

Electronic supplementary materials

Title:

Candidate genes underlying the quantitative trait loci for root-knot nematode resistance in a *Cucumis hystrix* introgression line of cucumber based on population sequencing

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Content:

Figs. S1–S4



Figure S1 Root symptoms of Introgression line IL10-1 (left) and *C. sativus* var. CC3 (right) after 45 days inoculation with *Meloidogyne incognita*

Note: Bar=1.0 cm

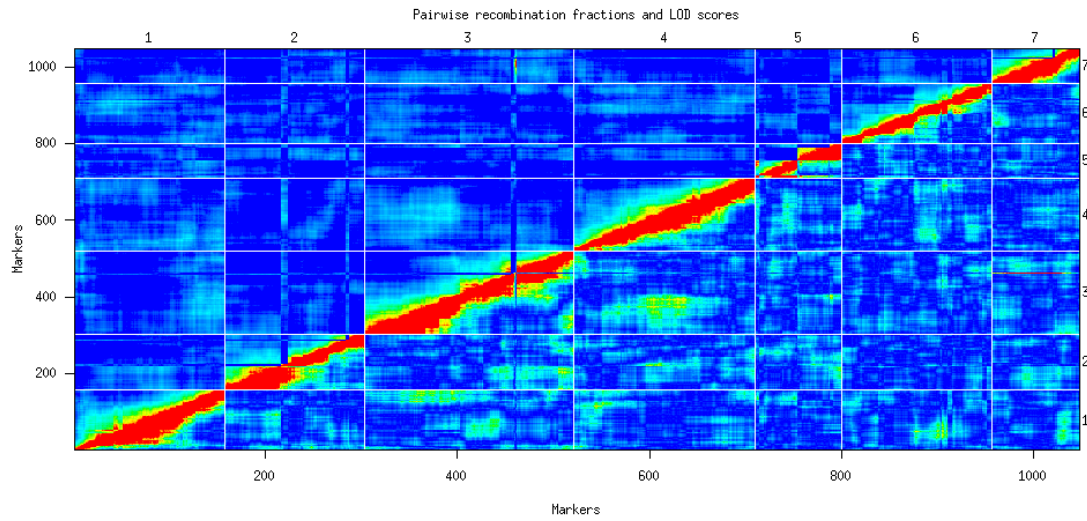


Figure S2 The heat-map of pairwise linkage markers analysis

Plot of estimated recombination fraction (upper-left triangle) and LOD scores (lower-right triangle) for all pairs of markers. Red indicates linked (large LOD score or small recombination fraction) and blue indicates not linked (small LOD score or large recombination fraction)

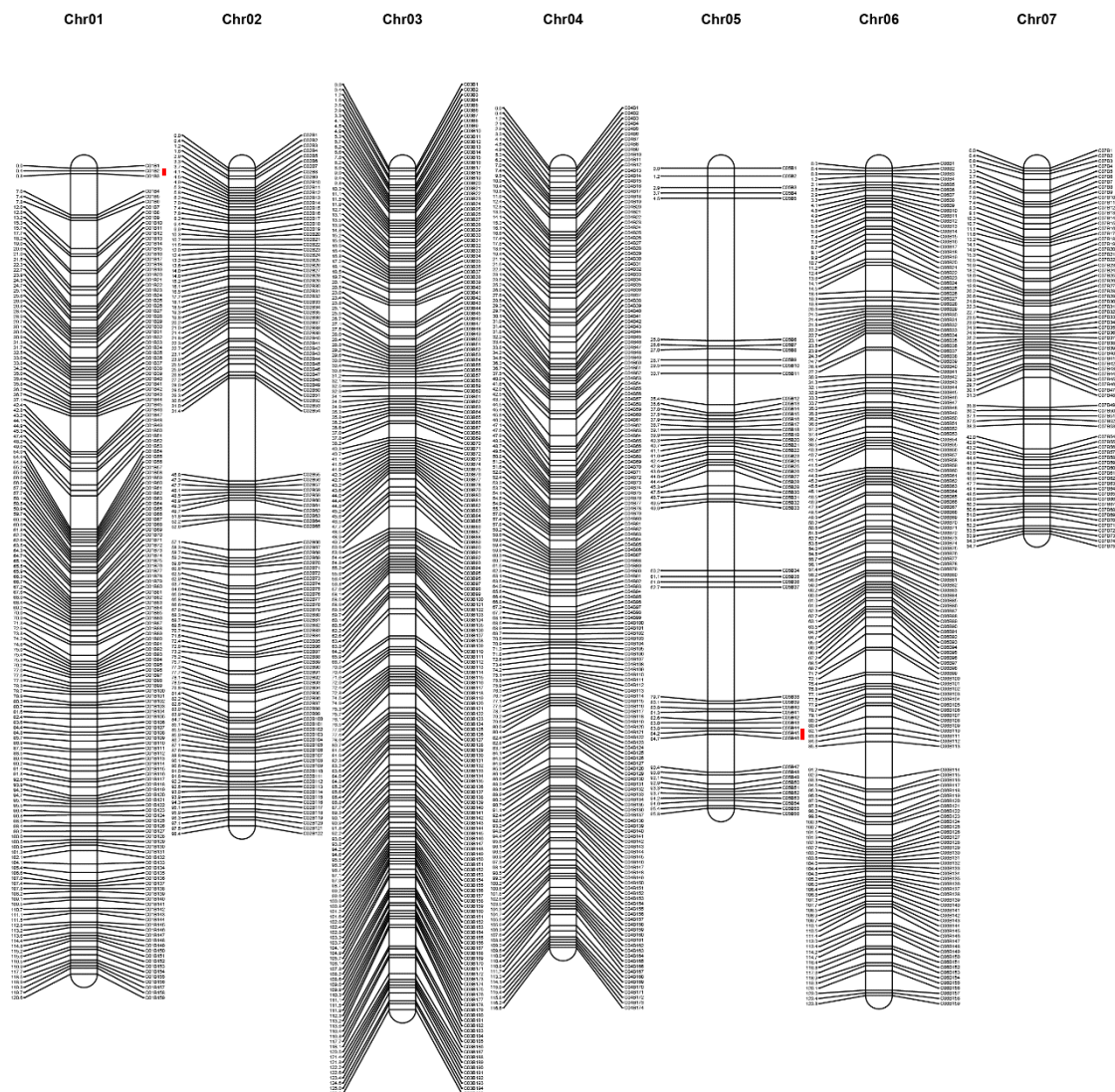


Figure S3 Genetic linkage Bin-map based on the RIL population derived from the cross IL10-1 × CC3

Note: Bin markers are named as CnBm, n represents for chromosome number, m represents for Bin number. The red vertical lines mark the locations of QTL.

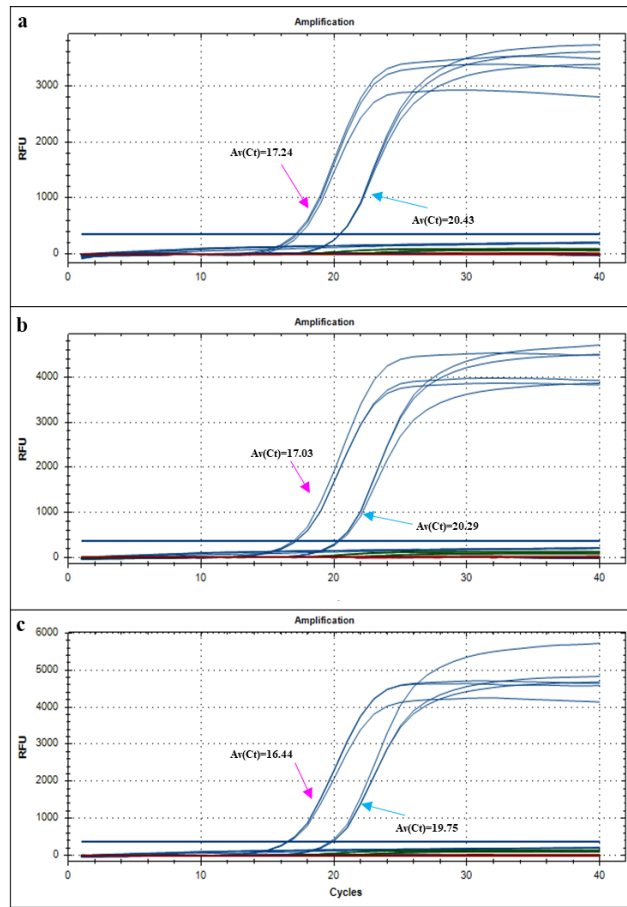


Figure S4 PCR efficiency was calculated for each target from the raw fluorescence data taken using a LightCycler 480 Real-Time PCR System.

a, b, c show the efficiency of different dilution rates (diluted 10:1) using cDNA of IL10-1 from 1, 2, 3 days post inoculation, which illustrating the efficiency is about 100%. Arrows in blue present cDNA diluted 10 times, and arrows in pink present cDNA without diluted.

Table S1 The Primers designed for RT-PCR analysis of The Four Candidate Genes to RKN

Gene ID	Primer sequences-Forward	Primer sequences-Reverse	Product Length (bp)	Product GC %
	5'-----'3	5'-----'3		
<i>EF1a</i>	ACTGTGCTGTCCTCATTATTG	AGGGTGAAAGCAAGAAGAGC	98	46.4
<i>Csa5M608240.1</i>	GGTGTGAATTTGAAAGCTAACG	ACACAACCGAATTTAGTGGTTG	132	26.5
<i>Csa5M610420.1</i>	CGTCATGTGAATCTGAGGAGTA	GCATTAAGGAAACAGGCAATGA	202	38.1
<i>Csa5M623410.1</i>	CACCATCCAACGCAACTGACACT	TGGAGATGAACCCAAGTTAGGCG	122	54.9
<i>Csa5M610370.1</i>	TAACTTACAAATTCCGGCCA	AATGAAGGGTAGGGAACAGA	159	42.5

Table S2 Gall index of the F2:3 and F2:6 population, derived from IL10-1×CC3, of four different seasons in different experimental bases

Indlabel	F2:3-11Spring	F2:3-12Spring	F2:6-14Autumn	F2:6-15Spring	Indlabel	F2:3-11Spring	F2:3-12Spring	F2:6-14Autumn	F2:6-15Spring
1_2	3	2.8	4	2.5	29_1	3.67	3.6	2.65	3.33
2_1	3.33	2.67	4	2	30_1	2.5	2.33	4.65	3
3_2	2.5	1.6	2.65	1	31_1	3	3.33	5	3.67
4_2	3.33	2.5	4	1.67	32_2	2	2.6	4.35	3
5_2	3	2.6	3.65	2	33_1	4.33	3.5	4.35	2.67
7_1	2.5	2.83	4.5	3	34_1	3	3.5	3.65	4
8_3	2.67	3.17	4	3.67	35_2	3	3.2	4.65	3.33
9_1	3.33	3.17	2	3	36_3	3	3	4	3
10_3	4.5	3	2.65	1.5	37_1	4	3.67	4	3.33
11_2	3.33	3.4	3.35	3.5	38_2	3	3.2	4.5	3.5
12_3	3.67	3.5	3.35	3	39_2	3.67	3.8	2.65	4
13_1	3.67	3.5	4.65	3.33	40_2	2.67	2.8	1.65	3
14_2	3.67	3.6	2.65	3.5	42_3	3	2	3.5	1
15_1	3.67	3.33	4	3	43_2	2.5	2.2	4.35	3.33
17_1	3.33	3.67	3	4	44_2	3.33	4.6	3.35	4.33
18_1	2.5	2.4	2.5	2.33	45_1	3	3	3.5	3
19_1	3.67	3	3	2.33	46_1	3.67	3.17	4	2.67
20_1	4	4	5	4	47_1	3	2.5	4.65	2
21_1	4.5	4.2	2.35	4	48_2	3.67	3.83	3.35	4
22_1	3.67	3.33	1.65	3	49_1	3.67	3.33	2	3
23_1	3	3	3.35	3	50_3	3.67	3.33	3.65	3
24_1	3.67	2.83	2.35	2	51_1	4.33	3.17	5	2
25_1	3	3	1.65	3	52_3	2.5	2.33	3.65	2
26_1	3	3.17	2.5	3.33	54_1	3	2	3.35	1
27_1	3	3.33	4.5	3.67	55_1	3.5	3.4	3.35	3.33
28_2	2.67	2.5	3	2.33	56_2	3.33	2.17	2.15	1

continued to Table S2

Indlabel	F_{2:3-11Spring}	F_{2:3-12Spring}	F_{2:6-14Autumn}	F_{2:6-15Spring}	Indlabel	F_{2:3-11Spring}	F_{2:3-12Spring}	F_{2:6-14Autumn}	F_{2:6-15Spring}
57_1	3.33	2.4	2.65	1	80_2	3.00	3.60	2.35	4.50
58_2	2.33	1.83	4	1.33	81_3	3.33	2.57	4.35	2.00
59_1	3.33	2.8	3	2	82_2	2.67	2.83	1.65	4.00
60_3	2.33	2.4	2.5	2.5	83_3	3.50	3.20	3.25	3.00
61_2	3.33	2.33	3	1.33	84_1	4.00	3.00	3.65	2.00
62_1	4	2.6	3.65	1.67	85_1	3.67	3.33	1.65	3
63_2	3	2.67	2	2.33	86_3	4	3.67	3.65	3.33
64_3	4.33	3.33	5	2.33	87_1	3.67	3.67	2.65	3.67
65_2	3.33	2.83	3.5	2.33	89_2	3.67	3.33	1.65	3
66_1	2.5	2.6	3.65	2.67	90_1	3	2.4	2.65	2
67_3	3.33	3.4	3.65	3.5	91_1	3.5	3	2	2.67
68_1	3	2.75	3.35	2	92_3	4	3.6	2.35	3.33
69_1	4.33	3.33	0	3.5	93_2	3	3.2	1.35	3.33
70_1	3.33	3.5	2.35	3.67	94_2	2.33	2.67	2.65	3
71_2	3.67	3.6	4.65	3.5	95_1	5	2.5	4.35	1.67
72_1	3.5	3	4.35	2.67	96_1	2.67	2.17	2.35	1.67
73_1	4	3.33	4.65	2.67	97_1	2.33	2.5	3.65	2.67
74_1	4.5	4	4.35	3.67	98_2	2.67	2.83	3	3
75_1	3	3.2	2.65	3.5	99_3	3	3.33	3	3.67
76_2	2.33	2.17	2	2	100_1	3	2.2	2.65	1.67
77_1	3	2.83	1.65	2.67	101_1	2.5	3	3	3.33
78_1	3	2.5	1	2	102_2	3.33	2.5	4	1.67
79_2	5	4.8	1.35	4.67	103_3	3	2.75	1	2.5

continued to Table S2

Indlabel	F_{2:3}-11Spring	F_{2:3}-12Spring	F_{2:6}-14Autumn	F_{2:6}-15Spring	Indlabel	F_{2:3}-11Spring	F_{2:3}-12Spring	F_{2:6}-14Autumn	F_{2:6}-15Spring
104_2	3	2.17	1.35	1.33	117_1	3.33	2.83	3	2.33
105_1	3.5	2.2	2	1.33	118_1	3.5	4	4	4.33
106_3	3.5	3.25	2.65	3	119_2	3.33	3.83	3.65	4.33
107_2	3	2.5	2	2	120_1	3.67	3.17	1	2.67
108_3	3.67	3.17	3	2.67	121_3	3.5	3.6	3.35	3.67
110_1	3.67	2.67	3.35	1.67	122_3	3	2.33	2.65	2.67
111_1	3.67	2.33	4	1	123_2	3.5	2.8	3	3.67
112_1	3.67	2.5	3	1.33	124_2	3	2.6	4.65	2.33
113_3	3.5	3	3	3.67	125_1	4	3.6	4.35	3.33
114_2	3	2.5	3.35	2	126_3	4	3	1.65	3.33
115_3	4	3.4	2.65	3	127_2	3.33	3.67	3.65	4
116_2	3	3	3.35	0	128_3	4	3.4	3.35	2.5

Table S3 The sequence information of The Four Candidate Genes to RKN

Gene ID	DNA sequence	protein sequence	position of mutations	mutation type
<i>Csa5M608240.1</i>	ATGAGGAAGCTGTTTATTGTTATGTTCTTTGTCTGTTTGGGAAGTTGGAGAAGCTATGCACAAGACAGTGGAGAAGCTCCAATGGAGAA AACAGAGATGGATTCTCTGTTCTCTTCTATTCAAGGCTTTGGGTAATTGGTGGAAATGGCTCAGATTATACCCAGATCCCTGTGGATGG ACGCCAATACAGGGGGTTTCTGTGATATATTGATGGGCTTTGGTATGTCACCTACTAAACATTTGGACCAACTCATGACAATTCTCTAG CTTGTTCCTCCAAATGCTCAITTCAGACAGCAATTTGTTCAACTCAAACACCTTAAAACTCTGTCCTTCTTAACTGTTTCGTCTCAACAA AAGGGAAGAATTCTGTTCACTCCAACTGGAGAATGGCTTAACTTCGCCGGAACTTTAGAATCTCTTGAGTTCAGATCAAACTCCGCA CTTTCCGGACAATTCCTGCCAGTTTAGGGACTTTGTCAAAGCTGCAATCTTTGGTCTGTTACAGAACGGATTTCGTCCGGTAAATACCA GAAAATTTTGGCGATTGATCGAATTGAAACGATTGGTCTTCTGCTGGGAACCTCACTACTGGCCCAATCACTAAAATCTAGGCAAGTT AAGCGAACTACTGATTTGGATTGAGTAGAAATCGTTGTCGGGTTCTTTACCATTAAAGTTTGGGAAATTTGACGGCCCTTTGAAGCT TGATCTAAGTGAAGACAAATTGAGTGGAAATTTGCCTAGTGAATTAGGCAATATGGGAAATTTGACGCTTTTGGACTTAAGCAACAATAG CTTCTACGGTGGATTGAGACAGTCGTTTGAAGAAGATGAGTTCCTTAGAAGAAATATCTATCCAGCAACCAATTTGGGGGAGAATCA ATACCATAAACTGGAAAAATCTACAAAA[T->A]TTAGCGATTTTGGATCTTCTTACATGGGCTGTATGGGGAATTCAGATTCAATTATC TGAATTGAAAAGTCTACGGTTTTTGGGACTTAGCCACAACAATTAACAGGAACCCCTCTCCAAAACCTTGCAAACTGCCATTTGTTA GTGCAATTACTTGTGGAAACAATTTGTCTGGTGACCTTAAATCTCCCAACAGTTTACGGGAAAATGGGAAGGAGATTTGGGGCAT GGGACAATCTAATCTGTGTTACCCCATTTGGAACGTTGGCGGCAAAAAATGCTCCATTTGGTGTGAAGCATGTGAGGAAGAAAAAGA AGAAGAAGTGGTGAATTTGATGAAGAAACCCATCTCCAAGCGAGTTTTGATACAAACAATTTGAAATTTGATGTTTCAAAGGGCTATT CTCTAATTGAAATGAAGAAATTTGGTTGAAATTTGGGGGAACACATTAACGATGGTCTGTTAATCAATATGCTTTTATGA	MRKLFVIMFFVCLGSWRSYAQDSGEAPM EKTEMDSLFSSIQGFVGNWVNGSDLYPD PCGWTPIQGVSCDIFDGLWVYVTSLNIGPT HDNSLACSPNAHFRQQLFQLKHLKTLSTFF NCFVSTKKGKNSVSLPTGEWLKLAGTLES EFRSNSALSGQIPASLGLSKLQSLVLLQN GFVGEIPESFGDLIELKRLVLVAGNSLTGPIT QNLGKSELLILDLSRNSLSGSLPLSLGNL TALLKLDLSENKLSGILPSELGNMGNLTL DLNSNSFYGGRLQSFEMSSLEEILSSNPI GGELNTINWKNLQ[N->K]LAILDLSYML YGEIPDLSSELKSLRFLGLSHNNLTGTPSP KLANLPFVSAIYLFGNLSDGLKFSQFY GKMGRRFAGAWDNPNLCYPIGLAAKNAP FGVKPCEEEKEEVVKLMKKPISKASFDT NNWNFDVSKGYSLIGNEEFWLKFGVNTL TMVLLINMLL*	23326853	T->A
<i>Csa5M610420.1</i>	ATGGCAAAAATTCCTTCAGTATCCTTTTTTTTCTCCTCTGCAACTTATATGCTTTCTATGGCTTCTTTGAACAATGAAGGCAATGCCCT TTTATCAITCAAGCAATCCATTACTGAAGACCCGAGGGATGCTTAGCAACTGGAATCTTCAGATGAAACCCCATGTAGTTGGAATGG AGTTACATGCAAGATCTAAGAGTTGTTTCTCTTAGTATCTTAGGAAGAACTTAATGGGGTCTTTCTCTCTCTAGGGTTTCTGTCT GAGCTTCGTCTATGTAATCTGAGGAGTAATAAACTCCATGGAACCTTTGCCAGTGGAGCTTTTCAAGCTAATGGAATTCAAAGTTTGGTG CTTTATGGAAATTCCTTCACTGGGTCTGTTCCAAATGAGATTGGTAAGCTTAAAAACCTTCAAATCTTTGATTTGTCACAGAATTCCTTA ATGGGTCATTGCCCTGTTTCCCTTAATGCAATGTACAAGGTTGAGAATCTTGATCTTAGTCAGAAATAATTTACTAATCTCTGCCTAGTGG TTTGGTTCCAGTTTGAATTTCTTGGAAACGTTGGATCTTTCTATAATAAGTTTAAATGGTCAATTCCAATGGATATGGTAATTTGTCTAG CTTACAAGGCACTGTTGATTTCTCACATAATTTGTTTTCTGGCTCTATCCACCCAGCCTGGGCAACCTTCCGAAAAAGGTTTATATTGAT CTTACTTATAATAATTTGAGTGGTCAATACCCAAAATGGTGTCTTATGAACAGAGGACCAACTGCTTTTATTGGGAATCTTGGCCTTT GTGGACCGCCTTGAAGAACCATGTTCTTCCGAACTCCGGGTGCGAGTTTCTCCGTCTCATTCCTTTTTTCCCGGACAATATCCCGC CTGGGAGTTCTGAGGGTAATGGTCAATAAGTTTGAACAAGGTTGGTTGAGTAGGAGCACTTAGTTGCAATAATCATAGGCGACATTGTA GGTATTGGCTCATCGGTTTGTCTTTTCTGATTGCTATTGAGGTTTGCACCTATAGAATGGGAAGAAGGCAGACCAATCTAGTTATG GATTTGAGAAGGGTGAGAAAGGAAGAAAGGATTGCTCTGCTTTCAAAGAGAGTGAATCTGAGAACGTTTCAGAGCATATCGAGCAAGTT TGATTTGGTACCCTGGATTCAACAAGTGACATTTGATCTTGACGAACTTCTCAAAGGCATCAGCAATTTGTTTTGGGAAAAAGTGGTATCGG GATCGTGTATAAAGTCGTGCTTGAAGATGGACTCACTTTAGCTGTGAGAAGATTGGGTGAAGGTGGTTCTCAAAGATTAAGAAATTTT AACTGAAGTTGAAGCAATTTGGAGGTTGAGGATCCAAATGTTGTTAGCCTTAGAGCATATTTGGTCTGTTGATAGAAAACCTGCTTA TTTACGATACATCCCAATGGGAACCTTGCATCTGCCGTTGATGGGAAGCCGGAACAACGTCGTTTACACCTTACCATGGTCTGTTCT GGTTTGAATCATGA[T->C]AGGCATTGCAAAAAGGTTGGTTTACTTGCACGAGTATAGCCCCAAAAAGTACGTTTATGGTAATTTGAAA ACAAACAACATACTTCTGGACACGACATGACACCAAAAATTTCTAATTTCCGGGTAGCCCGCTTGTAAACATTGCTGGAGGATCACC AACCGTCAATCGAGCCATATAGCAGAGGAAAAATCACAAAGAAACAACCTGAAGTCTGCCACCTCTGAAGCTAGTACATTCAGTTCT AGTATGAGTACTTACTACCAAGCCCTGAAGCGTTGAAAAGTCTGGAAGCCATCACAGAAATGGGACGTTTACTCATATGGTGTGATATTA CTCGAAATGATACCCGGAAGATTGCCATAGTTCAAGTGGGAACGTCAGAAATGGATCTTGTTCATAGGATCAACTCTGCATGAAAGA AAAGAAAGCCGCTTTCAGACGTAATAGACCCGTCATTGGCTCCAGACGACGATGCTGACGAGGATCATAGCGGTTTTGAAGATAGCAT TAGCTTGTGTTCAAAAATCCAGAAAGAAGACCTGCAATGAGGCATGTTTGTGATGCTTTGGGCAAGTTGGCTGTCACTCCAACTAA	MAKIPSVSFFLLCNLLCLSMASLNNEGN ALLSFKQSIDEDPEGCLSNWNSDETPCS WNGVTKCDLDRVVSLSPRKKLNGVLSL GFLSELRHVNLRSNKLHGTLPVELFQANG IQSLVLYGNSFTGVSVPNEIGLKNLQIFDL SQNFLNGSLPVSLMQCRLRILDLSQNNF TNSLPSGFGSSLNLETLDLSYNKFN MDIGNLSSLQGTVDVDFSHNLFSGSIPPSLGN LPEKVYIDLTYNNLSGIPQNGALMNRGP TAFIGNPGLCGPPLKNPCSETPGASSPSS PFFPDNYPPGSSENGHFKFDKGLSRSTL VAHIGDIVGICLIGLLFSYCYSRFCTHRNG KKADQSSYGFEKGEKGRKDCLCFQKSES ENVSEHIEQFDLVPDLSQVTFDLDELLKA SAFVLGKSGIGIVYKVVLEDGLTAVRRL GEGGSQRLKEFQTEVEAIGRLRHPNVSL RAYYWSVDEKLLIYDIPNGNLASAVHG KPGTTSFTPLPWSVRFGM[I->T]GIAGKGLV YLHEYSPPKYVHGNLKTNNILLGHDMP KISNFGLARLVNIAGGSPTVQSSHIAEKS QEKQLKATSEASTFSSMSTYYQAPEAL KVVKPSQKWDVYSYGVILLEMITGRLPIV QVGTSEMDLVQWQLCIEKKPLSDVIDP SLAPDDDADEIILAVLKIALACVQNNPERR PAMRHVCDALGKLAIVTPN*	23758300	T->C

