

## 野生种马铃薯 *SpPHYB* 基因的克隆与表达分析

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摘要: 采用 RT-PCR 技术从野生种马铃薯中克隆到一个光敏色素基因 *PHYB*, 其 cDNA 全长为 3470 bp。含有一个 3393 bp 的完整开放阅读框, 编码一条长 1130 个氨基酸的蛋白, 分子量为 125 kDa, 等电点为 5.6。该基因编码的蛋白序列与栽培种马铃薯、番茄和烟草同源基因编码的氨基酸序列一致性分别为 98%、95%、92%, 命名为 *SpPHYB*。半定量 PCR 分析表明, 根、茎、叶和芽中 *SpPHYB* 表达水平较高且相似, 但在花和块茎成熟器官中表达量稍低。

关键词: 野生种马铃薯; *SpPHYB*; 克隆; 表达

## Cloning and Expression Analysis of *SpPHYB* Gene from *Solanum pinnatisectum* Dunal

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**Abstract:** The full-length cDNA of *SpPHYB* gene was cloned from wild potato (*Solanum pinnatisectum*) by RT-PCR. The cDNA was 3470 bp long with an open reading frame (ORF) of 3393 bp and encoded 1130 amino acid residues with a predicted molecular weight of 125 kDa and an isoelectric point of 5.6. The protein sequence comparison showed that the predicted protein had higher identities to those from *Solanum tuberosum*, *Lycopersicon esculentum* and *Nicotiana tabacum* (98%, 95% and 92%). Semi-quantitative RT-PCR indicated that the expression level of *SpPHYB* was higher and similar in roots, stem, leaves and sprouts, and lower in flowers and tubers.

**Key words:** *Solanum pinnatisectum*; *SpPHYB*; cloning; expression

光敏色素是植物体内感受光信号的一类大小约 124 kDa 的光受体蛋白, 包含光敏色素 A、B、C、D 和 E 5 个成员(Nagatani 等 1991; Somers 等 1991; Lopez-Juez 等 1992), 其在植物种子萌发、幼苗生长、茎的伸长、子叶伸展、开花控制和花色苷合成等生长发育过程中均起作用(Furuya 1993; 周波和李玉花 2006)。光敏色素 B (*PHYB*) 参与植物开花调节和对光周期的识别, 虽然迄今为止与其相关的机制还不很清楚(Thiele 等 1999; Scofield 和 Paliyath 2005), 但近年来有报道认为, *PHYB* 的表达受抑制后, 无论在短日照还是长日照条件下马铃薯均能结薯, 而作为短日照植物的马铃薯, 在通常情况下, 只有短日照诱导下才能结薯, 这表明长日照条件下 *PHYB* 对薯块形成起抑制作用(Aksenova 等 2002; Boccalandro 等 2003)。但其抑制机制仍不清楚(Jackson 1999)。

马铃薯是无性繁殖植物, 块茎是其繁殖器官, 也是产品器官。采用基因工程技术抑制

*PHYB* 基因在植株体内的表达可能有调节马铃薯对光周期敏感性的作用, 因而对培育栽培适应性广的品种似乎有一定的潜在理论和应用意义。马铃薯 *Solanum pinnatisectum* 是一个花色苷合成光敏感的野生马铃薯, 用其研究马铃薯中光信号转导可能是一个适宜的植物材料。我们以前曾从此种马铃薯中克隆了 *PHYA* 基因(张易等 2006), 本文报道克隆 *PHYB* 基因的结果。

### 材料与方法

野生种马铃薯(*Solanum pinnatisectum* Dunal) 由美国国家马铃薯种质资源库提供。植株分别盆栽在塑料大棚(自然光照)和具有温光控制的人工生长室(8 h·d<sup>-1</sup> 光照或黑暗, 开花前 1 个月进行光、

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暗处理 30 d)内, 常规管理。于生长旺盛期(现蕾前)从大棚栽培的植株上取幼嫩叶片提取RNA, 用于 *SpPHYB* 基因 cDNA 全长的克隆; 开花期取根、茎、叶、花、芽和块茎提取 RNA, 用于组织表达实验; 用于光、暗诱导表达分析提取 RNA 的根、茎、叶、花、芽和块茎取自人工生长室培养的植株。试验中使用的 LA Taq DNA 聚合酶、pMD18-T 载体、大肠杆菌 DH5 $\alpha$  和凝胶回收试剂盒购自宝生物工程(大连)有限公司(TaKaRa)。

叶片总 RNA 的提取按照 Trizol 试剂盒提供的方法进行, 根据从 GenBank 搜索到的四倍体栽培型马铃薯、番茄、茄子的 *PHYB* 基因的序列, 设计 *SpPHYB* 扩增引物: P1 (5' TGTGTGGAGGAGAGAGAAATG 3') 和 P2 (5' GTAAGCTCCTAGCCAACTC 3')。参照 Promega 公司 AMV First Strand cDNA Synthesis Kit 制备 cDNA。PCR 扩增体系 25  $\mu$ L: 1  $\mu$ L cDNA 模板、0.5  $\mu$ L 引物 P1 和 P2 (10 pmol $\cdot$ L<sup>-1</sup>)、2.5  $\mu$ L PCR 缓冲液(10 $\times$ )、4  $\mu$ L dNTPs (2.5 mmol $\cdot$ L<sup>-1</sup>)、2.5  $\mu$ L MgCl<sub>2</sub> (25 mmol $\cdot$ L<sup>-1</sup>)、0.3  $\mu$ L LA Taq DNA 聚合酶(TaKaRa 公司)及 13.7  $\mu$ L 无菌双蒸水。PCR 扩增条件为: 94 预变性 3 min; 94 30 s, 51 30 s, 72 4 min, 循环 30 次; 72 延伸 10 min。扩增产物在 1% 琼脂糖凝胶上电泳分离。用 TaKaRa 公司试剂盒回收扩增产物。将扩增产物连接到 pMD18T-Vector 载体 (TaKaRa 公司)上。通过热激转化方法将克隆载体转入大肠杆菌 DH5 $\alpha$  感受态细胞中, 并在含氨苄青霉素和 X-gal 的平板上筛选白色菌落, 然后提取质粒, 鉴定, 从中挑选单克隆送上海博亚生物工程公司测序。

作 *SpPHYB* 组织表达和光、暗诱导表达分析时, 按照 Trizol 试剂盒提供的方法, 从根、茎、叶、花、芽、块茎中分别提取总 RNA, 根据克隆的 *PHYB* 开放阅读框(ORF)序列设计 P3 (5' ATTTGCTGTTGATGTTGAAGG 3'), 与 P2 组成引物对, 用半定量 RT-PCR 进行 *PHYB* 基因表达分析。PCR 扩增条件同前, 循环数为 26。采用 *GAPDH* 基因为内参, 引物分别为 *GAPDH1* (5' CAAGGACTGGAGAGGTGG 3') 和 *GAPDH2* (5' TTCACTCGTTGTCGTACC 3'), 循环数为 26。取 5  $\mu$ L PCR 产物点样, 1% 琼脂糖凝胶电泳检测扩

增产物, 并拍照。

## 实验结果

### 1 *SpPHYB* 基因的 cDNA 克隆及其编码蛋白的结构

通过 RT-PCR, 一次扩增获得长度在 3.4 kb 左右的 *PHYB* cDNA 片段, 与预期的大小一致。该片段回收后, 连接到 T-载体上, 送上海博亚生物工程公司测序。cDNA 序列的确切长度为 3470 bp, 结构分析表明, 该序列 5' 端的第 29 位存在起始密码子 ATG, 3' 端的第 3419 位存在终止密码子 TAG, ORF 的长度为 3393 bp, 编码一个 1130 氨基酸多肽, 分子量为 125 kDa, 等电点为 5.6。图 1 显示的为其 ORF 序列与结构。

在 NCBI 上的氨基酸序列比对结果显示, 野生种马铃薯克隆序列与栽培种马铃薯、番茄及烟草 *PHYB* 一致性分别达到 98%、95%、92%, 表明该序列为光敏色素 *PHYB*, 并且在茄科植物内是高度保守的(图 2), 此种编码 *PHYB* 的克隆序列命名为 *SpPHYB*。

### 2 *SpPHYB* 的系统进化

采用 CLUSTAL 程序, 对 *SpPHYB* 和相似性较高的其他代表性物种的 *PHYB* 编码蛋白序列进行了系统发育分析, 图 3 的结果显示, *SpPHYB* 与同科植物栽培种马铃薯和番茄在进化树上属于同一分支, 表明在进化上茄科 *SpPHYB* 是同步的。

### 3 *SpPHYB* 的组织表达

采用半定量 RT-PCR 的方法分析的结果显示, 根、茎、叶和芽中 *SpPHYB* 表达水平较高且相似, 但在花和块茎成熟器官中表达量稍低(图 4)。

### 4 *SpPHYB* 的光和暗诱导表达

采用半定量 RT-PCR 的方法分析了 *SpPHYB* 在光、暗条件下野生马铃薯植株不同组织的表达(图 5)。结果显示, 无论在光照还是黑暗条件下, 各组织 *SpPHYB* 都能表达, 处理间稍有差异, 但不很明显。

## 讨 论

本文从野生种马铃薯中克隆到 *SpPHYB* 基因, 其编码的氨基酸序列与栽培种马铃薯有很高

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1
29 ATGGCTTCTG GAAGTAGAAC AAAGCATTCC CATCATAATT CATCTCAAGC TCAATCTTCA GGTACAAGTA ATGTA AAITTA
109 CAAAGATTCA ATAAGCAAAG CTATAGCACA GTACACAGCT GATGCTAGGC TTCATGCTGT GTTTGAACAA TCTGGTGAGT
189 CTGGAAAGTT TTTTGATTAT TCAGAGTCTG TAAAACTAC TACACAATCT GTGCCTGAAA GGCAAATCAC TGCTTATTTG
269 ACTAAAATTC AAAGAGGAGG TCATAATCAG CCITTTGGTT GTATGATAGC TGTAGATGAG GCTAGTTTTC GTGTAATAGC
349 TTATAGTGAA AATGCCTTTG AAATGCTTAG TTTAACTCCA CAATCTGTTC CAAGCCTTGA GAAGTGTGAG ATCCTCACTA
429 TTGGAAGTGA TGTTAGGACC CTTTTTACCC CTTCTAGCTC TGTTTTGCTA GAAAGAGCAT TTGGGGCAGC TGAGATCACT
509 TTAACAACCC CAATTTGGAT TCATTCCAAG AATTCTGGAA AGCCCTTTTA TGCAATTTTG CACAGGGTTG ATGTTGGTAT
589 TGCCATTGAT TTGGAGCCTG CTAGAAGTGA GGACCCTGCT TTATCTATTG CTGGAGCAGT GCAGTCACAG AAACCTGCAG
669 TGAGGGCTAT TTCTCATTG CAATCACTTC CTGGTGGGGA CATTAAAGCTT TTGTGTGATA CTGTTGTGTA GAGTGTGAGG
749 GAGTTAACCG GGTATGACCG GGTATGGTA TATAAATTC ATGAGGATGA GCATGGAGAG GTAGTGGCTG AGAGTAAAAG
829 ATCAGATTTA GAGCCCTATA TCGGTTGCA TTATCCTGCT ACTGATAATC CTCAAGCTTC ACGGTTTTTG TTTAAGCAGA
909 ACAGGGTGAG AATGATTGTG GACTGTCATG CTACCCCTGT GCGGGTACT CAGGATGAAT CACTGATGCA GCCTTTATGT
989 CTAGTTGGTT CCACACTTAG AGCACCTCAT GGTGGCCAGC CACAGTACAT GGCAAATATG GGGTCTATTG CCTCATTAAAC
1 069 ACTGGCAGTT ATTATCAACG GAAATGATGA GGAAGCTGTG GGTGGCGGTC GAAATCAAT GAGGCTATGG GGCCTGGTTG
1 149 TTGGACACCA CACTTCTGTT CGGTCCATTC CTTTCCCTCT TAGGTATGCA TGTGAATTCC TTATGCAGGC CTTTGGACTC
1 229 CAATTGAACA TGGAGTTGCA ATTGGCGTCA CAGTTGTCTG AGAAACATGT TTTAAGGACA CAAACACTGT TATGTGACAT
1 309 GCTCCTTGA GACTCTCCAC CGGGGATTGT TACCCAAAGC CCCAGTATA TGGACCTTGT GAAGTGGAT GGTGCTGCTC
1 389 TATACTACCA GGGGAAGTAC TATCCATTAG GTGTCACACC AACTGAAGCT CAGATAAAGG ACATTGTGGA GTGGTTATTG
1 469 GCTTACCATG GAGACTCAAC AGGTTAAAGT ACTGACAGTT TGGCTGATGC TGGGTATCCT GGAGCAGCTT CACTTGGTGA
1 549 TGCAGTTTGT GGTATGGCTG TCGTTATAT ATCTTCTAAA GATTTCTTGT TTTGGTTTCG CTCCACACA GCGAAAGAA
1 629 ATAAAGTGGG TTGTAAAAG TCGGAGCTCA CCATGGGAAA ATGCCGAAAT GGATGCAATC CACTCTTTGC AGCTAATTCT
1 709 TTTCTGGAAG TTGTTAAAAG TCGGAGCTCA CCATGGGAAA ATGCCGAAAT GGATGCAATC CACTCTTTGC AGCTAATTCT
1 789 GCGAGATTCA TTTAAGGATG CTGAGGCAAG TAATTCTAAG GCTATTGTGC ATGCTCATCT TGGGGAAATG GAGTGTGCAAG
1 869 GGATAGATGA ACTGAGTTCT GTTCCAGAG AATGTTTAG ATTGATCGAA ACTGCAACAG CTCCCATATT TGCTGTTGAT
1 949 GTCGAAGGTC GCATAAATGG GTGGAATGCA AAGGTCGCTG AATTGACAGG TTTATCAGTT GAAGAAGCAA TGGGGAAGTC
2 029 CTTGGTTTCA GAGCTTGTGT ACAAAGAATC ACAGGAGACT GCTGAGAAGC TTCTGTATAA TGCTCTAAGA GCGGAGGAAG
2 109 ATAAAATGT AGAAATAAAG TTGAGGACAT TTGGAGCTGA ACAACTGGAG AAAGCTGTTT TTGTGGTGGT TAATGCTTGC
2 189 GCTAGCAAAG ATTACACAAA CAACATTGTT GGTGTTTGTCT TTGTTGGGCA GGATGTTACT GGGGAAAAAG TTGTTATGGA
2 269 CAAGTTTATT AACATCCAAG GTGATTACAA GGCCATTGTG CACAGCCCCA ATCCTCTGAT CCCTCCAATA TTTGCATCAG
2 349 ATGAGAACAC TTGTTGCTCC GAGTGAACA CTGCCATGGA AAAACTCACT GGTGGTCTA GAGGGGAGAT TGTGGAAAA
2 429 ATGTTAGTTG GTGAGATTTT TGGAAATTGT TGTGGGCTCA AGGGCCGAGA TGCCATGACA AAGTTCATGA TCGTGTGCA
2 509 TAATGCAATT GGAGGACAGG ATACAGACAA GTTTCCATTT TCCTTTTTTG ACCGAAATGG GAAATATGTG CAAGCTCTTT
2 589 TGACTGCTAA CAAGAGAGTC AATATGGAGG GCAATACTAT TGGGGCTTTC TGTTCATAC AGATAGCCAG TCCCGAACTG
2 669 CAGCAAGCTC TAAGAGTTCA AAGGCAACAG GAAAAGAAGT GTTATTCTCA GATGAAAGAG CTGGCATACA TTTGTCAGGA
2 749 AATAAAAAGT CCTCTTAATG GTATACGCTT TACAAATTCA TTGTTGGAGG CCACAAATTT GACAGAAAAT CAGAAGCAGT
2 829 ATCTAGAGAC AAGTCTGCT TGTGAGAGGC AGATGTCTAA GATCATTAGG GATGTTGATC TGGAAAACAT TGAGGACGGT
2 909 TCACTGACCC TTGAGAAAAG AGATTTTTTT CTTGGGAGTG TAATAGATGC TGTGTTAGC CAAGTATGT TATTGCTGAG
2 989 GAAAAAAGGC GTGCAGTTAA TCGTGATAT ACCAGAGGAA ATTAAGACAT TAACAGTACA TGGTGATCAA GTGAGAATTC
3 069 AACAGGTCTT GGCAGATTTT TTGTTGAACA TGGTACGGTA TGCACCATCA CCTGATGGGT GGGTAGAAAT CCAACTTCGA
3 149 CCAAGTATGA TGCCAAATATC TGATGGAGTA ACTGGTGTGC ATATTGAACT CAGGATTATA TGCCCTGGCG AAGGGCTTCC
3 229 TCCTGAATTG GTTCAAGATA TGTTCCACAG CAGTCGGTGG GTAACCTCAGG AAGGCCTAGG ACTGAGCAGC TGCAGAAAAA
3 309 TGTTAAAGCT TATGAATGGA GAAATCCAGT ATATCAGAGA ATCAGAAAAG TGCTATTCC TGATTGCTCT TGACCTGCCA
3 389 ATGACCCGCA AAGGTCCAAA GAGTGTGGC TAGGAGCTTA CAATCTCTAG AGGATCCCGG GGTACCGAGC TCGAATTCGT
3 469 AA

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图1 *SpPHYB* 的 cDNA 序列Fig.1 cDNA sequence of *SpPHYB*

下划线处分别为起始密码子和终止密码子。

的一致性(98%), 显示 PHYB 蛋白是保守性的。

在正常光照生长条件下, *SpPHYB* 在根、茎、叶、芽、块茎和花中都能表达, 尽管在块

茎和花的表达量稍低于其他器官, 这表明

*SpPHYB* 不具有组织表达特异性, 这与 Heyer 和 Gatz (1992) 在栽培种马铃薯中观察到的结果是相

Sp	MAAGSRTKHS...SSG...ACSSGTSNAYKLSISKATACTALARLHAVFECGSGESGRFTLYS...SVKTTTCS...VFFRCITAYLTK	82
St	MAAGSRTKHS...SSG...ACSSGTSNAYKLSISKATACTALARLHAVFECGSGESGRFTLYS...SVKTTTCS...VFFRCITAYLTK	82
Np	MAAGSRTKHS...SSG...ACSSGTSNAYKLSISKATACTALARLHAVFECGSGESGRFTLYS...SVKTTTCS...VFFRCITAYLTK	88
Le	MAAGSRTKHS...SSG...ACSSGTSNAYKLSISKATACTALARLHAVFECGSGESGRFTLYS...SVKTTTCS...VFFRCITAYLTK	84
Consensegrsrtkhs	q aqsgtsn nyklsiskatacytalarlhavfegsgesgk fôys svktttcs vpe qitayltk	
Sp	ICRCGHCIFCCMVAIVEASFR...IAYSENA...EMLSITFCQVSELEK...EITLITVIRLPTFSSSVLLERAFGAREITLLNFITWHSK	170
St	ICRCGHCIFCCMVAIVEASFR...IAYSENA...EMLSITFCQVSELEK...EITLITVIRLPTFSSSVLLERAFGAREITLLNFITWHSK	170
Np	ICRCGHCIFCCMVAIVEASFR...IAYSENA...EMLSITFCQVSELEK...EITLITVIRLPTFSSSVLLERAFGAREITLLNFITWHSK	176
Le	ICRCGHCIFCCMVAIVEASFR...IAYSENA...EMLSITFCQVSELEK...EITLITVIRLPTFSSSVLLERAFGAREITLLNFITWHSK	172
Conselcrgchicfgcarlavdeasf	iaysena emlsitfcqsvpsl eilt gtdvrlftfsssvllerafgareitllrpiwihsk	
Sp	NSCRFFYATLHRVVC...ITLLEFATITLFAI...STACAVCSCKLAVRAISHLCSLFCGDFRILCTVWVESVRELTCYFRVMVYKFHELEH	258
St	NSCRFFYATLHRVVC...ITLLEFATITLFAI...STACAVCSCKLAVRAISHLCSLFCGDFRILCTVWVESVRELTCYFRVMVYKFHELEH	258
Np	NSCRFFYATLHRVVC...ITLLEFATITLFAI...STACAVCSCKLAVRAISHLCSLFCGDFRILCTVWVESVRELTCYFRVMVYKFHELEH	264
Le	NSCRFFYATLHRVVC...ITLLEFATITLFAI...STACAVCSCKLAVRAISHLCSLFCGDFRILCTVWVESVRELTCYFRVMVYKFHELEH	260
Consensgrfyatllhrvvcgl	tlelefatitlfaistacavcscklavraishlqslpggd k lcoatvvesvreltgycrvmvykfhoeoh	
Sp	GEVVAESKR...DLLEFYICLHYFATITLFCASRFLFKQNFVR...IVDCHMTFVR...VQTESLMCFCLVGSILRAFHGCHACVMANCGSTASL	346
St	GEVVAESKR...DLLEFYICLHYFATITLFCASRFLFKQNFVR...IVDCHMTFVR...VQTESLMCFCLVGSILRAFHGCHACVMANCGSTASL	346
Np	GEVVAESKR...DLLEFYICLHYFATITLFCASRFLFKQNFVR...IVDCHMTFVR...VQTESLMCFCLVGSILRAFHGCHACVMANCGSTASL	352
Le	GEVVAESKR...DLLEFYICLHYFATITLFCASRFLFKQNFVR...IVDCHMTFVR...VQTESLMCFCLVGSILRAFHGCHACVMANCGSTASL	348
Consesevvaeskr	dllefyiclhfyatitlfcasrflfkqnfvrivdchmtfvrivqteslmcfclvgsilrpfhgchacvmancgstasl	
Sp	TLAVTINGN...EEAVGGR...SRVRLWGLVGHHTS...VRETFEFLRVACFELVCAFGLCLNVELCLASCLSEKHLVRLTICLLICMLIRSEFP	434
St	TLAVTINGN...EEAVGGR...SRVRLWGLVGHHTS...VRETFEFLRVACFELVCAFGLCLNVELCLASCLSEKHLVRLTICLLICMLIRSEFP	434
Np	TLAVTINGN...EEAVGGR...SRVRLWGLVGHHTS...VRETFEFLRVACFELVCAFGLCLNVELCLASCLSEKHLVRLTICLLICMLIRSEFP	439
Le	TLAVTINGN...EEAVGGR...SRVRLWGLVGHHTS...VRETFEFLRVACFELVCAFGLCLNVELCLASCLSEKHLVRLTICLLICMLIRSEFP	436
Conseltlaviingnecavogr	r srkrlwglvghhts r ipflryaceflmraefglolrmlloaeqlsekhvrltotllcoarllrsep	
Sp	GVIVCSFS...IMLVKICGAA...YKRYVFLGVIFTEACIKLIVBMLLYHGLSTGLSTLSL...LACVYGAASLGLAVCGVAVAYISKRF	522
St	GVIVCSFS...IMLVKICGAA...YKRYVFLGVIFTEACIKLIVBMLLYHGLSTGLSTLSL...LACVYGAASLGLAVCGVAVAYISKRF	522
Np	GVIVCSFS...IMLVKICGAA...YKRYVFLGVIFTEACIKLIVBMLLYHGLSTGLSTLSL...LACVYGAASLGLAVCGVAVAYISKRF	527
Le	GVIVCSFS...IMLVKICGAA...YKRYVFLGVIFTEACIKLIVBMLLYHGLSTGLSTLSL...LACVYGAASLGLAVCGVAVAYISKRF	524
Conssegivcsfsimdlvkicgaaly	q kyyrlgvrtteaqikivewll yhgstglstcsl cagyggaa lgvavcgravayi skdf	
Sp	LFWFRSH...TAKEIKWCGAKH...HEFLK...ITLFRSH...SFKAFLEWVKRS...PWNAEMTAHSLCLILRCSFKTAEASNSAVVPHALGEM	610
St	LFWFRSH...TAKEIKWCGAKH...HEFLK...ITLFRSH...SFKAFLEWVKRS...PWNAEMTAHSLCLILRCSFKTAEASNSAVVPHALGEM	610
Np	LFWFRSH...TAKEIKWCGAKH...HEFLK...ITLFRSH...SFKAFLEWVKRS...PWNAEMTAHSLCLILRCSFKTAEASNSAVVPHALGEM	615
Le	LFWFRSH...TAKEIKWCGAKH...HEFLK...ITLFRSH...SFKAFLEWVKRS...PWNAEMTAHSLCLILRCSFKTAEASNSAVVPHALGEM	611
Consellfwfrshatakewcgakhhelk...itlfrshsffkaflewvkrs pwnaemcathslclilrdsfktaeasns a vha lgen		
Sp	ELQCIDELSSVAREVRLITETAFITP...VDMCRINGW...KVAELTCLVFEA...GKSLVHLVYHESCEIAE...LINALRGEBK...RVE	698
St	ELQCIDELSSVAREVRLITETAFITP...VDMCRINGW...KVAELTCLVFEA...GKSLVHLVYHESCEIAE...LINALRGEBK...RVE	698
Np	ELQCIDELSSVAREVRLITETAFITP...VDMCRINGW...KVAELTCLVFEA...GKSLVHLVYHESCEIAE...LINALRGEBK...RVE	703
Le	ELQCIDELSSVAREVRLITETAFITP...VDMCRINGW...KVAELTCLVFEA...GKSLVHLVYHESCEIAE...LINALRGEBK...RVE	699
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Np	IKLRFIT...EQLEKAV...VWNA...S...DYTN...IVGV...FVCG...VIG...R...V...M...K...F...I...N...Q...D...Y...K...A...V...H...S...E...N...E...L...I...F...F...I...P...S...E...N...T...C...S...E...N...T...A...M	791
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St	ERLIGAS...R...E...T...C...R...M...V...G...E...T...F...C...S...C...R...L...K...G...F...D...M...T...K...R...V...I...L...H...N...A...I...G...C...C...T...I...R...K...F...F...S...F...E...R...N...G...K...V...Y...C...A...L...L...T...A...N...K...R...W...M...E...C...D...I...G...A...C...F...T...I...Q	874
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图2 SpPHYB 与其他植物同源蛋白氨基酸序列比对

Fig.2 Comparison on amino acid sequences between SpPHYB and its homologous proteins from other plants

Sp : 野生马铃薯 ; St : 栽培型马铃薯 ; Np : 烟草 ; Le : 番茄。

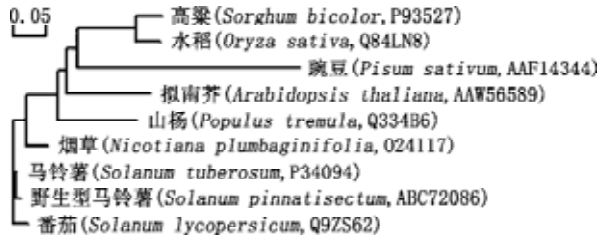


图3 SpPHYB的系统发生分析

Fig.3 Phylogenetic analysis of SpPHYB

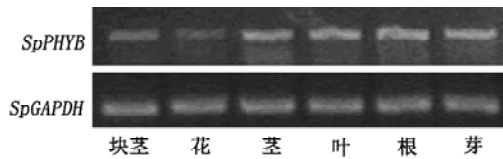


图4 SpPHYB在不同组织的表达

Fig.4 Expression of SpPHYB in different tissues

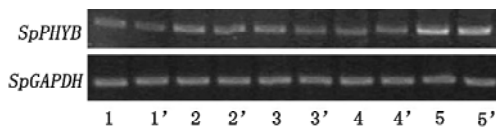


图5 光和暗诱导下野生型马铃薯 SpPHYB 的组织表达

Fig.5 Expression of SpPHYB in different tissues of

*S. pinnatisectum* under light and dark conditions

1~5 为光照处理的根、茎、叶、块茎、芽; 1'~5' 为黑暗处理的根、茎、叶、块茎、芽。

似的。

本文的结果表明, 经 8 h 短光照和黑暗处理的马铃薯植株, 其 SpPHYB 在块茎中的表达较低, 且处理间的差异不很明显, 这表明尽管光照对 SpPHYB 的表达量有影响, 但 SpPHYB 的表达与否并不依赖于光照条件。

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