine max (L.) Merr.; Glycine max; cv. Wye	
	Rank		Rank
species		species	
	Lineage		Lineage
cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; fabids; Fabales; Fabaceae; Papilionoideae; 50 kb inversion clade; NPAAA clade; indigoferoid/millettioid clade; Phaseoleae; Glycine; Soja		cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; fabids; Fabales; Fabaceae; Papilionoideae; 50 kb inversion clade; NPAAA clade; indigoferoid/millettioid clade; Phaseoleae; Glycine; Soja	
	Parent		Parent
Soja () - (Rank: subgenus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=1462606)		Soja () - (Rank: subgenus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=1462606)	
	NCBI Taxonomy ID		NCBI Taxonomy ID
3847 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3847)		3847 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3847)	
	is Taxon A an Intraspecies?		is Taxon B an Intraspecies?
No		No	

GENOTYPIC CHANGE

	Generic Gene Name		UniProtKB Glycine max
SHMT		K4FZF8 (http://www.uniprot.org/uniprot/K4FZF8)	
	Synonyms		GenebankID or UniProtKB
-		JQ714079 (https://www.ncbi.nlm.nih.gov/nucleotide/JQ714079)	
	String		
-			
	Sequence Similarities		
Belongs to the SHMT family.			
	GO - Molecular Function		
GO:0008168 : methyltransferase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0008168)			
GO:0030170 : pyridoxal phosphate binding (https://www.ebi.ac.uk/QuickGO/term/GO:0030170)			
GO:0004372 : glycine hydroxymethyltransferase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0004372)			
	GO - Biological Process		

GO:0019264 : glycine biosynthetic process from serine
(<https://www.ebi.ac.uk/QuickGO/term/GO:0019264>)
GO:0035999 : tetrahydrofolate interconversion
(<https://www.ebi.ac.uk/QuickGO/term/GO:0035999>)

GO - Cellular Component

GO:0009507 : chloroplast (<https://www.ebi.ac.uk/QuickGO/term/GO:0009507>)

Mutation #1

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=^No^#gephebase-summary-title>)

Molecular Type

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=^Coding^#gephebase-summary-title>)

Aberration Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=^SNP^#gephebase-summary-title>)

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

R130P (G-to-C) and Y358N (T-to-A)

Experimental Evidence

Linkage Mapping (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=^Linkage Mapping^#gephebase-summary-title>)

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Arg	Pro	130

Main Reference

A soybean cyst nematode resistance gene points to a new mechanism of plant resistance to pathogens. (2012) (<https://pubmed.ncbi.nlm.nih.gov/23235880>)

Authors

Liu S; Kandoth PK; Warren SD; Yeckel G; Heinz R; Alden J; Yang C; Jamai A; El-Mellouki T; Juvale PS; Hill J; Baum TJ; Cianzio S; Whitham SA; Korkin D; Mitchum MG; Meksem K

Abstract

Soybean (*Glycine max* (L.) Merr.) is an important crop that provides a sustainable source of protein and oil worldwide. Soybean cyst nematode (*Heterodera glycines* Ichinohe) is a microscopic roundworm that feeds on the roots of soybean and is a major constraint to soybean production. This nematode causes more than US\$1 billion in yield losses annually in the United States alone, making it the most economically important pathogen on soybean. Although planting of resistant cultivars forms the core management strategy for this pathogen, nothing is known about the nature of resistance. Moreover, the increase in virulent populations of this parasite on most known resistance sources necessitates the development of novel approaches for control. Here we report the map-based cloning of a gene at the Rhg4 (for resistance to *Heterodera glycines* 4) locus, a major quantitative trait locus contributing to resistance to this pathogen. Mutation analysis, gene silencing and transgenic complementation confirm that the gene confers resistance. The gene encodes a serine hydroxymethyltransferase, an enzyme that is ubiquitous in nature and structurally conserved across kingdoms. The enzyme is responsible for interconversion of serine and glycine and is essential for cellular one-carbon metabolism. Alleles of Rhg4 conferring resistance or susceptibility differ by two genetic polymorphisms that alter a key regulatory property of the enzyme. Our discovery reveals an unprecedented plant resistance mechanism against a pathogen. The mechanistic knowledge of the resistance gene can be readily exploited to improve nematode resistance of soybean, an increasingly important global crop.

Additional References

Mutation #2

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=^No^#gephebase-summary-title>)

Molecular Type

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=^Coding^#gephebase-summary-title>)

Aberration Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=^SNP^#gephebase-summary-title>)

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

R130P (G-to-C) and Y358N (T-to-A)

Experimental Evidence

Linkage Mapping (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=^Linkage Mapping^#gephebase-summary-title>)

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Tyr	Asn	358

Main Reference

A soybean cyst nematode resistance gene points to a new mechanism of plant resistance to pathogens. (2012) (<https://pubmed.ncbi.nlm.nih.gov/23235880>)

Authors

Liu S; Kandoth PK; Warren SD; Yeckel G; Heinz R; Alden J; Yang C; Jamai A; El-Mellouki T; Juvale PS; Hill J; Baum TJ; Cianzio S; Whitham SA; Korkin D; Mitchum MG; Meksem K

Abstract

Soybean (*Glycine max* (L.) Merr.) is an important crop that provides a sustainable source of protein and oil worldwide. Soybean cyst nematode (*Heterodera glycines* Ichinohe) is a microscopic roundworm that feeds on the roots of soybean and is a major constraint to soybean production. This nematode causes more than US\$1 billion in yield losses annually in the United States alone, making it the most economically important pathogen on soybean. Although planting of resistant cultivars forms the core management strategy for this pathogen, nothing is known about the nature of resistance. Moreover, the increase in virulent populations of this parasite on most known resistance sources necessitates the development of novel

approaches for control. Here we report the map-based cloning of a gene at the Rhg4 (for resistance to *Heterodera glycines* 4) locus, a major quantitative trait locus contributing to resistance to this pathogen. Mutation analysis, gene silencing and transgenic complementation confirm that the gene confers resistance. The gene encodes a serine hydroxymethyltransferase, an enzyme that is ubiquitous in nature and structurally conserved across kingdoms. The enzyme is responsible for interconversion of serine and glycine and is essential for cellular one-carbon metabolism. Alleles of Rhg4 conferring resistance or susceptibility differ by two genetic polymorphisms that alter a key regulatory property of the enzyme. Our discovery reveals an unprecedented plant resistance mechanism against a pathogen. The mechanistic knowledge of the resistance gene can be readily exploited to improve nematode resistance of soybean, an increasingly important global crop.

Additional References

RELATED GEPHE

1 (Rhg1) (<https://www.gephebase.org/search-criteria?/or+Taxon ID=^3847^/and+Trait=Pathogen resistance/and+groupHaplotypes=true#gephebase-summary-title>)

Related Genes

No matches found.

Related Haplotypes

EXTERNAL LINKS

COMMENTS

@Epistasis - The full strength of Peking type soybean cyst nematode resistance phenotype is due to the combination of alleles rhg1a (chromosome 18) and Rhg4 (chromosome 8).