

10.1071/FP16036\_AC

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Supplementary Material: *Functional Plant Biology*, 2020, 47(8), 716–726.

## Supplementary Material

### **Production and roles of IAA and ABA during development of superior and inferior rice grains**

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**Table S1. List of primers used in this work**

Locus ID	Gene	Primers	Product size (bp)
LOC_Os02g42314	<i>OsUBC</i> (Reference gene)	F: CTGCGAGCTGAAACACTTTG R: TTCTCGCTGCACCTCCTTAT	105
LOC_Os01g16714	<i>OsYUC9</i>	F: CTGGCTCAAGAGTGATGACG R: TCCTCGTAGCTGCCGTAGAT	135
LOC_Os12g08780	<i>OsYUC11</i>	F: ACTGGCTTAAGAATGGTGAGGA R: GCGTCATGAGCAATACCAGA	139
LOC_Os02g17230	<i>OsYUC12</i>	F: GAGTTATCGACGTGCTCGAA R: TGCTTTCACCATTCTTTAGCC	147
LOC_Os11g11430	<i>OsIAA29</i>	F: CAACTATTCATGTCACCATTG R: ATGGGACATCACCAAGGAAG	131
LOC_Os12g42280	<i>OsNCED2(5)</i>	F: AGGAGGTGTGGCAAGAAGAA R: CCAGCACATTCGTGATGAAC	100

**Table S2. Loci represented by top 100 probe sets coexpressed with *OsIAA29/OsYUC12*, listed by mutual coexpression rank**

This list has 89 genes after removal of duplicates, probes with no listed genes or probes for known pseudogenes. Six genes overlap with top 200 probes coexpressed with *OsYUC11*. Gene product information was derived from a combination of the Rice Genome Annotation Project, the Grassius transcription factor database (Gray *et al.*, 2009) and published experimental studies

<b>MSU7 locus ID</b>	<b>Gene name/description</b>
LOC_Os11g11430	OsIAA29
LOC_Os11g45360	DEFL15
LOC_Os02g07624	DEF4
LOC_Os02g17230	OsYUC12
LOC_Os12g13960	LTPL33
LOC_Os04g12639	ZmEBE-1-like carboxy-terminal protease
LOC_Os01g70680	DEF1
LOC_Os01g28810	Expressed protein
LOC_Os08g04740	PMEI/INVINH homologue
LOC_Os05g07850	Leucine-rich repeat receptor-like protein kinase
LOC_Os04g49720	OsINVINH3
LOC_Os11g18140	ZmEBE-1-like carboxy-terminal protease
LOC_Os06g17480	OsNF-YB9/OsLEC1A <sup>1</sup>
LOC_Os02g55230	ZmEBE-1-like carboxy-terminal protease
LOC_Os11g14880	LTPL32
LOC_Os07g41290	DEFL13
LOC_Os02g15710	Plastocyanin-like
LOC_Os08g35670	OsRR33 type-B response regulator
LOC_Os12g12230	DEFL43
LOC_Os02g07550	DEFL1
LOC_Os11g03870	LTPL31
LOC_Os06g06260	OsGELP78 GDSL like lipase <sup>2</sup>
LOC_Os08g41030	OsERF115 <sup>1</sup>
LOC_Os02g38940	Cytochrome P450 71D8
LOC_Os09g11790	DEFL14
LOC_Os11g15620	OsFBX420
LOC_Os02g54960	ZmEBE-1-like carboxy-terminal protease
LOC_Os04g10260	OsbZIP35
LOC_Os12g27940	Expressed protein
LOC_Os01g12030	Endoglucanase GH9
LOC_Os04g38550	Expressed protein
LOC_Os03g39170	Frigida

LOC_Os10g03870	OsFBX353
LOC_Os01g11650	OsGELP3 GDSL like lipase
LOC_Os04g28120	OsPRR12 pseudo-response regulator
LOC_Os05g48560	Expressed protein
LOC_Os08g42890	INVINH/PMEI homologue
LOC_Os07g17460	OsFBL36
LOC_Os06g45920	ZmEBE-1-like carboxy-terminal protease
LOC_Os09g34880	OsZIP76
LOC_Os01g26320	ZmEBE-1-like carboxy-terminal protease
LOC_Os08g25200	Paired amphipathic helix repeat-containing protein
LOC_Os10g19925	DEFL68
LOC_Os06g22420	C2H2 zinc finger protein
LOC_Os09g20340	Leucine zipper protein like DUF630/DUF632 protein <sup>2</sup>
LOC_Os05g28440	Expressed protein
LOC_Os04g03860	Expressed protein
LOC_Os02g07600	DEF3
LOC_Os04g22240	zinc finger, C3HC4 type
LOC_Os06g07700	ZmMRP-1-like myb-SHAQKYF
LOC_Os06g07740	ZmMRP-1-like myb-SHAQKYF
LOC_Os11g11530	ZmEBE-1-like carboxy-terminal protease
LOC_Os11g11620	ZmEBE-1-like carboxy-terminal protease
LOC_Os06g02460	Expressed protein
LOC_Os01g41370	FBD domain containing protein <sup>2</sup>
LOC_Os01g41350	FBD domain containing protein <sup>2</sup>
LOC_Os03g52594	CCR4-NOT transcription factor
LOC_Os11g41880	Nuclear PHD finger proteins
LOC_Os04g44580	Expressed protein
LOC_Os04g35000	Expressed protein
LOC_Os04g31170	Expressed protein
LOC_Os07g01450	DNA directed RNA polymerase,
LOC_Os02g28660	Expressed protein
LOC_Os01g46220	OsGELP23 GDSL like lipase
LOC_Os09g08300	Expressed protein
LOC_Os04g41980	Expressed protein
LOC_Os08g13110	hypothetical protein
LOC_Os02g43030	Vacuolar iron transporter homolog
LOC_Os07g01620	Dirigent
LOC_Os10g07998	WAT1-related protein
LOC_Os06g07640	ZmMRP-1-like myb-SHAQKYF
LOC_Os03g31630	OsSub29 Putative Subtilisin
LOC_Os01g68820	Expressed protein
LOC_Os02g34320	OsHHLH32
LOC_Os10g17930	OsFBX381

LOC_Os07g17160	OsEIL6
LOC_Os01g58660	LTPL29/PR602 <sup>1</sup>
LOC_Os02g09910	OsPHD9
LOC_Os05g40790	CCR4-NOT transcription factor
LOC_Os01g33350	Zinc-binding protein
LOC_Os08g40350	Expressed protein
LOC_Os08g04710	PMEI/INVINH
LOC_Os05g23910	OsNF-YC11 <sup>1,2</sup>
LOC_Os03g17550	Serine/threonine-protein kinase
LOC_Os08g26990	OsRR13 type-A response regulator
LOC_Os02g49410	OsNF-YB1/OsHAP3K <sup>1,2</sup>
LOC_Os08g04290	OsFIE1
LOC_Os01g28474	AL1 aleurone layer specific protein <sup>1</sup>
LOC_Os07g09814	OsFBX221

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<sup>1</sup> Aleurone-expressed genes

<sup>2</sup> Genes found in both *OsIAA29/OsYUC12* and *OsYUC11* gene clusters

**Table S3. Loci represented by top 200 probe sets coexpressed with *OsYUC11* ranked by Pearson correlation coefficient**

This list has 145 genes after removal of duplicates, probes with no listed genes or probes for known pseudogenes. Six genes overlap with top 100 probes coexpressed with *OsYUC12/OsIAA29*. Pearson correlation coefficients for probe sets ranged from 0.831 to 0.966. Gene product information was derived from a combination of the Rice Genome Annotation Project, the Grassius transcription factor database (Gray *et al.*, 2009) and published experimental studies.

<b>MSU7 locus ID</b>	<b>Gene name/description</b>
LOC_Os12g08780	OsYUC11
LOC_Os09g24290	Agenet domain-containing protein
LOC_Os09g24310	Agenet domain-containing protein
LOC_Os02g09190	CYP71
LOC_Os01g74590	OsMYB24
LOC_Os03g26044	Cellulose synthase-like OsCSLA5
LOC_Os10g04900	OsFBX364
LOC_Os02g19420	Expressed protein
LOC_Os01g25450	AIG1 family protein
LOC_Os07g31470	OsMYB87
LOC_Os07g47240	OsGZF1
LOC_Os06g21900	Proton dependent oligopeptide transport (POT)
LOC_Os07g42390	Expressed protein
LOC_Os10g25850	OsNF-YA8/OsCA2P9 <sup>1</sup>
LOC_Os04g42634	Expressed protein
LOC_Os06g02028	OsEya1
LOC_Os08g09700	OsFBX270
LOC_Os01g13360	Phosphatidylinositol 3- and 4-kinase family protein
LOC_Os01g24460	OsNF-YC9/OsCA5P3 <sup>1,5</sup>
LOC_Os10g04890	Expressed protein
LOC_Os10g40260	Expressed protein
LOC_Os02g34370	Expressed protein
LOC_Os11g31340	OsNAC114
LOC_Os01g24880	Zinc finger, C3HC4 type
LOC_Os07g49120	Short-chain alcohol dehydrogenase
LOC_Os01g01290	OsNF-YC8/OsCA5P1 <sup>1,5</sup>
LOC_Os10g04980	OsFBX365
LOC_Os01g29840	OsNAC5
LOC_Os04g38520	Loricrin TF
LOC_Os10g41160	Expressed protein
LOC_Os03g07226	Thioredoxin

LOC_Os11g31360	OsNAC115
LOC_Os05g34310	OsNAC49
LOC_Os07g13830	OsFBX228
LOC_Os02g14720	Expressed protein
LOC_Os01g08570	2 Oxoglutarate and iron dependent oxygenase
LOC_Os02g49410	OsNF-YB1/OsLEC1A/ OsCA3P4 <sup>1,2</sup>
LOC_Os02g15070	Glutelin GluB-6 <sup>4</sup>
LOC_Os05g01960	RTFL8 (ROTUNDIFOLIA LIKE 8)
LOC_Os01g67310	Patatin
LOC_Os05g23910	OsNF-YC11/ OsCA5P10 <sup>1,2,5</sup>
LOC_Os07g11900	Prolamin13b.1 <sup>3</sup>
LOC_Os07g11910	Prolamin13b.2 <sup>3</sup>
LOC_Os07g11920	Prolamin13b.3 <sup>3</sup>
LOC_Os12g16880	Prolamin13a.3 <sup>3</sup>
LOC_Os12g16890	Prolamin13a.4 <sup>3</sup>
LOC_Os07g11630	LTPL163
LOC_Os07g11650	LTPL164
LOC_Os10g29540	Protein kinase MAPKKK
LOC_Os08g37600	Citrate transporter
LOC_Os01g46910	Microneme protein Sm70
LOC_Os02g25640	Glutelin GluC <sup>4</sup>
LOC_Os11g33000	Prolamin10.4 <sup>3</sup>
LOC_Os05g12670	Expressed protein
LOC_Os10g12400	Nodulin
LOC_Os02g15090	Glutelin GluD-1 <sup>4</sup>
LOC_Os05g47820	Expressed protein
LOC_Os06g04930	Expressed protein
LOC_Os01g48580	OsUBC39 Ubiquitin conjugating enzyme E2
LOC_Os08g16860	OsFBX282
LOC_Os11g31380	OsNAC116
LOC_Os07g12080	LTPL169
LOC_Os07g11410	RAL5 Seed allergenic protein
LOC_Os01g55690	Glutelin GluA-1 <sup>4</sup>
LOC_Os10g26060	Glutelin GluA-2 <sup>4</sup>
LOC_Os03g13730	Translocase of chloroplast 34
LOC_Os06g31070	Prolamin16.2 <sup>3</sup>
LOC_Os12g41790	DEFL3
LOC_Os10g29549	Expressed protein
LOC_Os08g28940	OsFBX289
LOC_Os03g31360	Glutelin GluA-3 <sup>4</sup>
LOC_Os08g16630	OsFBX279
LOC_Os11g23890	Peptide transporter PTR2
LOC_Os12g14070	DnaK family protein

LOC_Os04g45470	Vacuolar-processing enzyme
LOC_Os07g10580	Prolamin13a.2 <sup>3</sup>
LOC_Os08g45110	OsEREB141
LOC_Os07g11380	RAL4 Seed allergenic protein
LOC_Os07g11510	RAL6 Seed allergenic protein
LOC_Os07g11330	RAL2 Seed allergenic protein
LOC_Os05g49930	OsGRAS28
LOC_Os06g30280	Expressed protein
LOC_Os04g35010	bHLH144
LOC_Os02g16820	Glutelin GluB-5 <sup>4</sup>
LOC_Os02g16830	Glutelin GluB-4 <sup>4</sup>
LOC_Os01g38390	Expressed protein
LOC_Os06g51084	Starch Branching Enzyme I
LOC_Os05g41970	SSA1 2S albumin seed storage family protein
LOC_Os07g10570	Prolamin13a.1 <sup>3</sup>
LOC_Os02g12310	OsNAC15
LOC_Os07g11360	RAL3 Seed allergenic protein
LOC_Os01g13460	OsHLH9
LOC_Os05g51400	protein kinase APK1B
LOC_Os07g08420	bZIP58/RISBZ1 <sup>1</sup>
LOC_Os09g20340	Leucine zipper protein like DUF630/DUF632 protein <sup>2</sup>
LOC_Os02g15150	Glutelin GluB-2 <sup>4</sup>
LOC_Os04g44570	Aquaporin TIP3-2
LOC_Os04g39560	Expressed protein
LOC_Os07g11120	Hydrolase, NUDIX family
LOC_Os07g13634	Cytokinin-N-glucosyltransferase 1
LOC_Os03g46100	Cupin domain containing protein
LOC_Os12g07120	OsGATA26
LOC_Os09g06950	Expressed protein
LOC_Os01g01470	OsNAC2
LOC_Os02g14600	Glutelin GluB-7 <sup>4</sup>
LOC_Os03g49190	Oleosin 18 kD
LOC_Os05g50390	Expressed protein
LOC_Os07g36920	OsFBX255
LOC_Os03g10110	Cupin domain containing protein
LOC_Os01g38650	Expressed protein
LOC_Os10g32720	AWPM-19-like membrane family protein,
LOC_Os10g12390	Expressed protein
LOC_Os04g43170	Caleosin related protein
LOC_Os03g57960	Cupin domain containing protein
LOC_Os12g42670	Expressed protein
LOC_Os05g10800	Expressed protein
LOC_Os06g11812	Wound/stress protein



LOC_Os05g26350	Prolamin13b.8 <sup>3</sup>
LOC_Os05g26460	Prolamin13b.15 <sup>3</sup>
LOC_Os05g26620	Prolamin13b.18 <sup>3</sup>
LOC_Os08g06060	OsMPK2/OsMAPK2
LOC_Os11g28270	OsC3H66
LOC_Os06g06260	OsGELP78 GDSL like lipase <sup>2</sup>
LOC_Os09g33670	Zinc finger, C3HC4
LOC_Os05g10820	Hypothetical protein
LOC_Os05g26040	Pumilio-family RNA binding repeat
LOC_Os02g15169	Glutelin GluB-1b <sup>4</sup>
LOC_Os02g15178	Glutelin GluB-1a <sup>4</sup>
LOC_Os06g06560	Starch Synthase 1
LOC_Os09g15520	Oleosin putative
LOC_Os11g37270	Antimicrobial peptide MBP-1
LOC_Os04g34510	Expressed protein
LOC_Os03g16730	Expressed protein
LOC_Os10g11580	OsNF-YC12/OsCA5P19 <sup>1,5</sup>
LOC_Os08g23870	Late embryogenesis abundant group 1 LEA4
LOC_Os07g44430	1-Cys peroxiredoxin A-like
LOC_Os01g39850	OsNF-YC10/OsCA5P4 <sup>1,5</sup>
LOC_Os03g61860	Expressed protein
LOC_Os12g03220	Expressed protein
LOC_Os07g08950	FAD-linked oxidoreductase
LOC_Os01g19770	Tim17
LOC_Os01g41370	FBD domain containing protein <sup>2</sup>
LOC_Os01g41350	FBD domain containing protein <sup>2</sup>
LOC_Os03g08200	DUF567 domain containing protein
LOC_Os07g11310	LTPL166

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<sup>1</sup> Aleurone expressed genes

<sup>2</sup> Genes found in both *OsIAA29/OsYUC12* and *OsYUC11* gene clusters

<sup>3</sup> Prolamin nomenclature from Saito *et al.* (2012)

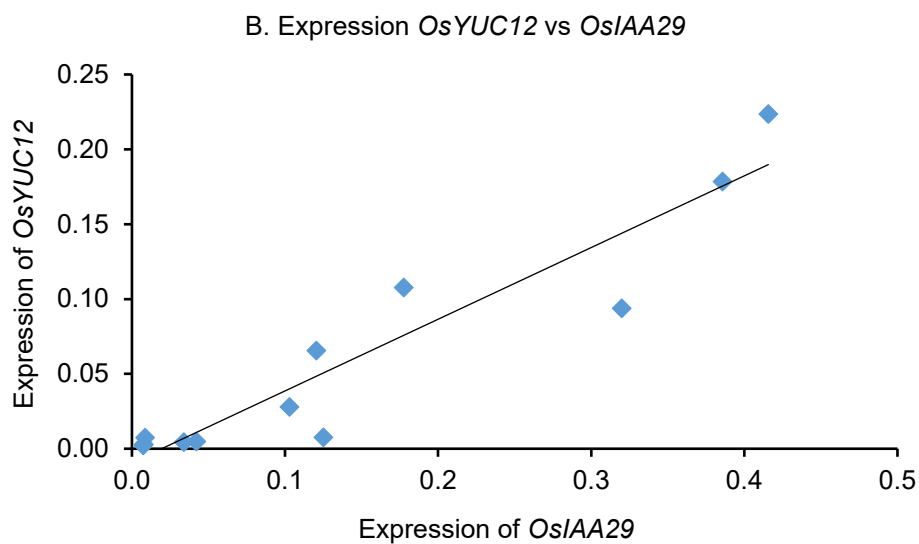
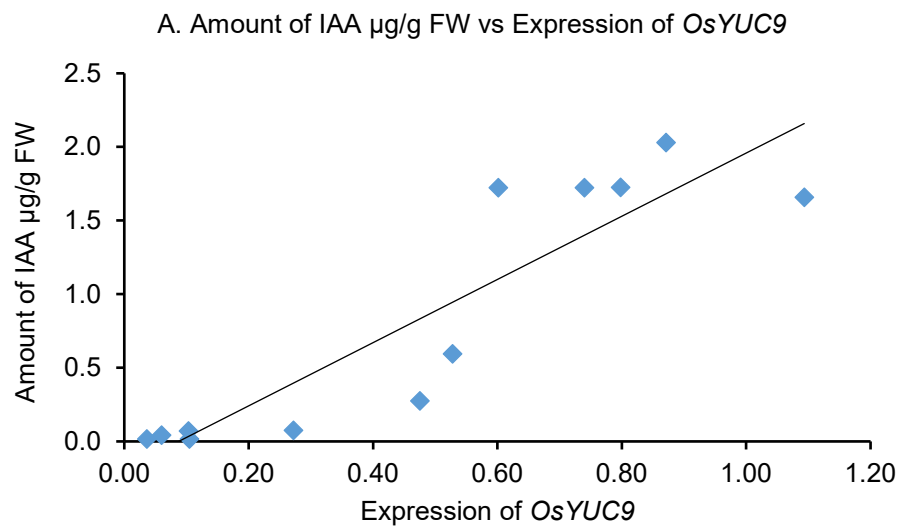
<sup>4</sup> Glutelin numbering taken from Kawakatsu *et al.* (2008)

<sup>5</sup> NF-YC numbering taken from Xu *et al.* (2016)

**Table S4. List of genes in the *OsYUC11* cluster with TGTCT on both strands as well as a GCN4 motif in the 1000 bp promoter region**

MSU7	Gene name/function
LOC_Os01g55690	Glutelin GluA-1
LOC_Os02g15150	Glutelin GluB-2
LOC_Os02g15178	Glutelin GluB-1a
LOC_Os02g15169	Glutelin GluB-1b <sup>1</sup>
LOC_Os02g16820	Glutelin GluB-5
LOC_Os02g16830	Glutelin GluB-4
LOC_Os03g31360	Glutelin GluA-3
LOC_Os10g26060	Glutelin GluA-2
LOC_Os07g10570	Prolamin13a.1 <sup>1</sup>
LOC_Os07g10580	Prolamin13a.2
LOC_Os12g16890	Prolamin13a.4
LOC_Os07g11510	RAL6 - Seed allergenic protein
LOC_Os06g51084	Starch Branching Enzyme I
LOC_Os04g44570.1	Aquaporin TIP3-2
LOC_Os05g34310.1	OsNAC49
LOC_Os06g02028.1	OsEYA1
LOC_Os01g41370	FBD domain containing protein
LOC_Os07g36920.1	OsFBX255
LOC_Os10g04980.1	OsFBX365

<sup>1</sup> Included after manual search of promoter



**Fig. S1.** (A) IAA content of grains versus expression of *OsYUC9* in individual samples of superior and inferior rice grains. (B) Expression of *OsYUC12* vs *OsIAA29* in superior and inferior rice grains.

## References

Gray J, Bevan M, Brutnell T, Buell CR, Cone K, Hake S, Jackson D, Kellogg E, Lawrence C, McCouch S, Mockler T, Moose S, Paterson A, Peterson T, Rokhsar D, Souza GM, Springer N, Stein N, Timmermans M, Wang GL, Grotewold E (2009) A recommendation for naming transcription factor proteins in the grasses. *Plant Physiology* **149**(1), 4–6.

doi:10.1104/pp.108.128504

Kawakatsu T, Yamamoto MP, Hirose S, Yano M, Takaiwa F (2008) Characterization of a new rice glutelin gene GluD-1 expressed in the starchy endosperm. *Journal of Experimental Botany* **59**, 4233–4245. doi:10.1093/jxb/ern265

Saito Y, Shigemitsu T, Yamasaki R, Saito Y, Shigemitsu T, Yamasaki R, Sasou A, Goto F, Kishida K, Kuroda M, Tanaka K, Morita S, Satoh S, Masumura T (2012) Formation mechanism of the internal structure of type I protein bodies in rice endosperm: relationship between the localization of prolamin species and the expression of individual genes. *The Plant Journal* **70**, 1043–1055. doi:10.1111/j.1365-313X.2012.04947.x

Xu J-J, Zhang X-F, Xue H-W (2016) Rice aleurone layer specific OsNF-YB1 regulates grain filling and endosperm development by interacting with an ERF transcription factor. *Journal of Experimental Botany* **67**, 6399–6411. doi:10.1093/jxb/erw409