



黑麦草ALS基因抗性分析与结构预测

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2026年1月11日

Contents

01

研究背景

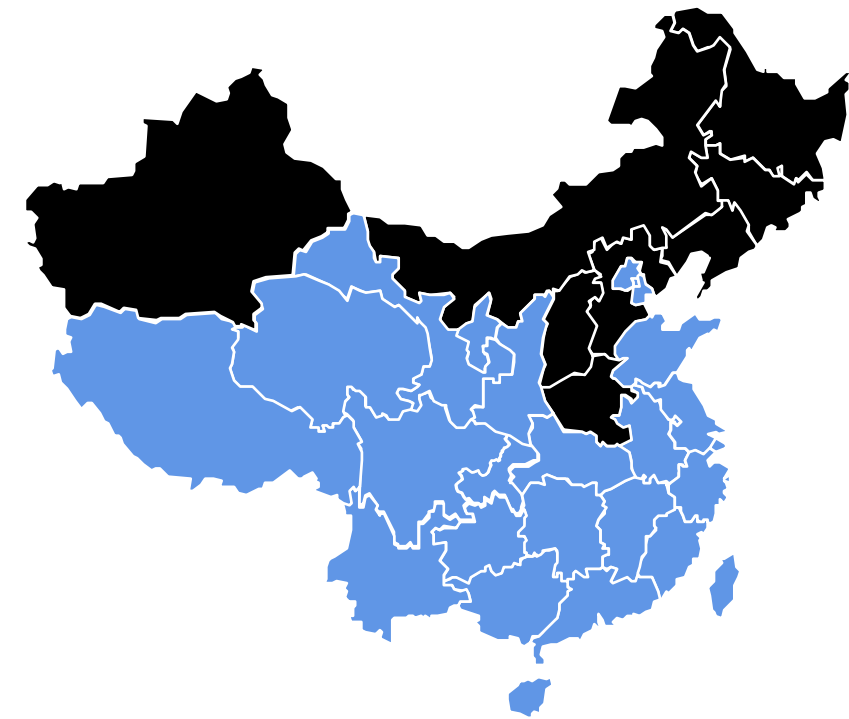
02

研究内容

03

研究前景

多年生黑麦草 (*Lolium perenne*) 是一种原产于欧洲、中亚、中东和北非的杂草，在08世纪初作为草坪草引入中国，随后扩散进入麦田成为影响冬小麦产量的主要杂草，在河南等地区，农民长期使用ALS抑制剂类除草剂（如甲基二磺隆）防治多年生黑麦草，但由于多年连续使用，杂草已产生显著抗药性，导致防治效果急剧下降。

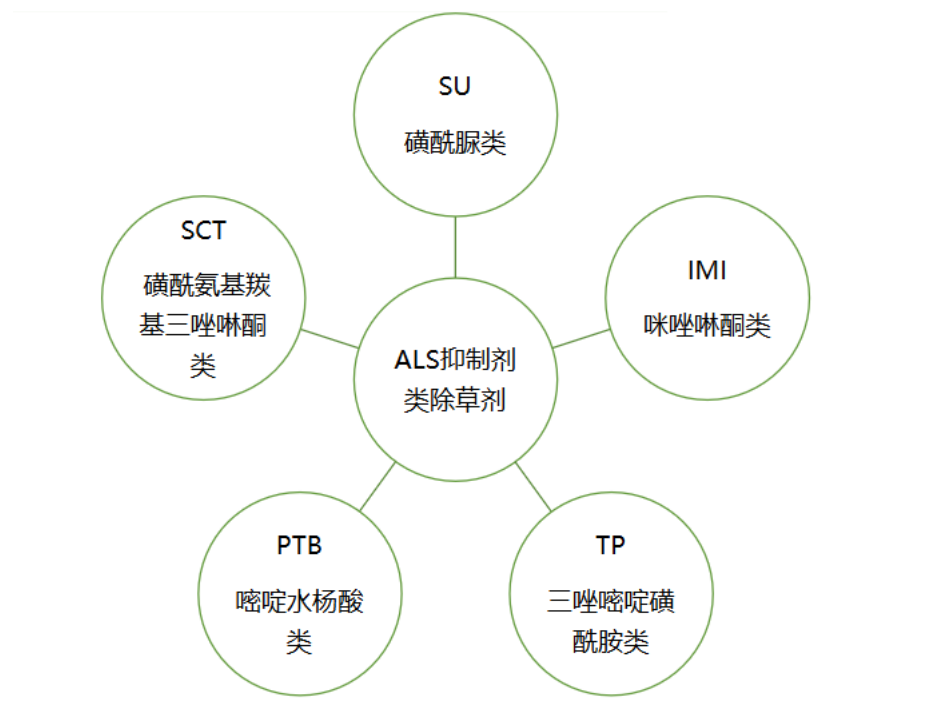


黑麦草在我国的主要分布地区（黑色区域）



黑麦草

ALS（乙酰乳酸合酶）抑制剂是一类高效、低毒的除草剂，通过抑制植物体内支链氨基酸（缬氨酸、亮氨酸、异亮氨酸）合成途径中的关键酶——ALS酶来发挥作用。



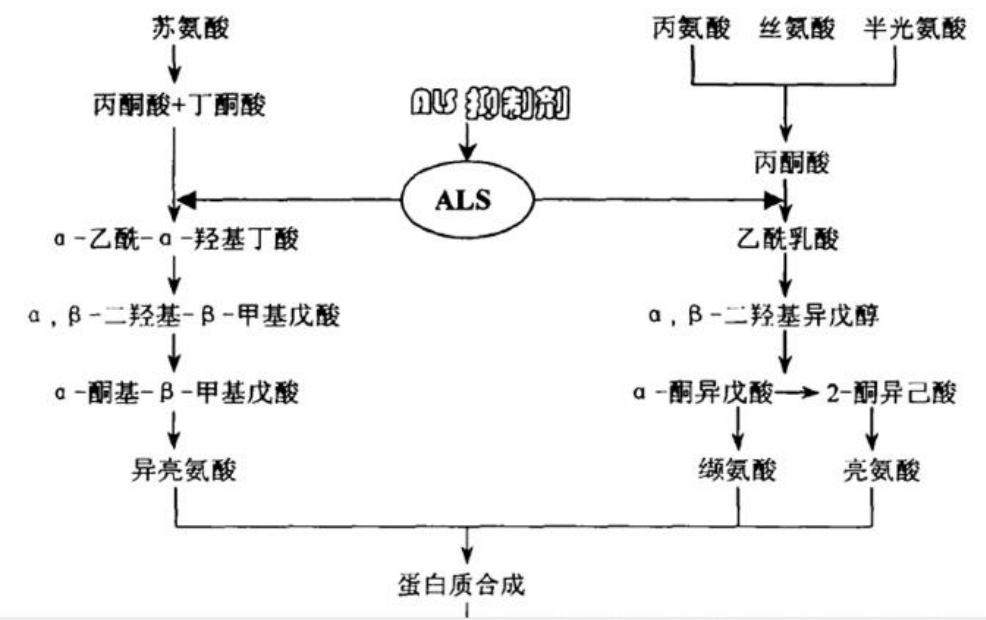
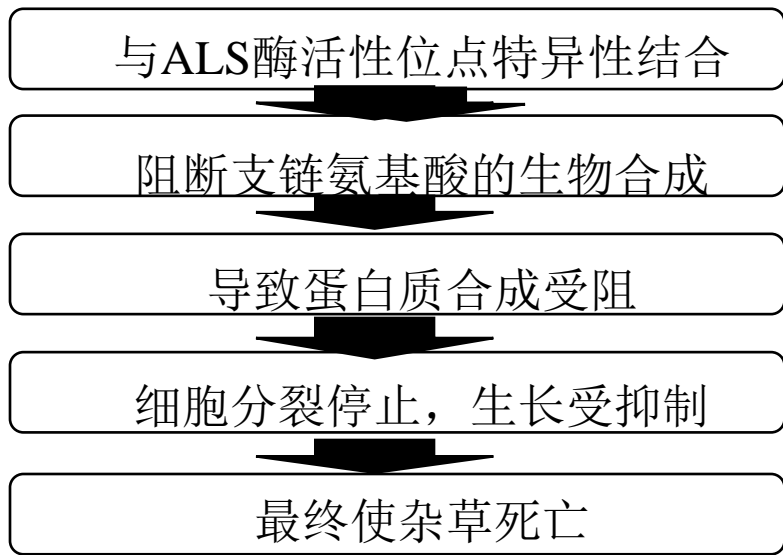
该类农药主要包括：磺酰脲类（Sulfonylureas）、咪唑啉酮类（Imidazolinones）、三唑并嘧啶类（Triazolopyrimidines）、嘧啶水杨酸类（Pyrimidinylthiobenzoates）和磺酰氨基羰基三唑啉酮类。



ALS酶在植物体内催化两个重要反应：

- 丙酮酸 → 乙酰乳酸（缬氨酸和亮氨酸合成前体）
- 丙酮酸 → 乙酰羟丁酸（异亮氨酸合成前体）

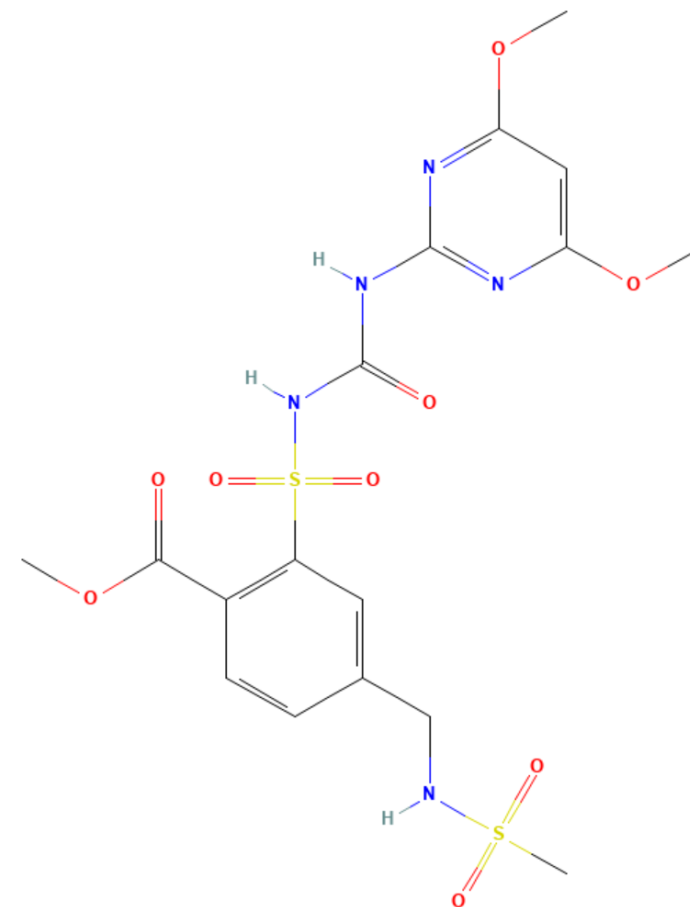
当ALS抑制剂进入植物体后：



ALS类除草剂的作用机制



- 甲基二磺隆：全称甲基2-[(4,6-二甲氧基嘧啶-2-基)氨基甲酰氨基磺酰基]-4-甲磺酰氨基甲基苯甲酸酯，分子式为 $C_{17}H_{21}N_5O_9S_2$ 。
- 甲基二磺隆通过特异性抑制乙酰乳酸合酶（ALS），阻断支链氨基酸（缬氨酸、亮氨酸、异亮氨酸）的生物合成途径，最终导致杂草死亡。
- 对作物安全的原因在于作物能够快速代谢分解该除草剂，而敏感杂草缺乏这种代谢能力。因而作为除草剂被广泛使用。



PubChem CID:11409499



1. 黑麦草ALS序列查找

Lolium rigidum clone 6c chloroplast acetolactate synthase gene, partial cds; chloroplast

GenBank: KM000068.1

[FASTA](#) [Graphics](#)

[Go to:](#)

LOCUS KM000068 1866 bp DNA linear PLN 20-SEP-2014
 DEFINITION Lolium rigidum clone 6c chloroplast acetolactate synthase gene, partial cds; chloroplast.
 ACCESSION KM000068
 VERSION KM000068.1
 KEYWORDS .
 SOURCE chloroplast Lolium rigidum
 ORGANISM [Lolium rigidum](#)
 Eukaryota; Viridiplantae; Streptophyta; Embryophyta; Tracheophyta; Spermatophyta; Magnoliopsida; Liliopsida; Poales; Poaceae; BOP clade; Pooideae; Poodae; Poae; Poae Chloroplast Group 2 (Poae type); Lolioidinae; Loliinae; Lolium.
 REFERENCE 1 (bases 1 to 1866)
 AUTHORS Al-Doss, A. A., Al-Faifi, S. A., Ghazy, A. I., Salem, A. K., Ammar, M. H., Migdadi, H. M. and Althamra, M. I.
 TITLE Molecular evidence for new ALS-resistance alleles in Saudi Lolium rigidum populations
 JOURNAL Unpublished
 REFERENCE 2 (bases 1 to 1866)
 AUTHORS Al-Doss, A. A., Al-Faifi, S. A., Ghazy, A. I., Salem, A. K., Ammar, M. H., Migdadi, H. M. and Althamra, M. I.

ALS基因与其对应的蛋白

Lolium multiflorum acetolactate synthase (ALS) gene, partial cds

GenBank: MK922479.1

[FASTA](#) [Graphics](#)

[Go to:](#)

LOCUS MK922479 1355 bp DNA linear PLN 11-DEC-2019
 DEFINITION Lolium multiflorum acetolactate synthase (ALS) gene, partial cds.
 ACCESSION MK922479
 VERSION MK922479.1
 KEYWORDS .
 SOURCE Lolium multiflorum (Italian ryegrass)
 ORGANISM [Lolium multiflorum](#)
 Eukaryota; Viridiplantae; Streptophyta; Embryophyta; Tracheophyta; Spermatophyta; Magnoliopsida; Liliopsida; Poales; Poaceae; BOP clade; Pooideae; Poodae; Poae; Poae Chloroplast Group 2 (Poae type); Lolioidinae; Loliinae; Lolium.
 REFERENCE 1 (bases 1 to 1355)
 AUTHORS Kaya Altop, E. and Erken, S.
 TITLE Determination of ALS and accase herbicides resistance of Lolium spp. in wheat fields in Samsun Province
 JOURNAL [Hereditas](#)

chloroplast acetolactate synthase

[GenPept](#) [FASTA](#) [Graphics](#) [BLAST](#)

Name: chloroplast acetolactate synthase
RefSeq Selected Product: AIN75605.1, 622 amino acids
Taxonomic Group: monocots
Assembly Accessions: 0
Protein Accessions: 1
CDS Regions: 1
Total Rows: 1

Source	CDS Region in Nucleotide	Protein	Name	Organism	Strain	Assembly
INSDC	KM000068.1 1-1866(+)	AIN75605.1	chloroplast acetolactate synthase	Lolium rigidum		

2. 查找近缘物种

通过蛋白序列，利用NCBI的Blast找到序列相似的物种的蛋白序列

Standard Protein BLAST

blastn **blastp** blastx tblastn tblastx

BLASTP programs search protein databases using a protein

Enter Query Sequence

Enter accession number(s), gi(s), or FASTA sequence(s) [Clear](#)

>AIN75605.1 chloroplast acetolactate synthase, partial (chloroplast) [Lolium rigidum]
MATATSTAVAFSGATAALPKPRTLPRHQLPTSRRALTAPIRCSAVSPSPAPSP
APPATALRPWGPSEPRK

Query subrange [?](#)

From

To

Or, upload file [?](#)

Job Title

Enter a descriptive title for your BLAST search [?](#)

Align two or more sequences [?](#)

Choose Search Set

Database [?](#)

Organism exclude

Optional Enter organism common name, binomial, or tax id. Only 20 top taxa will be shown. [?](#)

Exclude Models (XM/XP) Non-redundant RefSeq proteins (WP) Uncultured/environmental sample sequences

Optional

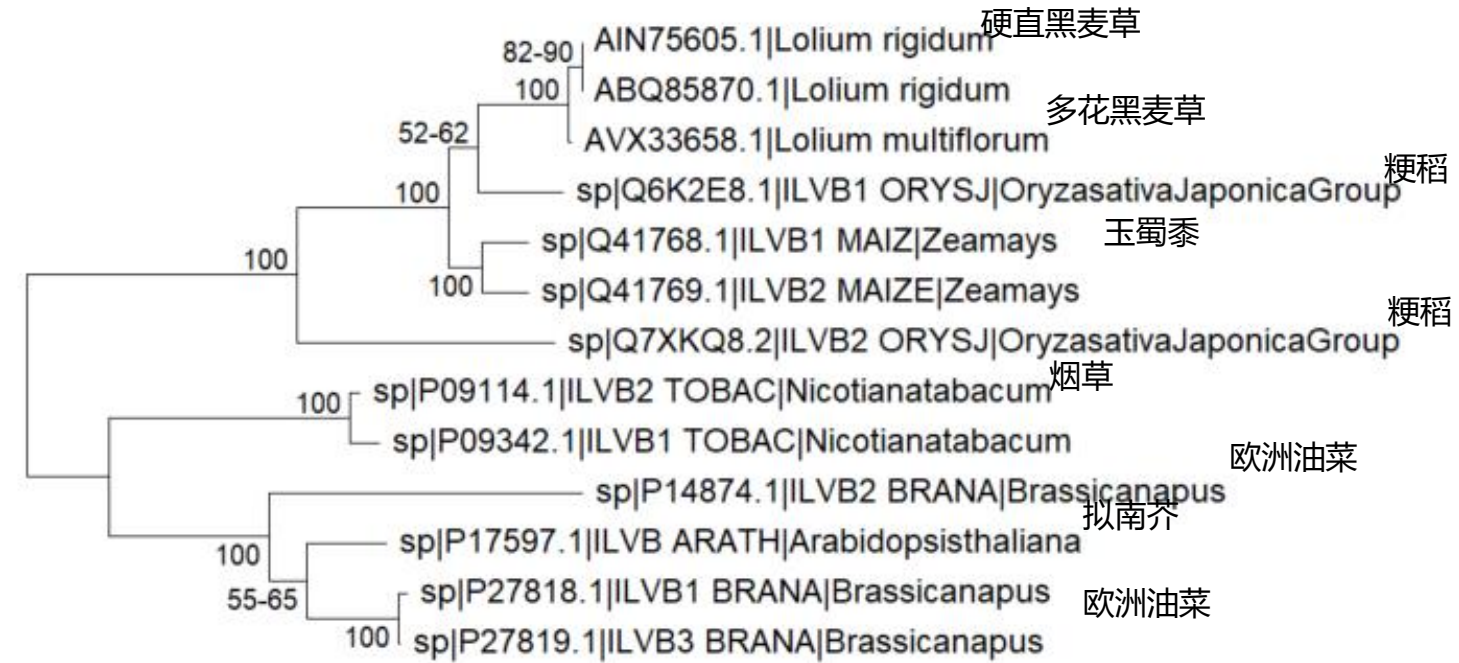
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 1_chloroplastic; AltName: Full=Acetohydroxy-acid synthase 1; Flags: Precu...	Zea mays	1134	1134	97%	0.0	90.37%	638	Q41768.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 1_chloroplastic; AltName: Full=Acetohydroxy-acid synthase 1; Flags: Precu...	Oryza sativa Jap...	1122	1122	96%	0.0	92.95%	644	Q6K2E8.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 2_chloroplastic; AltName: Full=Acetohydroxy-acid synthase 2; Flags: Precu...	Zea mays	1095	1095	97%	0.0	89.20%	638	Q41769.1
<input checked="" type="checkbox"/>	RecName: Full=Probable acetolactate synthase 2_chloroplastic; AltName: Full=Acetohydroxy-acid synthase 2; Fla...	Oryza sativa Jap...	960	960	91%	0.0	82.04%	663	Q7XKQ8.2
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 2_chloroplastic; AltName: Full=ALS II; AltName: Full=Acetohydroxy-acid sy...	Nicotiana tabacum	926	926	91%	0.0	76.64%	664	P09114.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 1_chloroplastic; AltName: Full=ALS I; AltName: Full=Acetohydroxy-acid sy...	Nicotiana tabacum	925	925	91%	0.0	76.28%	667	P09342.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 1_chloroplastic; AltName: Full=ALS I; AltName: Full=Acetohydroxy-acid sy...	Brassica napus	920	920	100%	0.0	69.50%	655	P27818.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 3_chloroplastic; AltName: Full=ALS III; AltName: Full=Acetohydroxy-acid s...	Brassica napus	919	919	100%	0.0	69.94%	652	P27819.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase_chloroplastic; Short=AtALS; AltName: Full=Acetohydroxy-acid synthase; Al...	Arabidopsis thali...	905	905	91%	0.0	74.51%	670	P17597.1
<input checked="" type="checkbox"/>	RecName: Full=Acetolactate synthase 2_chloroplastic; AltName: Full=ALS II; AltName: Full=Acetohydroxy-acid sy...	Brassica napus	859	859	91%	0.0	70.25%	637	P14874.1
<input type="checkbox"/>	RecName: Full=Acetolactate synthase large subunit; Short=AHAS; AltName: Full=Acetohydroxy-acid synthase lar...	Corynebacterium...	518	518	93%	1e-176	48.63%	626	P42463.1



3. 构建系统发育树

通过蛋白序列，利用Blast找到其近缘物种，建立发育树

Species/Abbrv	PRVVQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDKPMSLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGEELRRFVELTGIPVTTTLMGLGNFSPDD
1. sp Q41768.1 ILVB1 MAIZ Zeamays	PRVVQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDKPMSLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGEELRRFVELTGIPVTTTLMGLGNFSPDD
2. sp Q6K2E8.1 ILVB1 ORYSJ OryzasativaJaponicaGroup	PRVIQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDTSNMLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGDELRRFVELTGIPVTTTLMGLGNFSPDD
3. sp Q41769.1 ILVB2 MAIZE Zeamays	PRVVQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDTPMSLPGYIARLPKPPATEFLEQVLRVLVGEARRPILYVGGGCSASGEELCRFVELTGIPVTTTLMGLGNFSPDD
4. sp Q7XKQ8.2 ILVB2 ORYSJ OryzasativaJaponicaGroup	PRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVPVVDAPMRLPGYISRLPKPPAANLLDEVIRLVGDAERPVLVGGGCSASGYELRRFVELTGIPVTTTLMGLGNFSPDD
5. sp P09114.1 ILVB2 TOBAC Nicotianatabacum	PRVVREAFFLARSGRPGPVLIDVPKDIQQQLVIPDQPMRLPGYMSRLPKLPNEMLLEQIVRLISESKKPVLVGGGCSQSSSEELRRFVELTGIPVASTLMGLGAFPTGD
6. sp P09342.1 ILVB1 TOBAC Nicotianatabacum	PRVVREAFFLARSGRPGPILIDVPKDIQQQLVIPDQPMRLPGYMSRLPKLPNEMLLEQIVRLISESKKPVLVGGGCSQSSSEELRRFVELTGIPVASTLMGLGAFPTGD
7. sp P27818.1 ILVB1 BRANA Brassicnapus	PRIVQEAFFLATSGRPGPVLVDVPKDIQQQLAIPNVQPMRLPGYMSRLPQPEVSQLGQIVRLISESKRPVLVGGGSLNSSSEELGRFVELTGIPVASTLMGLGSPCND
8. sp P27819.1 ILVB3 BRANA Brassicnapus	PRIVQEAFFLATSGRPGPVLVDVPKDIQQQLAIPNVQPMRLPGYMSRLPQPEVSQLGQIVRLISESKRPVLVGGGSLNSSSEELGRFVELTGIPVASTLMGLGSPCND
9. sp P17597.1 ILVB ARATH Arabidopsisthaliana	PRIEEAFFLATSGRPGPVLVDVPKDIQQQLAIPNVEQAMRLPGYMSRMPKPPEDSHLEQIVRLISESKKPVLVGGGCLNSSDELGRFVELTGIPVASTLMGLGSPCDD
10. sp P14874.1 ILVB2 BRANA Brassicnapus	PRIVREAFFLATSVRPGPVLIDVPKDVQQQFAIPNVEQPMRLPLYMSTMPKPKVSHLEQILRLVSESKRPVLVGGGCLNSSSEELRRFVELTGIPVASTLMGLGSPCDD
11. AIN75605.1 Lolium rigidum	PRVIQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDAPMSLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGEELRRFVELTGIPVTTTLMGLGNFSPDD
12. AVX33658.1 Lolium multiflorum	---IQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDAPMSLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGEELRRFVELTGIPVTTTLMGLGNFSPDD
13. ABQ85870.1 Lolium rigidum	PRVIQEAFFLASSGRPGPVLVDIPKDIQQQMAVPVVDAPMSLPGYIARLPKPPATELLEQVLRVLVGEARRPILYVGGGCSASGEELRRFVELTGIPVTTTLMGLGNFSPDD



研究背景

研究内容

研究前景

4. 序列保守性分析

通过蛋白序列利用uniprot分析是否保守

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	150
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	136
AINT5605.1 LoIomium_rigidum 鞘膜	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	134
ABQ85870.1 LoIomium_rigidum 鞘膜	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	27
AVX33658.1 LoIomium_multiflorum 多花蕈菌	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	0
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	130
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	130
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	138
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	156
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	159
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	162
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	147
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	LCRCGVSDVFAYPGGASMEIHQALTRSPVIRNHLFRHEQGEAFAASGYARASSGRVG	144

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	242
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	192
AINT5605.1 LoIomium_rigidum 鞘膜	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	190
ABQ85870.1 LoIomium_rigidum 鞘膜	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	83
AVX33658.1 LoIomium_multiflorum 多花蕈菌	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	0
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	186
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	194
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	184
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	212
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	215
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	210
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	218
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	VGVATSGPGATNLVSLADALDSDVPMVAITGVPRRMIGTDAFQETPIVEVTRSI	200

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	262
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	248
AINT5605.1 LoIomium_rigidum 鞘膜	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	246
ABQ85870.1 LoIomium_rigidum 鞘膜	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	139
AVX33658.1 LoIomium_multiflorum 多花蕈菌	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	40
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	242
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	250
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	242
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	268
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	271
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	274
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	259
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	TKHNYLILDVDDIPRVINEAFFLASTGRPGPVLVDIPKDIQQQMAVFPWDAPMRLP	256

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	318
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	304
AINT5605.1 LoIomium_rigidum 鞘膜	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	302
ABQ85870.1 LoIomium_rigidum 鞘膜	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	195
AVX33658.1 LoIomium_multiflorum 多花蕈菌	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	96
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	298
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	298
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	GYIARLPKPPATELLEQVLRVVGESRRRFLVYVGGGCSASGEELRRRFVELTGPVTT	306
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	GYMSRLPKLPNEMLEQIVRLISESKRPVLYVGGGCSASGEELRRRFVELTGPVTT	324
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	GYMSRLPKLPNEMLEQIVRLISESKRPVLYVGGGCSASGEELRRRFVELTGPVTT	327
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	GYMSRMLKPPEDVSHLEQIVRLISESKRPVLYVGGGCSASGEELRRRFVELTGPVTT	330
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	GYMSRMLKPPEDVSHLEQIVRLISESKRPVLYVGGGCSASGEELRRRFVELTGPVTT	315
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	GYMSRMLKPPEDVSHLEQIVRLISESKRPVLYVGGGCSASGEELRRRFVELTGPVTT	312

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	373
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	359
AINT5605.1 LoIomium_rigidum 鞘膜	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	357
ABQ85870.1 LoIomium_rigidum 鞘膜	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	250
AVX33658.1 LoIomium_multiflorum 多花蕈菌	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	151
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	353
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	353
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	TLMGLGNFPSDD-PLSLRMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	362
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	TLMGLGAYPTGD-ELSLQMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	379
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	TLMGLGAYPTGD-ELSLQMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	382
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	TLMGLGAYPTGD-ELSLQMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	370
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	TLMGLGAYPTGD-ELSLQMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	385
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	TLMGLGAYPTGD-ELSLQMLGMHGTVYANYAVDKADLLLAFGVRFDRVDTGKLEAF	367

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	429
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	412
AINT5605.1 LoIomium_rigidum 鞘膜	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	410
ABQ85870.1 LoIomium_rigidum 鞘膜	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	303
AVX33658.1 LoIomium_multiflorum 多花蕈菌	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	204
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	406
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	404
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	413
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	432
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	435
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	438
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	423
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	ASRAKIVHVIDIPSAEIGKKNKQPHVSIQADVKLALQGLMNLLEEGSAAARAKNLDLS	420

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	485
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	466
AINT5605.1 LoIomium_rigidum 鞘膜	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	468
ABQ85870.1 LoIomium_rigidum 鞘膜	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	359
AVX33658.1 LoIomium_multiflorum 多花蕈菌	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	260
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	462
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	462
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	469
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	498
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	481
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	494
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	479
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	AWRSELEKKEKVEFPLGYRTFGEIIPPOYAIVQLDEVNNGEAIVATGVGQHMWATQ	476

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	541
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	524
AINT5605.1 LoIomium_rigidum 鞘膜	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	522
ABQ85870.1 LoIomium_rigidum 鞘膜	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	415
AVX33658.1 LoIomium_multiflorum 多花蕈菌	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	316
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	518
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	518
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	525
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	544
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	547
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	550
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	535
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	HYTYRPRROWLSSAGLGMGFGLPAAAGAAVANPAGTVVDIDGGDSLMMNIOELAM	532

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	597
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	578
AINT5605.1 LoIomium_rigidum 鞘膜	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	576
ABQ85870.1 LoIomium_rigidum 鞘膜	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	469
AVX33658.1 LoIomium_multiflorum 多花蕈菌	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	370
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	572
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	572
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	579
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	598
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	601
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	589
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	604
sp P27819.1 V1W03_B8ANA Brassicacnapus 拟南芥	VRVEDLPVKVMVLLNNQHLGMVQWEDRFYKANNRAHTYLGPNPEACE-SEIYDFVTTI	586

Q7XKQ8:Transit peptide

sp Q7XKQ8.2 V1W02_01RYS1 Oryzasthiva.Japonica Group 鞘膜	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	653
sp Q6K2E8.1 V1W01_01RYS1 Oryzasthiva.Japonica Group 鞘膜	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	634
AINT5605.1 LoIomium_rigidum 鞘膜	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	622
ABQ85870.1 LoIomium_rigidum 鞘膜	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	516
AVX33658.1 LoIomium_multiflorum 多花蕈菌	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	408
sp Q41768.1 V1W01_MAZ1 Zeamays 玉米	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	628
sp Q41769.1 V1W02_MAZ1 Zeamays 玉米	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	628
sp P14874.1 V1W02_B8ANA Brassicacnapus 拟南芥	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	635
sp P09114.1 V1W02_T0BAC Nicotianatabacum 烟草	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	654
sp P09342.1 V1W01_T0HAC Nicotianatabacum 烟草	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	657
sp P17597.1 V1W01_ARAB1 Arabidopsisthaliana 拟南芥	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLDIPVHQEHLVPMIPSGGAFKDI	660
sp P27818.1 V1W01_B8ANA Brassicacnapus 拟南芥	AGGFGIIPAAVRTKKEEVRRAAIKMLLETPGGYLLD	

5. 序列比对

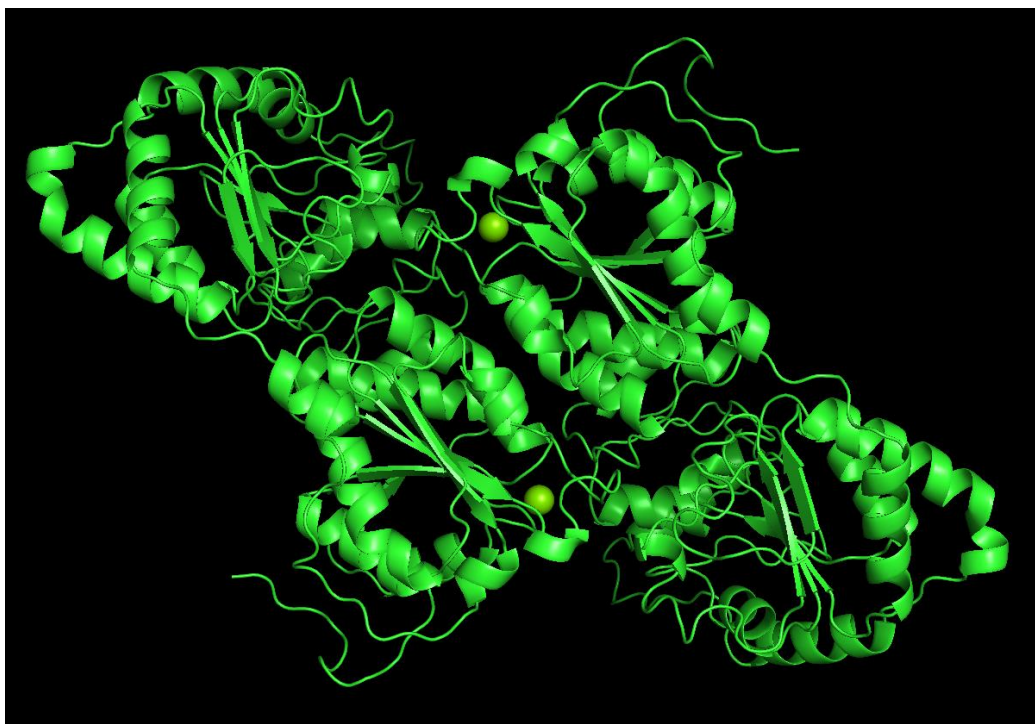
序列比对找突变位点，发现376位氨基酸位点突变，
GAT变为GAG，氨基酸从D变为E



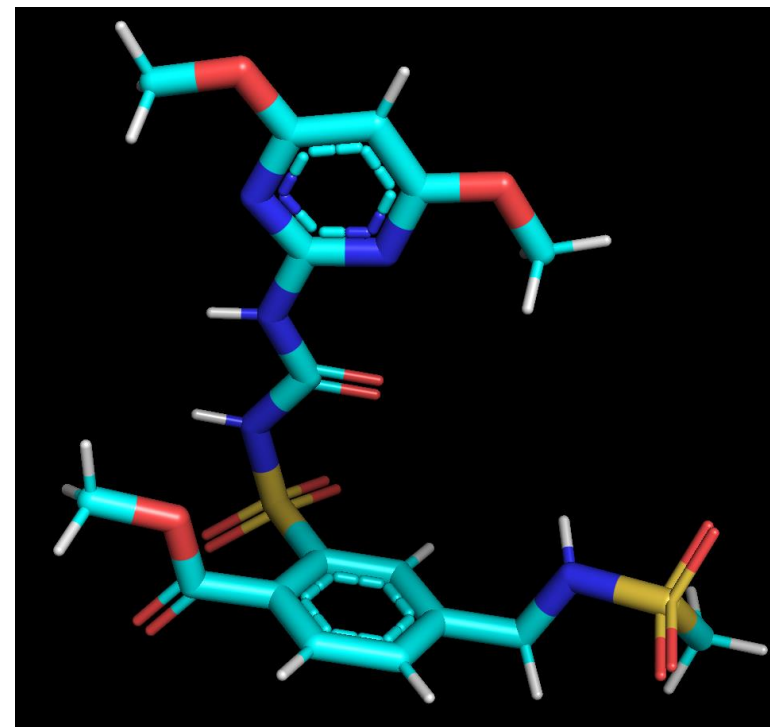


6. 结构预测

以拟南芥为模板，通过Swissmodel构建敏感型和抗药型黑麦草中ALS 3D结构，从Pubmed下载甲基二磺隆 3D结构，通过Autodock vina进行分子对接，利用DS可视化，分析比较敏感型和抗药型黑麦草中ALS与甲基二磺隆的相互作用

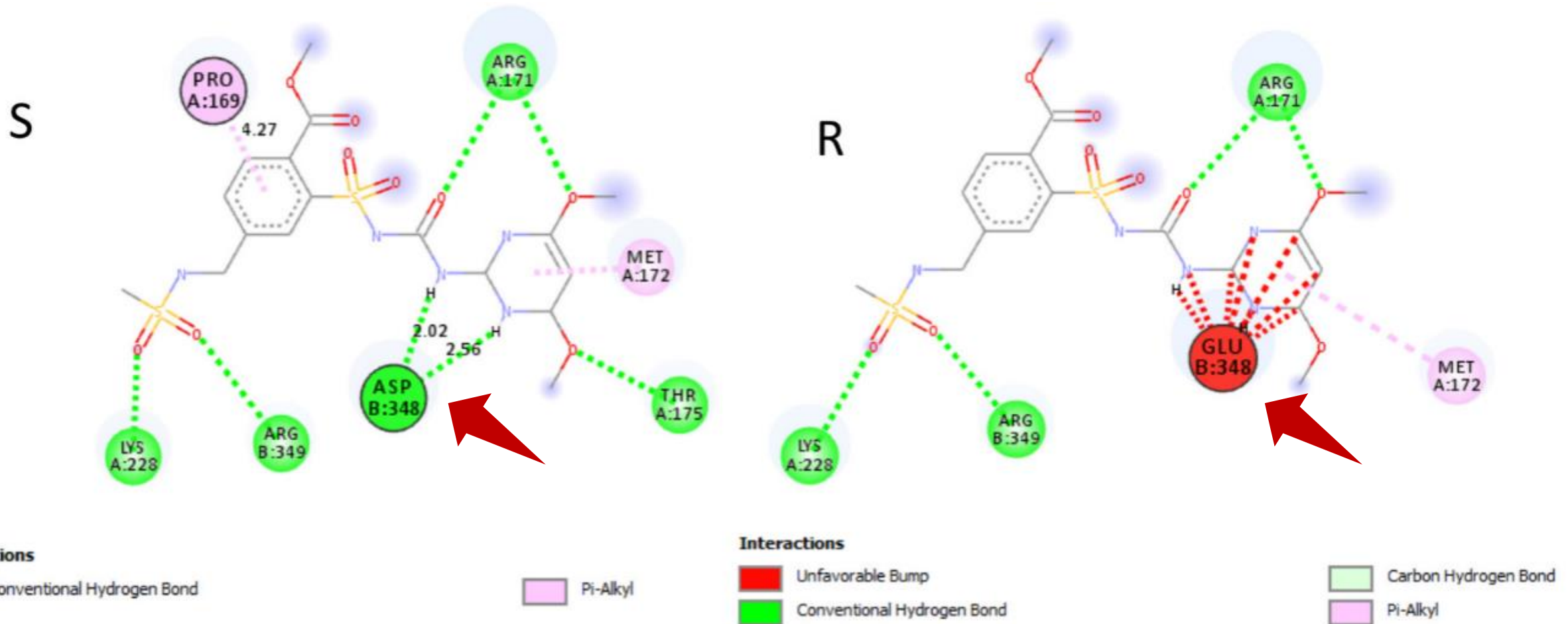


ALS 3D结构



甲基二磺隆 3D结构

敏感型黑麦草中ALS残基天冬氨酸与配体之间通过氢键相互作用，而抗药型黑麦草中ALS残基谷氨酸（由GAT突变为GAG导致）与配体之间结合不紧密，以排斥力为主





- **科学理论贡献：**黑麦草中乙酰乳酸合酶发生Asp376Glu突变，导致黑麦草对甲基二磺隆抗性增强，补充了靶标抗性的分子互作机制，为其他杂草抗性研究提供参考。
- **农业生产指导：**研究表明当前单一ALS类除草剂防控杂草逐渐失效，需及时调整防控方案，建议结合非ALS，同时综合耕作措施降低除草剂选择压力，延缓杂草抗性发展。此外，可考虑通过基因编辑等手段增强作物对除草剂的抗性，提高除草剂使用效率。

组员合影（左至右依次为黄菲侠、陈星宇、薛熙豪、熊岳）：





THANKS!