

GEPHE SUMMARY

Gephebase Gene
Chitin synthase 1 (CHS1)

Entry Status
Published

GepheID
GP00001600

Main curator
Prigent

PHENOTYPIC CHANGE

Trait Category
Physiology

Trait
Xenobiotic resistance (insecticide) (benzoylurea)

Trait State in Taxon A
Plutella xylostella BCS-S and Japan reference strains susceptible

Trait State in Taxon B
Plutella xylostella Sudlon-Tfm strain sampled in a Philippine cabbage field selected with triflumuron under laboratory conditions resistant to diverse BPU and also etoxazole (>178-fold)

Ancestral State
Unknown

Taxonomic Status
Intraspecific

Taxon A

Latin Name
Plutella xylostella

Common Name
diamondback moth

Synonyms
diamondback moth; cabbage moth; Plutella xylostella (Linnaeus, 1758); Putella xylostella

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphimesnoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Yponomeutoidea; Plutellidae; Plutella

Parent
Plutella () - (Rank: genus)

NCBI Taxonomy ID
51655

is Taxon A an Intraspecies?
Yes

Taxon A Description
Plutella xylostella BCS-S and Japan reference strains susceptible

Taxon B

Latin Name
Plutella xylostella

Common Name
diamondback moth

Synonyms
diamondback moth; cabbage moth; Plutella xylostella (Linnaeus, 1758); Putella xylostella

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphimesnoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Yponomeutoidea; Plutellidae; Plutella

Parent
Plutella () - (Rank: genus)

NCBI Taxonomy ID
51655

is Taxon B an Intraspecies?
Yes

Taxon B Description
Plutella xylostella Sudlon-Tfm strain sampled in a Philippine cabbage field selected with triflumuron under laboratory conditions resistant to diverse BPU and also etoxazole (>178-fold)

GENOTYPIC CHANGE

Generic Gene Name
CHS1

Synonyms
CHS1; PxCHS1B

String
-

Sequence Similarities
-

GO - Molecular Function
GO:0016758 : transferase activity, transferring hexosyl groups

GO - Biological Process
-

UniProtKB Plutella xylostella
A3KCN0

GenebankID or UniProtKB
KX420690

GO - Cellular Component
GO:0016021 : integral component of membrane

Presumptive Null
No

Molecular Type
Coding

Aberration Type
SNP

SNP Coding Change
Nonsynonymous

Molecular Details of the Mutation
T>G p.I1042M (I1056 in *D. melanogaster*) located in the C-terminal transmembrane domain

Experimental Evidence
Candidate Gene

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	-	-	-

Main Reference
Resistance mutation conserved between insects and mites unravels the benzoylurea insecticide mode of action on chitin biosynthesis. (2016)

Authors
Douris V; Steinbach D; Panteleri R; Livadaras I; Pickett JA; Van Leeuwen T; Nauen R; Vontas J

Abstract
Despite the major role of chitin biosynthesis inhibitors such as benzoylureas (BPUs) in the control of pests in agricultural and public health for almost four decades, their molecular mode of action (MoA) has in most cases remained elusive. BPUs interfere with chitin biosynthesis and were thought to interact with sulfonyleurea receptors that mediate chitin vesicle transport. Here, we uncover a mutation (I1042M) in the chitin synthase 1 (CHS1) gene of BPU-resistant *Plutella xylostella* at the same position as the I1017F mutation reported in spider mites that confers etoxazole resistance. Using a genome-editing CRISPR/Cas9 approach coupled with homology-directed repair (HDR) in *Drosophila melanogaster*, we introduced both substitutions (I1056M/F) in the corresponding fly CHS1 gene (kky). Homozygous lines bearing either of these mutations were highly resistant to etoxazole and all tested BPUs, as well as buprofezin-an important hemipteran chitin biosynthesis inhibitor. This provides compelling evidence that BPUs, etoxazole, and buprofezin share in fact the same molecular MoA and directly interact with CHS. This finding has immediate effects on resistance management strategies of major agricultural pests but also on mosquito vectors of serious human diseases such as Dengue and Zika, as diflubenzuron, the standard BPU, is one of the few effective larvicides in use. The study elaborates on how genome editing can directly, rapidly, and convincingly elucidate the MoA of bioactive molecules, especially when target sites are complex and hard to reconstitute in vitro.

Additional References

RELATED GEPHE

Related Genes
5 (ABCC2, CYP6BG1, FMO2, MAP4K4, para (kdr))
Related Haplotypes
1

EXTERNAL LINKS

COMMENTS

The mutation was present at low frequency (3%) in the Sudlon strain before selection and fixed in selected Sudlon-Tfm strain. It is homozygous in 7% of Japan strain and also present in field populations in China and India. Selected strain showed significant longer larval and pupal development time indicative of possible fitness costs associated with benzoylurea resistance. Transgenic flies with the same mutation is highly resistant to etoxazole and all tested benzoylureas as well as buprofezin