Fig. S1.

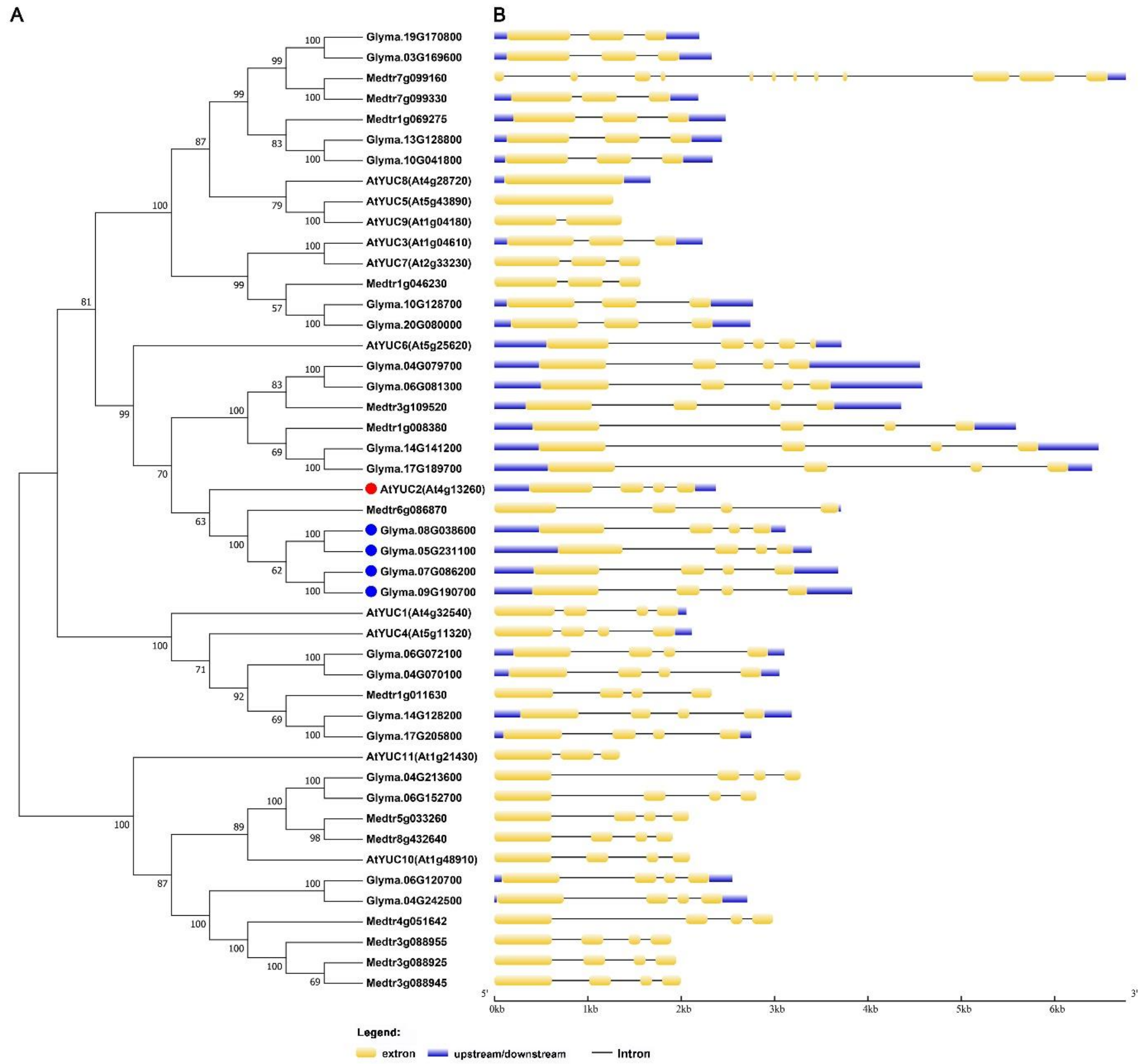

Fig. S1. Phylogenetic relationship of YUC family proteins and the structures of their associated genes. The phylogenetic tree (A) was made using MEGA6.0 with 1,000 bootstraps, while the gene structures (B) were constructed using the Gene Structure Display Server. All of the sequences were collected from the databases of *Arabidopsis thaliana*, *Medicago truncatula* and *Glycine max* in Phytozome.

Fig. S2.

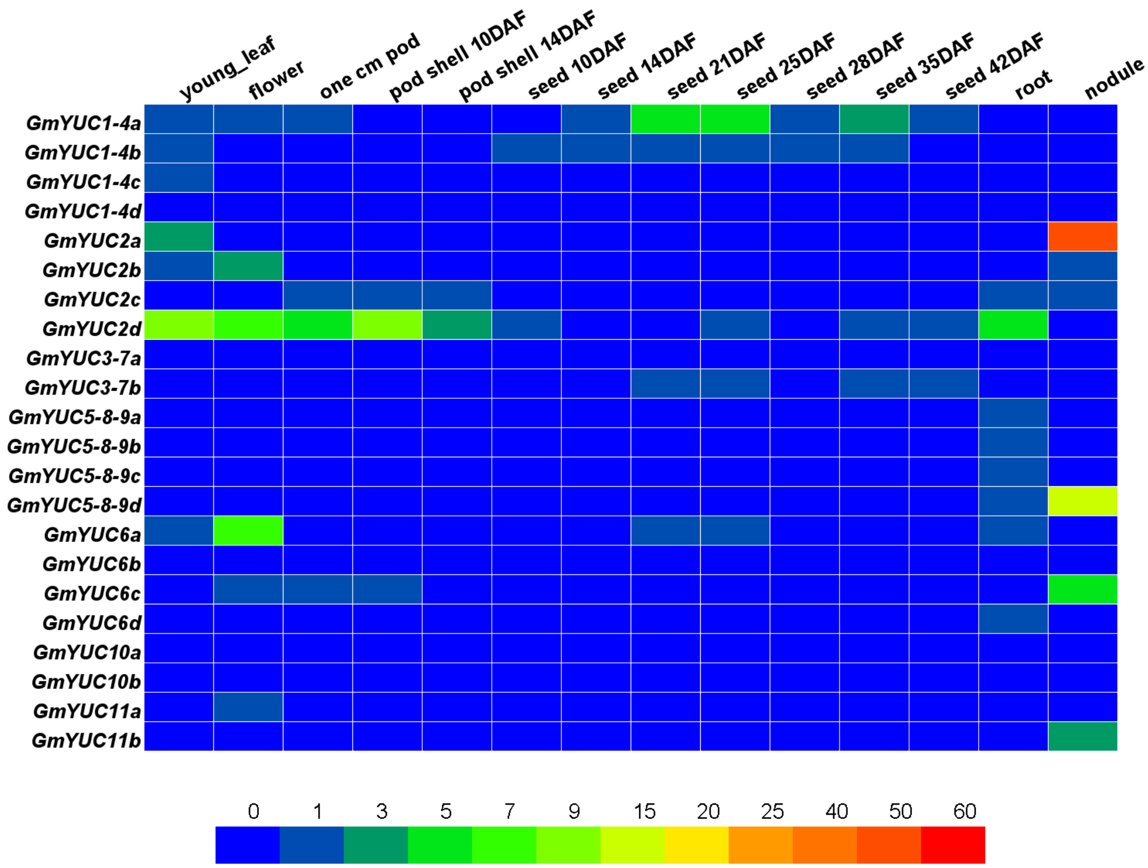

Fig. S2. *YUCCA* family gene expression in soybean. The data were obtained from transcriptome data available at SoyBase (http://soybase.org/soyseq/). A heatmap of differentially expressed *GmYUC* genes was drawn using Heatmap Illustrator (v1.0).

Fig. S3.

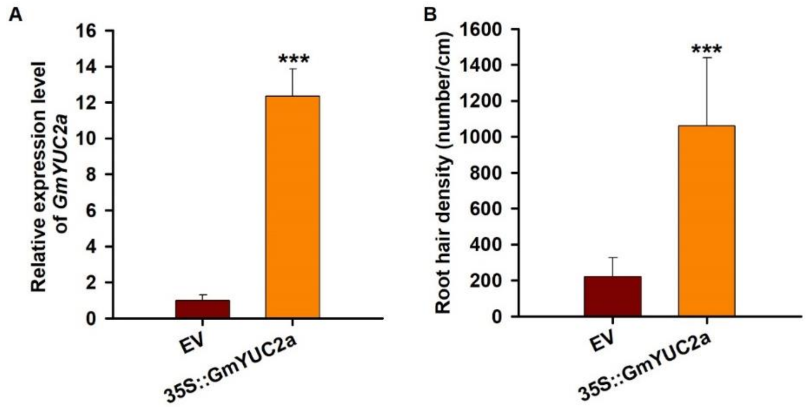

Fig. S3. *GmYUC2a* transcript levels and root hair density were increased in *35S::GmYUC2a* transgenic roots. (A) RT-qPCR was used to determine *GmYUC2a* transcript levels in transgenic roots expressing either the EV or *35S::GmYUC2a* at 10 days after transplantation. *GmYUC2a* expression was normalized against the geometric mean of the soybean reference gene *GmELF1b*. Statistically significant differences were identified using Student's *t*-test. (B) The root hair density of EV or *35S::GmYUC2a* at 10 days after transplantation. Three independent biological repeats were performed. Three independent biological replicates were performed using 15 hairy roots per replicate. Error bars indicate SD. Significant differences are marked with '***' (P < 0.001).

Fig. S4.

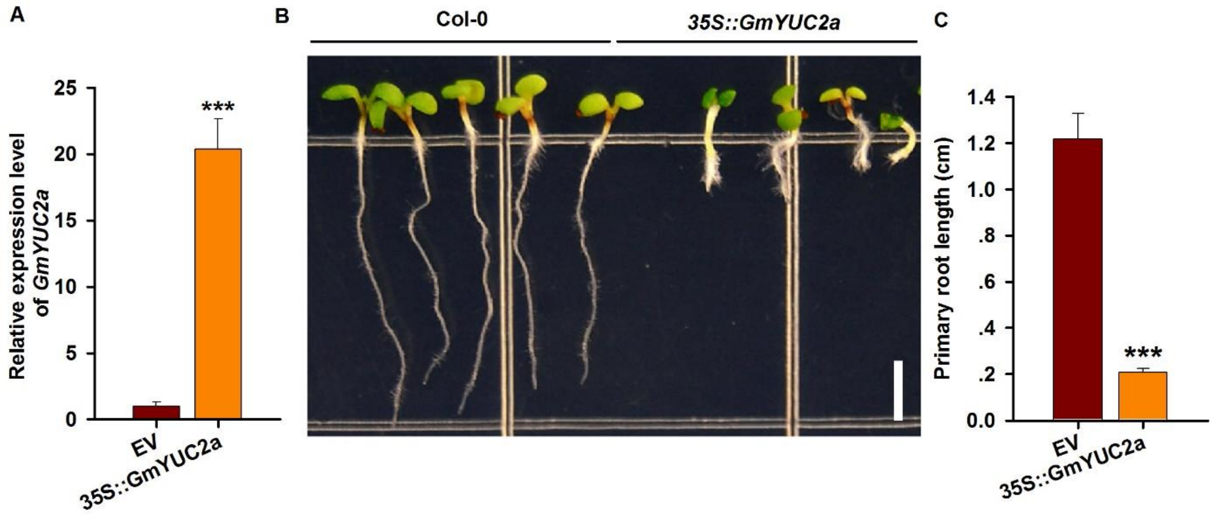

Fig. S4. *GmYUC2a* overexpression inhibited primary root growth in *Arabidopsis*. (A) RT-qPCR analysis of *GmYUC2a* expression in EV and *35S::GmYUC2a* plants at 7 days after germination. *AtUBQ5* was used as the reference gene. (B) The root phenotype of *Arabidopsis* plants transformed with either EV or *35S::GmYUC2a*. Bar=2 mm. (C) The primary root length of EV and *35S::GmYUC2a* transgenic plants. Three independent biological repeats were performed and were conducted using 10 plants per replicate. Error bars indicate SD. Statistically significant differences were determined using Student's *t*-tests. Significant differences are marked with '*******' ($P < 0.001$).

Fig. S5.

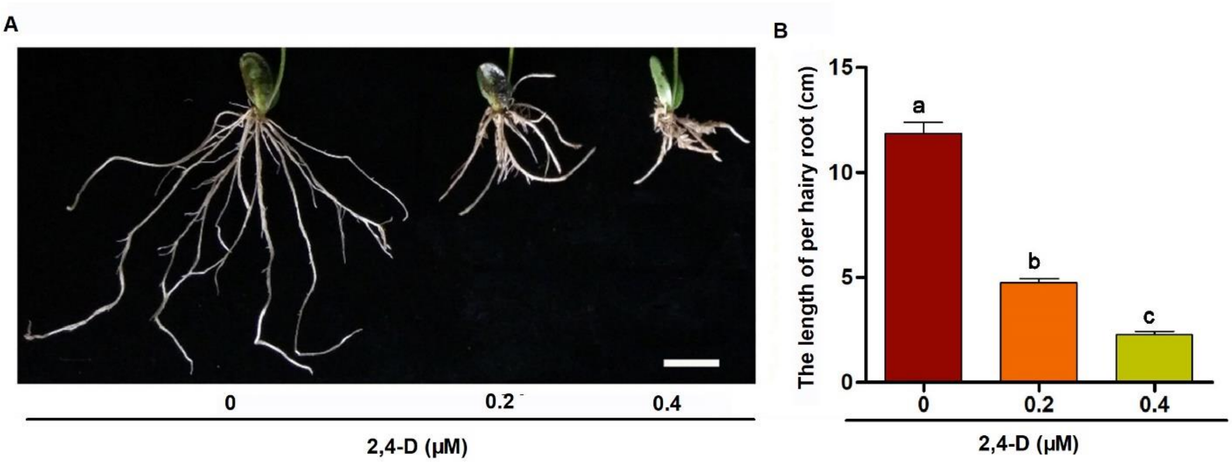

Fig. S5. Hairy root development was affected by 2,4-D treatment. (A) The hairy root phenotype of transgenic composite plants harboring empty vector treated with different concentrations of 2,4-D. Bar=2 mm. (B) The length of per. hairy root was counted (n=10). The data shown are the averages ± standard deviation. Three independent biological repeats were performed. Student's *t*-test was used for significant difference analysis. Different letters indicate significant differences by the Student-Newman-Kuels test (P<0.05).

Fig. S6.

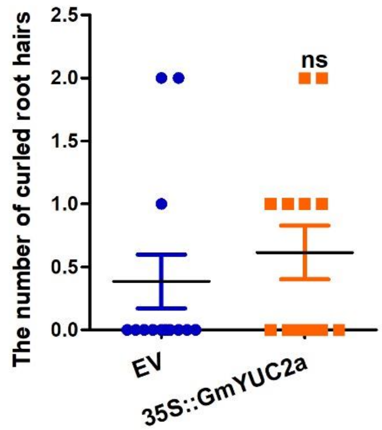

Fig. S6. *GmYUC2a* overexpression did not lead to root hair deformation without rhizobial inoculation. At 15 days, 2-cm root segments of transgenic hairy roots having EV or *35S::GmYUC2a* below root-hypocotyl junction were cut and stained with 1% (w/v) methylene blue. The number of considerably deformed root hairs were estimated (n=10).

Fig. S7.

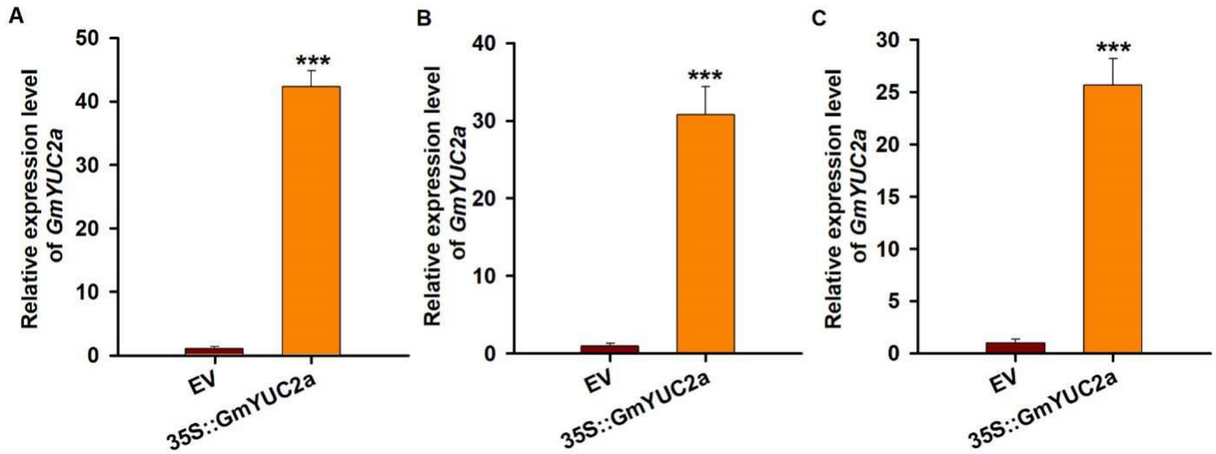

Fig. S7. *GmYUC2a* expression in EV or *35S::GmYUC2a* transgenic roots of soybean. RT-qPCR analysis of *GmYUC2a* transcription in transgenic roots expressing either the EV or *35S::GmYUC2a* at 3 DAI(A), 6 DAI(B) and 10 DAI(C). The housekeeping gene *GmELF1b* was used as a reference gene. Three independent biological repeats were performed. Error bars indicate SD. Statistically significant differences were identified using Student's *t*-tests. Significant differences are marked with '*******' ($P < 0.001$).

Fig. S8.

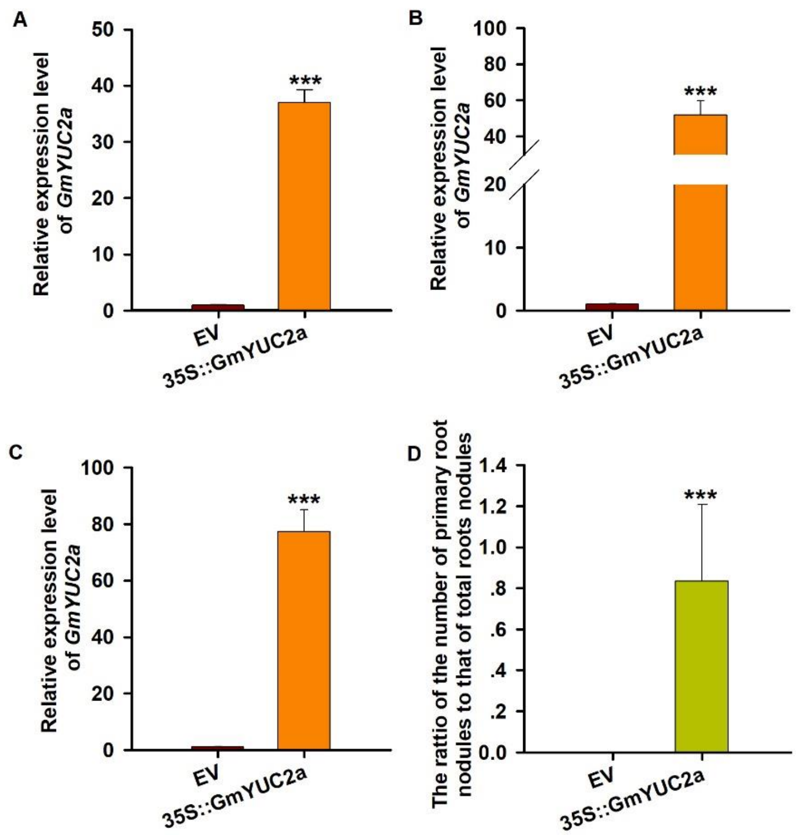

Fig. S8. *GmYUC2a* transcription in transgenic roots having EV or *35S::GmYUC2a*. (A-C) RT-qPCR analysis of *GmYUC2a* transcription in transgenic roots expressing either the EV or *35S::GmYUC2a* at 10 (A), 17 (B), and 28 DAI (C). (D) The ratio of the number of primary root nodules to that of total nodules were estimated at 17 DAI (n=10). The housekeeping gene *GmELF1b* was used as a reference gene. We repeated it using three independent biological repeats. Error bars indicate SD. Statistically significant differences were identified using Student's *t*-tests. Significant differences are marked with '***' ($P < 0.001$).

Fig. S9.

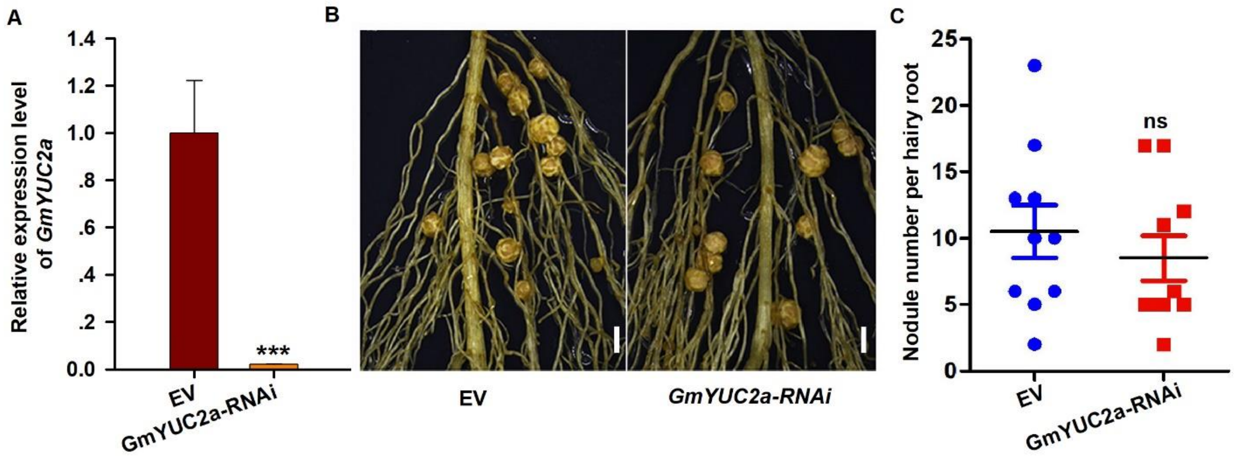

Fig. S9. *GmYUC2a* silencing did not affect nodule development. (A) The expression level of *GmYUC2a* in transgenic hairy roots carrying the EV or *GmYUC2a-RNAi* at 28 DAI. *GmELF1b* was used as a reference gene. (B) The nodule phenotype of transgenic hairy roots expressing EV or *GmYUC2a-RNAi*. Bar=2 mm. (C) The nodule number in transgenic roots harboring the EV or *GmYUC2a-RNAi* at 28 DAI. Three independent biological repeats were performed (n = 15 hairy roots per replicate). Error bars indicated SD. Student's *t*-test was used to determine significance. *** $P < 0.001$. ns, not significant, $P>0.05$.

Table S1. The *YUC* family genes in *Glycine max*.

	Gene	Description in Phytozome	PFAM
AtYUC1	At4g32540	YUC1	Pyridine nucleotide-disulphide oxidoreductase
GmYUC1-4a	Glyma.04g070100	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC1-4b	Glyma.17g205800	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC1-4c	Glyma.06g072100	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC1-4d	Glyma.14g128200	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
MedtrYUC1-4	Medtr1g011630	indole-3-pyruvate monooxygenase	Flavin-binding monooxygenase-like
AtYUC2	At4g13260	YUC2	Flavin-binding monooxygenase-like
GmYUC2a	Glyma.08g038600	DIMETHYLANILINE MONOOXYGENASE	Pyridine nucleotide-disulphide oxidoreductase
GmYUC2b	Glyma.05g231100	DIMETHYLANILINE MONOOXYGENASE	Pyridine nucleotide-disulphide oxidoreductase
GmYUC2c	Glyma.07g086200	DIMETHYLANILINE MONOOXYGENASE	Flavin-binding monooxygenase-like
GmYUC2d	Glyma.09g190700	DIMETHYLANILINE MONOOXYGENASE	Flavin-binding monooxygenase-like
MedtrYUC2	Medtr6g086870	indole-3-pyruvate monooxygenase	Flavin-binding monooxygenase-like
AtYUC3	At1g04610	YUC3	Flavin-binding monooxygenase-like
GmYUC3-7a	Glyma.10g128700	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA3-RELATED	Flavin-binding monooxygenase-like
GmYUC3-7b	Glyma.20g080000	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA3-RELATED	Flavin-binding monooxygenase-like
MedtrYUC3-7	Medtr1g046230	indole-3-pyruvate monooxygenase YUCCA8	Pyridine nucleotide-disulphide oxidoreductase
AtYUC4	At5g11320	YUC4	Flavin-binding monooxygenase-like
AtYUC5	At5g43890	YUC5	Pyridine nucleotide-disulphide oxidoreductase
GmYUC5-8-9a	Glyma.10g041800	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA5-RELATED	Pyridine nucleotide-disulphide oxidoreductase
GmYUC5-8-9b	Glyma.13g128800	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA5-RELATED	Pyridine nucleotide-disulphide oxidoreductase
GmYUC5-8-9c	Glyma.03g169600	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA5-RELATED	Pyridine nucleotide-disulphide oxidoreductase
GmYUC5-8-9d	Glyma.19g170800	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA5-RELATED	Pyridine nucleotide-disulphide oxidoreductase
MedtrYUC5-8-9a	Medtr7g099160	flavin containing monooxygenase YUCCA8-like protein	Flavin-binding monooxygenase-like
MedtrYUC5-8-9b	Medtr7g099330	indole-3-pyruvate monooxygenase	Pyridine nucleotide-disulphide oxidoreductase
MedtrYUC5-8-9c	Medtr1g069275	indole-3-pyruvate monooxygenase	Pyridine nucleotide-disulphide oxidoreductase
AtYUC6	At5g25620	YUC6	Pyridine nucleotide-disulphide oxidoreductase
GmYUC6a	Glyma.04g079700	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC6b	Glyma.17g189700	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC6c	Glyma.06g081300	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
GmYUC6d	Glyma.14g141200	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA2-RELATED	Flavin-binding monooxygenase-like
MedtrYUC6a	Medtr3g109520	indole-3-pyruvate monooxygenase YUCCA8	Flavin-binding monooxygenase-like
MedtrYUC6b	Medtr1g008380	indole-3-pyruvate monooxygenase	Flavin-binding monooxygenase-like
AtYUC7	At2g33230	YUC7	Flavin-binding monooxygenase-like
AtYUC8	At4g28720	YUC8	Pyridine nucleotide-disulphide oxidoreductase
AtYUC9	At1g04180	YUC9	L-lysine 6-monooxygenase (NADPH-requiring)
AtYUC10	At1g48910	YUC10	Flavin-binding monooxygenase-like
GmYUC10a	Glyma.06g152700	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA10-RELATED	Flavin-binding monooxygenase-like
GmYUC10b	Glyma.04g213600	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA10-RELATED	Flavin-binding monooxygenase-like
MedtrYUC10a	Medtr5g033260	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like
MedtrYUC10b	Medtr8g432640	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like
AtYUC11	At1g21430	YUC11	Flavin-binding monooxygenase-like
GmYUC11a	Glyma.06g120700	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA11-RELATED	Flavin-binding monooxygenase-like
GmYUC11b	Glyma.04g242500	INDOLE-3-PYRUVATE MONOOXYGENASE YUCCA11-RELATED	Flavin-binding monooxygenase-like
MedtrYUC11a	Medtr4g051642	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like
MedtrYUC11b	Medtr3g088955	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like
MedtrYUC11b	Medtr3g088925	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like
MedtrYUC11d	Medtr3g088945	flavin containing monooxygenase YUCCA10-like protein	Flavin-binding monooxygenase-like

Table S2. The expression data of *GmYUC* family genes in different tissues of soybean (RPKM Normalized data).

		young_leaf	flower	one cm pod	pod shell 10DAF	pod shell 14DAF	seed 10DAF	seed 14DAF	seed 21DAF	seed 25DAF	seed 28DAF	seed 35DAF	seed 42DAF	root	nodule
GmYUC1-4a	Glyma.04g070100 (Glyma04g07450)	1	2	2	0	0	0	2	5	5	2	3	1	0	0
GmYUC1-4b	Glyma.17g205800 (Glyma17g30920)	1	0	0	0	0	1	1	2	1	1	1	0	0	0
GmYUC1-4c	Glyma.06g072100 (Glyma06g07570)	1	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC1-4d	Glyma.14g128200 (Glyma14g15820)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC2a	Glyma.08g038600 (Glyma08g04310)	3	0	0	0	0	0	0	0	0	0	0	0	0	60
GmYUC2b	Glyma.05g231100 (Glyma05g35430)	1	3	0	0	0	0	0	0	0	0	0	0	0	2
GmYUC2c	Glyma.07g086200 (Glyma07g09500)	0	0	2	1	1	0	0	0	0	0	0	0	1	1
GmYUC2d	Glyma.09g190700 (Glyma09g32320)	9	8	6	10	4	1	0	0	1	0	1	1	5	0
GmYUC3-7a	Glyma.10g128700 (Glyma10g25760)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC3-7b	Glyma.20g080000 (Glyma20g20180)	0	0	0	0	0	0	0	1	1	0	2	2	0	0
GmYUC5-8-9a	Glyma.10g041800 (Glyma10g04760)	0	0	0	0	0	0	0	0	0	0	0	0	2	0
GmYUC5-8-9b	Glyma.13g128800 (Glyma13g19100)	0	0	0	0	0	0	0	0	0	0	0	0	1	0
GmYUC5-8-9c	Glyma.03g169600 (Glyma03g32670)	0	0	0	0	0	0	0	0	0	0	0	0	2	0
GmYUC5-8-9d	Glyma.19g170800 (Glyma19g35420)	0	0	0	0	0	0	0	0	0	0	0	0	1	19
GmYUC6a	Glyma.04g079700 (Glyma04g08440)	1	7	0	0	0	0	0	1	1	0	0	0	2	0
GmYUC6b	Glyma.17g189700 (Glyma17g25630)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC6c	Glyma.06g081300 (Glyma06g08560)	0	2	1	1	0	0	0	0	0	0	0	0	0	5
GmYUC6d	Glyma.14g141200 (Glyma14g20670)	0	0	0	0	0	0	0	0	0	0	0	0	1	0
GmYUC10a	Glyma.06g152700 (Glyma06g15810)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC10b	Glyma.04g213600 (Glyma04g39160)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC11a	Glyma.06g120700 (Glyma06g12650)	0	1	0	0	0	0	0	0	0	0	0	0	0	0
GmYUC11b	Glyma.04g242500 (Glyma04g42140)	0	0	0	0	0	0	0	0	0	0	0	0	0	3

Collected from Severin et al., 2010.

Table S3. Primers used in this study. The references are listed if the primers were previously reported.

Primers Name	Forward Primer	Reserve Primer	Comments
GmYUC2apro::GUS	CGGGATCCTACACGACATGGCCCTAACTA	GAAGATCTTGCACAAGGTCATGACAACGT	
35S::GmYUC2a	TCCCCCGGGATGGAGTACTTGAAGGAAGTGGA	CGGGATCCCTACACACGCGTGGTATTAGC	
GmYUC2a-RNAi	GGTACCACTAGTTCTCTCTAAACGTGGCCTTCTT	GAGCTCGGATCCCTACACACGCGTGGTATTAGC	
qRT-GmYUC2a	GTTGAGGTAAAGATGGGTAAAATGACAAG	CATAAGTCTTGAGCTGCCACATTGAAG	
qRT-GmNIN (Glyma04G00210)	CATCTTGAGCCTCTACCACC	GCTTTGACTCTAAAAGTGCCGG	Turner et al., 2013
qRT-GmTIR1C (Glyma19G39420)	GGTGACAAGGCCCTTTTG	CTCACCGAGCAGGAGGAC	
qRT-GmARF8a (Glyma02G40650)	ACAGCCACAAGCCCAAGTAATG	TGTCTCCTGGACTTGGACCA	Wang et al., 2015
qRT-GmIAA1 (Glyma10G32330)	GGTTATAAGGGATCTGACTATGAACC	CAACCCAAACCCCTTGCC	Turner et al., 2013
qRT-GmIAA14 (Glyma10G32340)	GACAAATGAGCATGGTCTGAGTT	CTTCCTTGGTCTGAAGATTAAGC	Turner et al., 2013
qRT-GmIAA20 (Glyma19G40970)	TCTCTCACTCAAGAACTTCCC	CACAAAAGGGTGGTGTGATTG	Turner et al., 2013
qRT-ELF1b	GTTGAAAAGCCAGGGGACA	TCTTACCCCTTGAGCGTGG	Jian et al., 2008
qRT-AtUBQ5	AAGAAGACTTACACCAAGCCG	CCTCAAACGCTGAACCTTTC	
Hy	TACACAGCCATCGGTCCAGA	TAGGAGGGCGTGGATATGTC	
Bar	AAGGATAGTGGGATTGTGCG	AGTCGGGAAACCTGTCGTG	