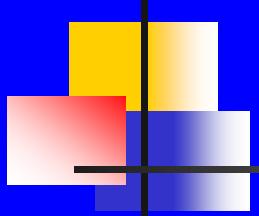


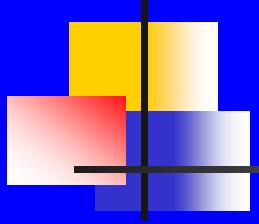
QTL analysis for protein and gossypol contents in upland cottonseeds with two different genetic systems across environments

Zhu Shuijin
Zhejiang University, Hangzhou
E-mail: shjzhu@zju.edu.cn

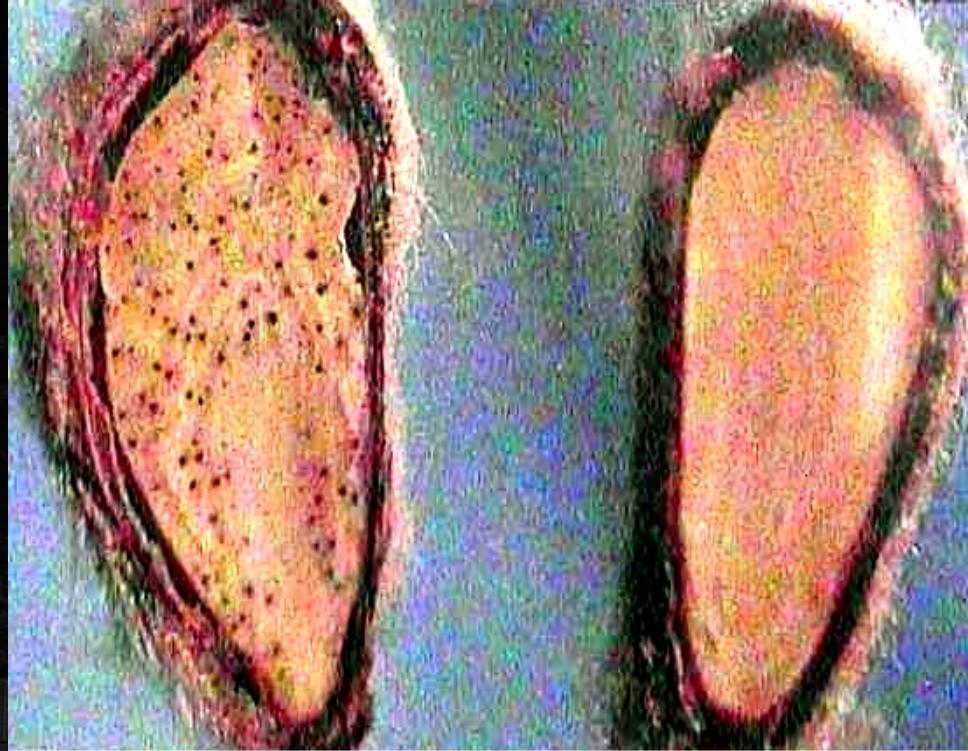


Contents

- 1. Cotton seeds and they utilization**
- 2. Analysis for cottonseed qualities**
- 3. Population for QTL mapping**
- 4. QTL mapping of protein contents**
- 5. QTL mapping of gossypol contents**



Cotton seeds and they utilization



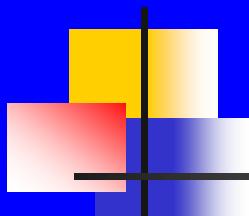
Cotton:

Fiber: main products

Fuzz: by-product

Hull: by-product

Kernel: by-product



Kernels



Utilization of cotton oil

棉籽油



Utilization of cotton oil

风制

杭州昆仑特种

A

涂料

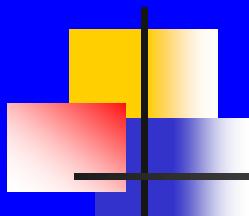


Utilization of cotton oil



全球医院网
QQYY.com



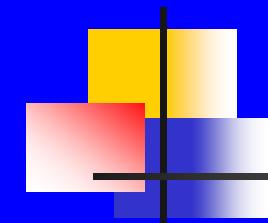


Utilization of cotton cake

Gossypol content in the feeds

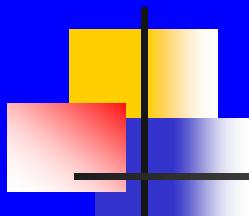
Cake types	Cotton cake in the feeds (%)						
	0	10	20	30	40	50	100
$G_{1_2}G_{1_3}$	0	0. 0976	0. 1952	0. 2927	0. 3903	0. 4879	0.988
$g_{1_2}g_{1_3}$	0	0. 0001	0. 0002	0. 0003	0. 0004	0. 0005	0. 001
GL_2^e	0	0. 0001	0. 0002	0. 0003	0. 0004	0. 0005	0. 001
$g_{1_2}g_{1_3}F_1$	0	0. 0558	0. 1116	0. 1674	0. 2232	0. 2790	0. 565
$g_{1_2}g_{1_3}F_2$	0	0. 0268	0. 0535	0. 0803	0. 1071	0. 1338	0. 271
$GL_2^eF_1$	0	0. 0002	0. 0003	0. 0005	0. 0006	0. 0008	0. 002
$GL_2^eF_2$	0	0. 0084	0. 0168	0. 0252	0. 0336	0. 0420	0. 085

Utilization of gossypol





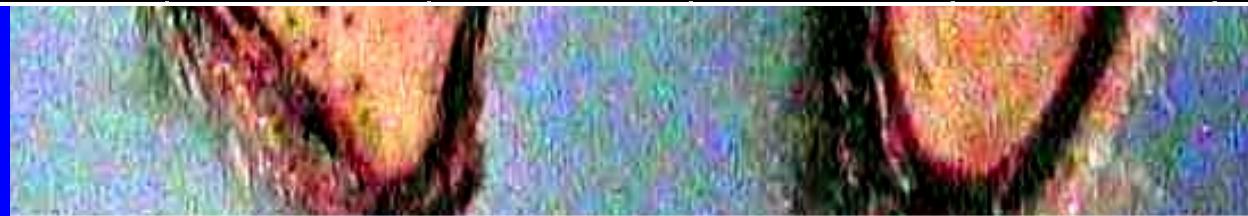


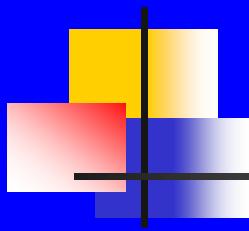


The composition of cottonseeds



Species	Hull	Kernel	Protein	Oil	gossypol
<i>G.hirsutum</i>	38.2	51.8	37.64	35.14	0.98
<i>G.bardadense</i>	40.3	58.7	35.6	31.18	1.14
<i>G.arboreum</i>	45.4	49.5	33.33	35.15	1.15
<i>G.herbicium</i>	46.5	49	35.51	33.27	1.04

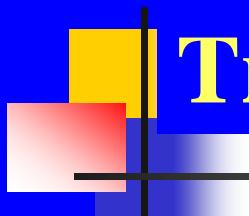




Analysis for cottonseed qualities

Traditional methods





Traditional methods

Advantages

Accuracy and sensitivity

Disadvantages

Expensive

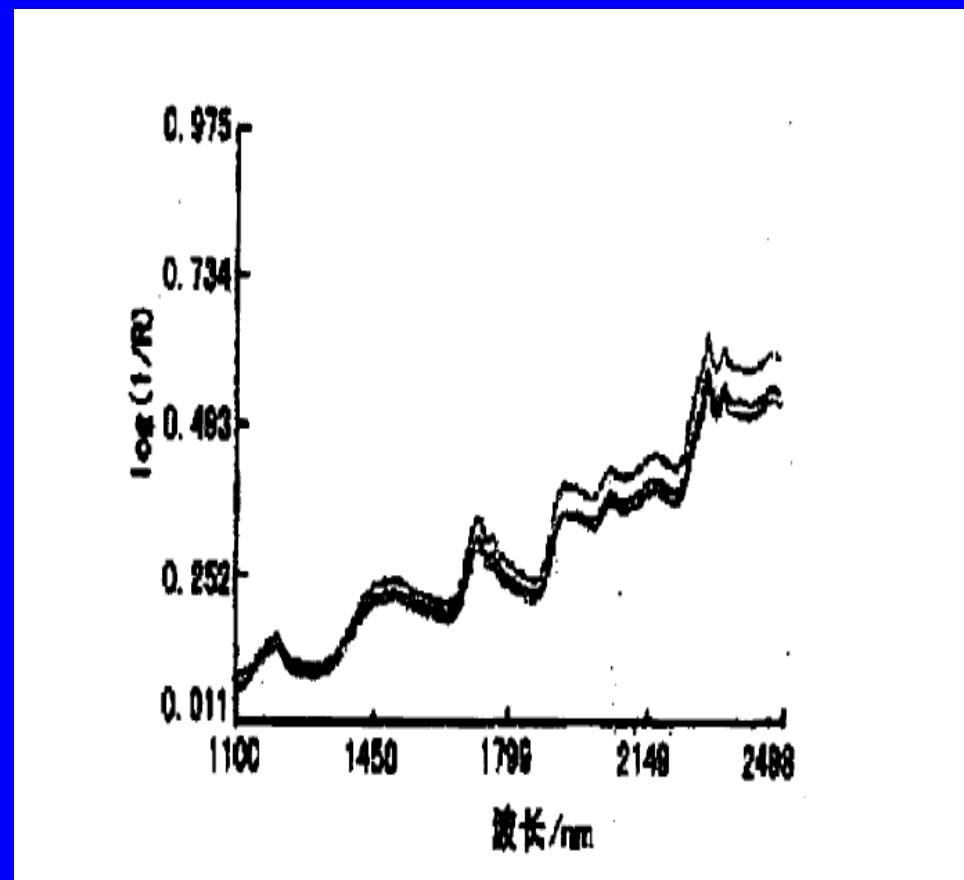
Labor and time consuming

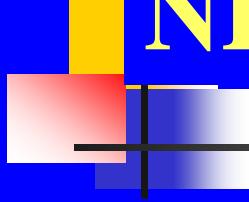
Destructive

...

Limitation in Breeding for cottonseed improvement

Spectral analysis, near infrared reflection (NIR) spectroscopy





NIR method

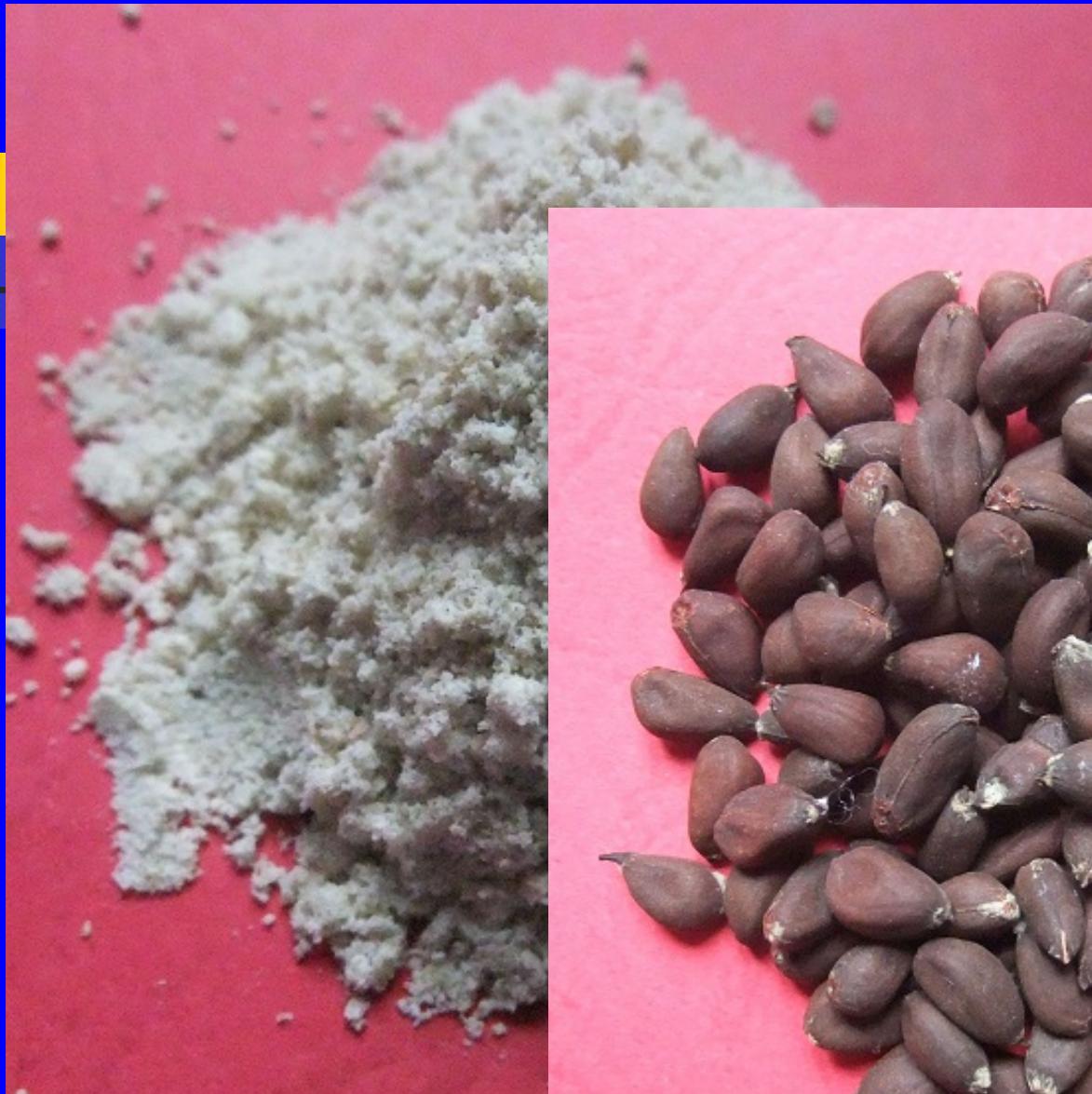
Advantages:

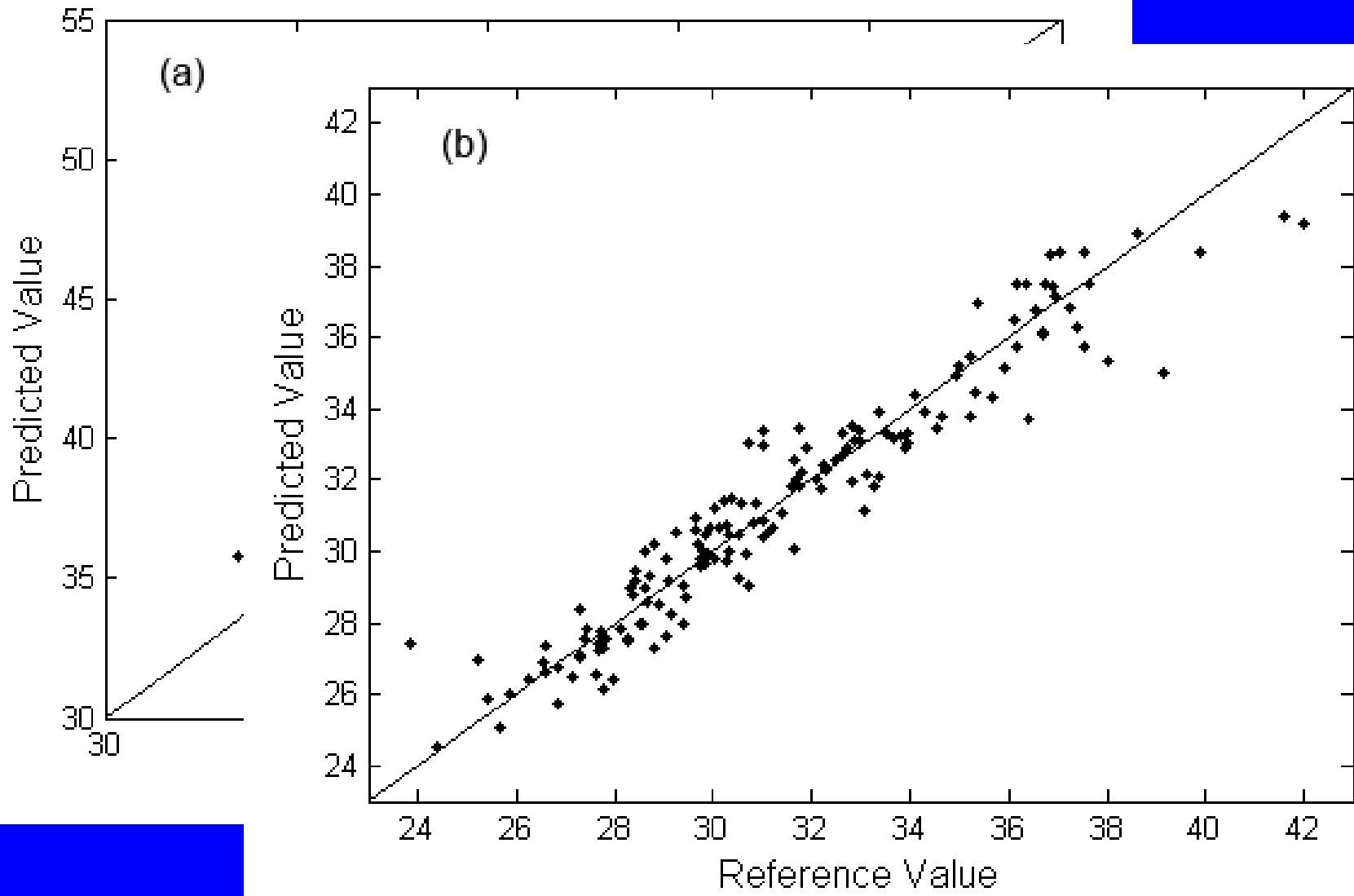
Determination at same time

Cheap and fast

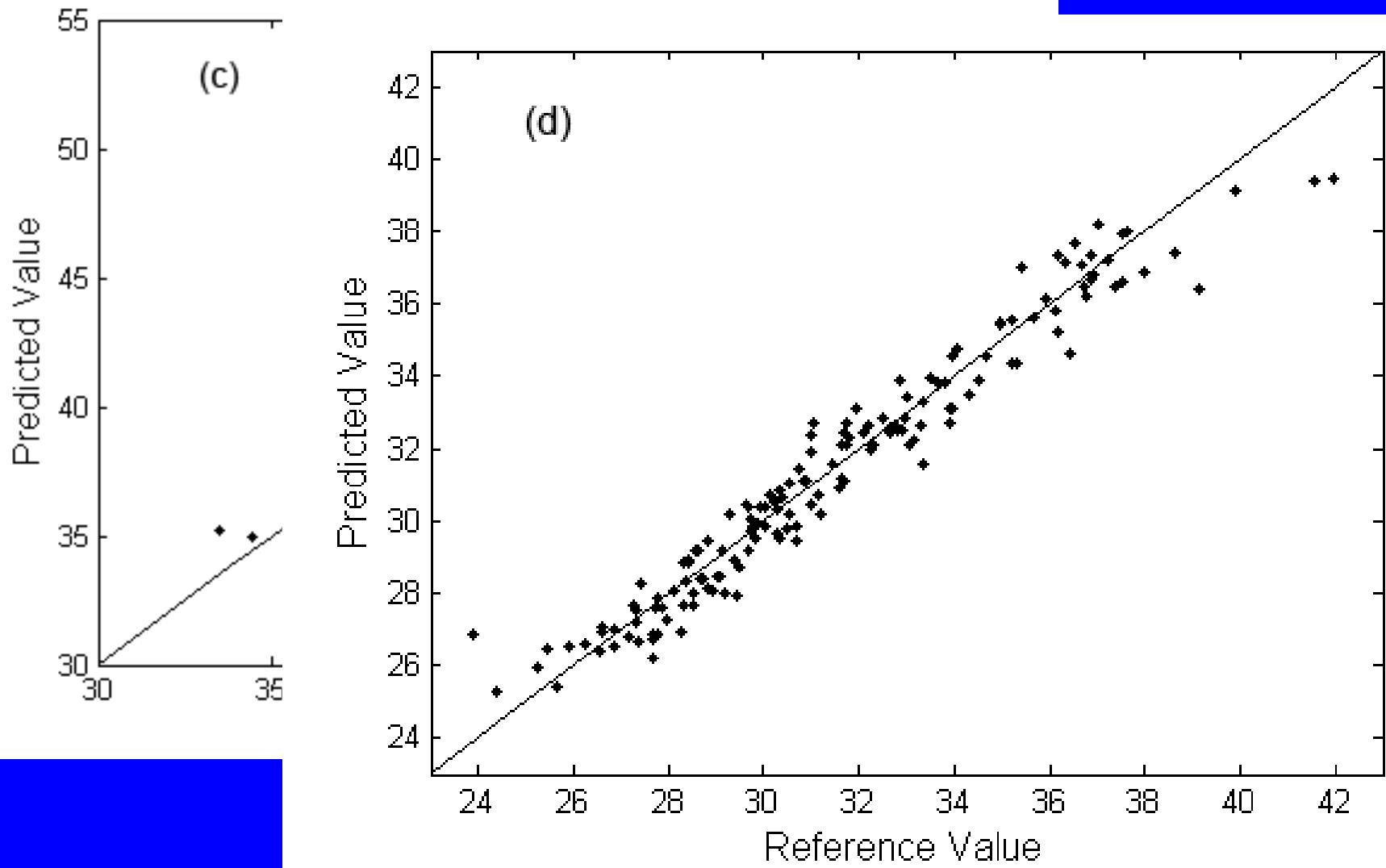
without environmental problems

...

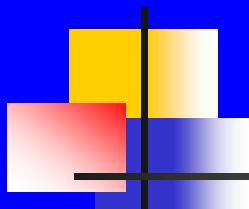




Reference values vs predicted values
classical calibration models



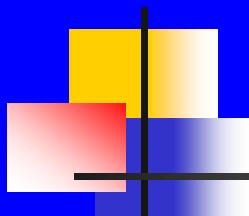
**Reference values vs predicted values
calibration models**



Parameters of protein and oil contents in intact cottonseeds

Comps	samples	RMSECV	RESEP	R ²	RPD
Protein	48	1.133	0.977	0.959	4.871
Oil	77	0.845	0.834	0.950	4.429

(Huang et al. Industrial Crops and Products, 2013)



Evaluation of amino acid contents in cottonseeds

12 amino acids, such as lysine etc:

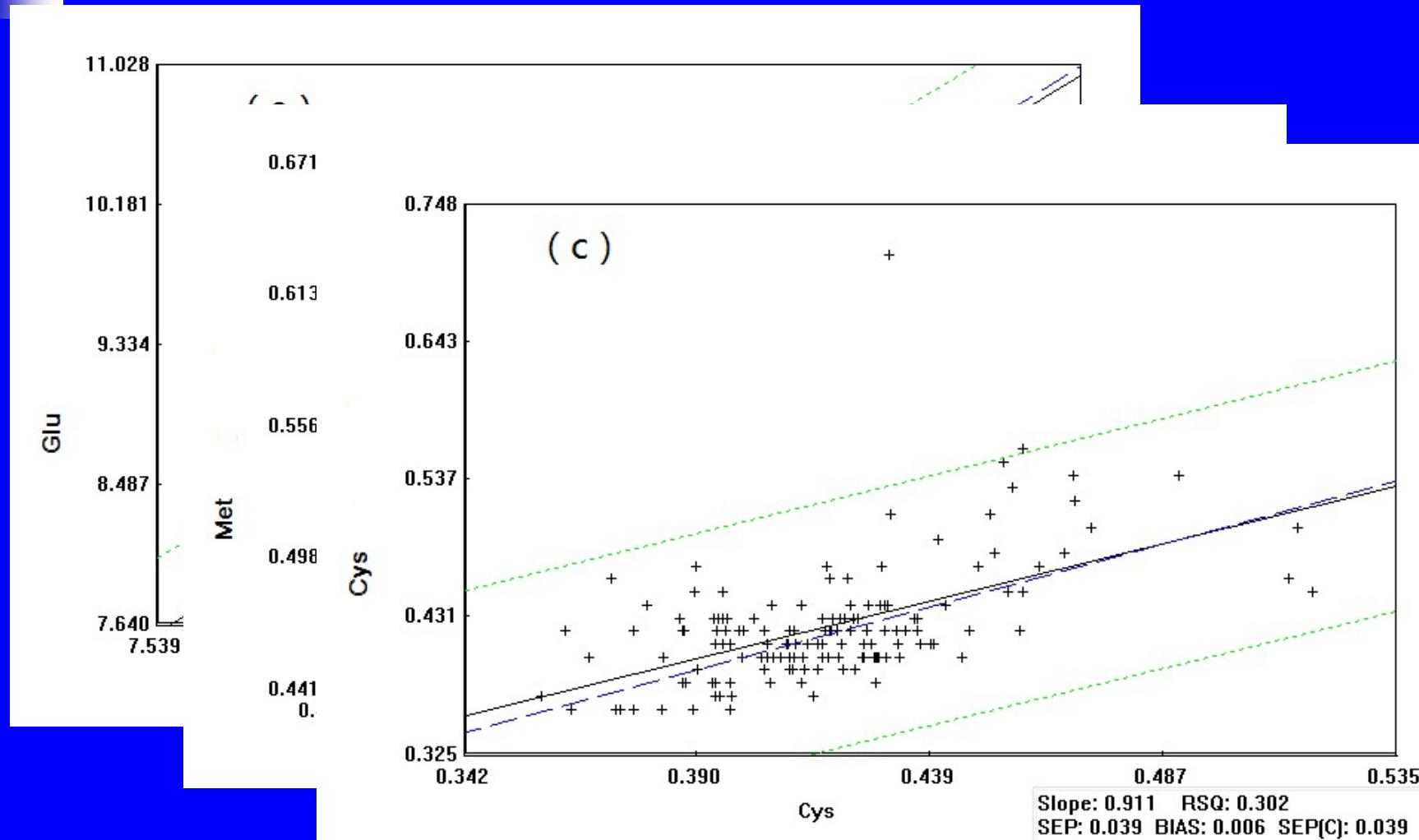
$$R^2=0.910\sim0.979$$

4 amino acid, such as serine etc:

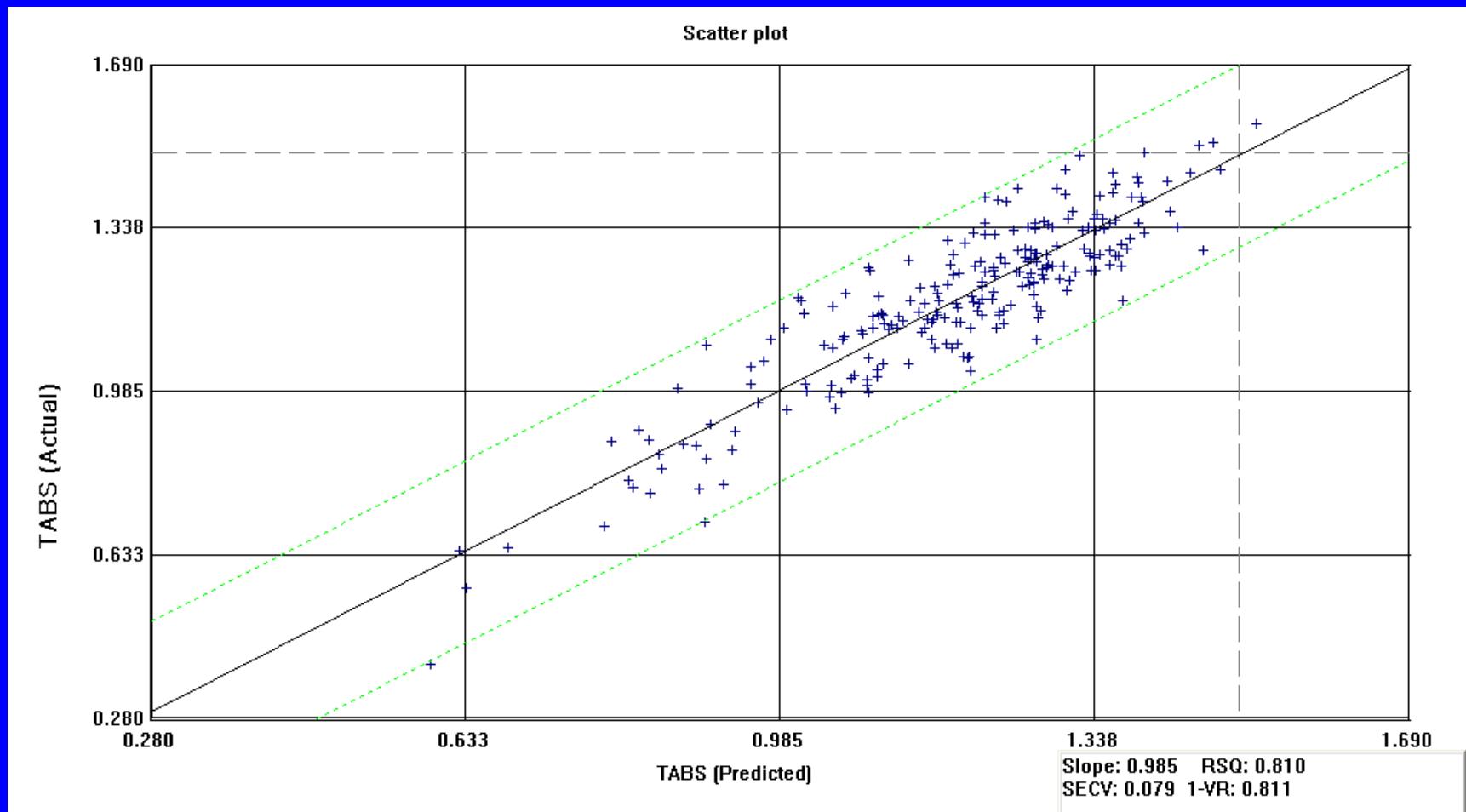
$$R^2=0.800\sim0.830$$

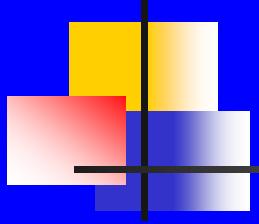
R² of cysteine was only 0.438

Evaluation of amino acid contents in cottonseeds

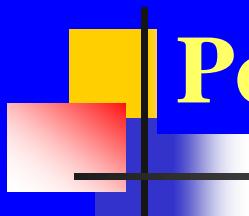


Evaluation of gossypol contents in cottonseeds



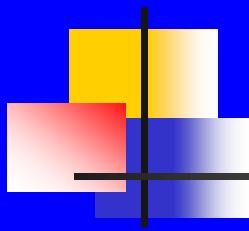


Population for QTL mapping of cottonseed qualities



Population of mapping

Year	Traits	IF ₂						Parents	
		Mean	S.D	Max	Min	Skew	Kurt	HS46	MAR
2009	OC (%)	33.07	1.51	38.44	28.68	0.29	0.82	31.01a	31.49b
	PC (%)	33.87	1.89	38.32	28.56	-0.15	-0.33	35.01a	34.02b
	GC (%)	0.94	0.17	1.48	0.56	0.41	-0.07	1.08a	0.97b
2010	OC (%)	30.43	0.9	33.34	27.8	-0.03	0.32	29.70A	30.69B
	PC (%)	34.25	0.92	36.79	31.23	-0.08	0.09	35.07a	33.53b
	GC (%)	1.27	0.1	1.56	0.97	0.04	0.15	1.27a	1.33b

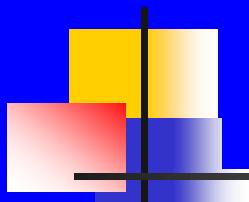


QTL mapping of protein contents in cottonseed

QTL mapping of protein contents (two years separate analysis)

Year	QTL	Lg	Flanking markers	Position	Range
2009	<i>qPC-22-1</i>	chr22	BNL4030b(c22)-JESPR50(c22)	35.6	31.6-35.6
	<i>qPC-25</i>	chr25	BNL3655-BNL1015	3.5	1.4-6.2
	<i>qPC-LG3-1</i>	lg3	NAU5146c-RAPD-I10-620	51.4	47.6-60.4
2010	<i>qPC-6</i>	chr6	NAU1151(c6,c12)-CIR203(c6)	122.7	119.8-124.7
	<i>qPC-15</i>	chr15	BNL786(c15)-CIR311(15)	30.2	28.4-31.2
	<i>qPC-LG5</i>	lg5	DPL212*-NAU3551b	34.3	31.3-35.5
	<i>qPC-LG7</i>	lg7	TMB1791-TMC10	4.8	3.0-6.8

Year	QTL	a^e	d^e	a^m	$H^2(a^e)$	$H^2(d^e)$	$H^2(a^m)$
2009	<i>qPC-22-1</i>	-0.3392**	0.3398**	0.0947	0.0284	0.0057	0
	<i>qPC-25</i>	0.7088**	0.4599**	-0.5457**	0.1241	0.0105	0.0294
	<i>qPC-LG3-1</i>	0.3834**	0.1313	0.0123	0.0363	0	0
2010	<i>qPC-6</i>	-0.034	-0.1055*	0.1576**	0	0.0022	0.0096
	<i>qPC-15</i>	0.0354	-0.1467*	-0.1349**	0	0.0042	0.007
	<i>qPC-LG5</i>	-0.4549**	-0.053	0.3318**	0.2002	0	0.0426
	<i>qPC-LG7</i>	-0.3785**	0.0573	0.2514**	0.1386	0	0.0245



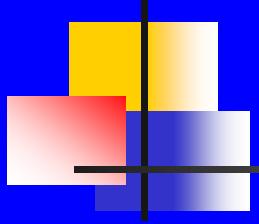
QTL mapping of protein contents (two years jointed analysis)

QTL	Lg	Interval	Position	Range
<i>qPC-22-2</i>	chr22	CIR253-JESPR65	0	0.0-3.0
<i>qPC-25</i>	chr25	BNL3655-BNL1015	3.5	2.5-6.2
<i>qPC-LG3-2</i>	lg3	NAU5045-NAU5146c	50.6	47.6-60.4
<i>qPC-lG5</i>	lg5	DPL212-NAU3551b	34.3	30.3-36.5
<i>qPC-LG6</i>	lg6	NAU5328-170-RAPD-G17-120	25	23.0-27.2
<i>qPC-5</i>	chr5	BNL3992(c5)-TMB1667	100.1	98.1-102.1

QTL mapping of protein contents (two years jointed analysis)

QTL	a^e	d^e	a^m	a^eE_1	d^eE_1	a^mE_1	a^eE_2
<i>qPC-22-2</i>	-0.1201**	0.0014	0.0079	-0.0005	0.0111	0.0005	0.1851**
<i>qPC-25</i>	0.3372**	0.1672**	-0.2404**	0.1613*	0.0935	-0.16*	-0.1951**
<i>qPC-LG3-2</i>	0.1863**	0.0521	-0.0008	-0.0734	-0.0003	0.0716	-0.0565
<i>qPC-lG5</i>	-0.3475**	-0.0924	0.2824**	-0.0014	-0.0009	0.0014	-0.0157
<i>qPC-LG6</i>	0.0095	-0.3401**	0.137**	-0.0142	-0.0009	0.0138	-0.0006
<i>qPC-5</i>	-0.5238**	1.703**	0.2071*	0.0001	0.5196**	-0.0001	0.102

QTL	d^eE_2	a^mE_2	$H^2(a^e)$	$H^2(d^e)$	$H^2(a^m)$	H^2
<i>qPC-22-2</i>	-0.011	-0.1889**	0.0066	0	0	0.0227
<i>qPC-25</i>	-0.0949	0.213**	0.0523	0.0026	0.0106	0.0894
<i>qPC-LG3-2</i>	0.0003	0.0578	0.016	0	0	0.016
<i>qPC-lG5</i>	0.0009	0.016	0.0555	0	0.0147	0.0702
<i>qPC-LG6</i>	0.0009	0.0006	0	0.0106	0.0035	0.0141
<i>qPC-5</i>	-0.5001**	-0.0975	0.1077	0.2278	0.0067	0.3728

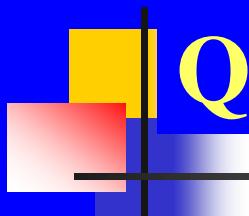


QTL mapping of gossypol contents in cottonseed

QTL mapping of gossypol contents (two years separate analysis)

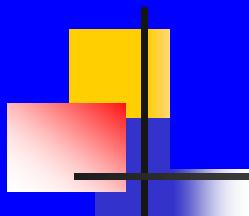
Year	QTL	Lg	Flanking markers	Position	Range
2009	<i>qGC-22</i>	chr22	CIR253-JESPR65	0	0.0-4.0
	<i>qGC-LG6</i>	lg6	NAU1222*-NAU456	14.9	13.9-15.9
2010	<i>qGC-3</i>	chr3	MGHES67-BNL2496(c17)	13.7	11.3-16.7
	<i>qGC-LG5</i>	lg5	DPL79-NAU4072	12.9	9.8-15.9
	<i>qGc-LG10</i>	lg10	RAPD-H20-240-RAPD-H19-650	7.6	6.7-8.6

Year	QTL	a^e	d^e	a^m	$H^2(a^e)$	$H^2(d^e)$	$H^2(a^m)$
2009	<i>qGC-22</i>	0.0363**	0.0023	-0.0161**	0.0449	0	0.0035
	<i>qGC-LG6</i>	-0.0816**	-0.0381**	0.0519**	0.2266	0.0099	0.0367
2010	<i>qGC-3</i>	0.0228**	-0.0026	-0.0094*	0.054	0	0.0037
	<i>qGC-LG5</i>	-0.0066*	-0.009	-0.0139**	0.0046	0	0.008
	<i>qGc-LG10</i>	0.0048	-0.0267**	-0.0179**	0	0.0149	0.0134



QTL mapping of gossypol contents

Year	QTL	Lg	Flanking markers	Position	Range
2009	<i>qGC-22</i>	chr22	CIR253-JESPR65	0	0.0-4.0
	<i>qGC-LG6</i>	lg6	NAU1222*-NAU456	14.9	13.9-15.9
2010	<i>qGC-3</i>	chr3	MGHES67-BNL2496(c17)	13.7	11.3-16.7
	<i>qGC-LG5</i>	lg5	DPL79-NAU4072	12.9	9.8-15.9
	<i>qGc-LG10</i>	lg10	RAPD-H20-240-RAPD-H19-650	7.6	6.7-8.6



QTL mapping of gossypol contents (two years jointed analysis)

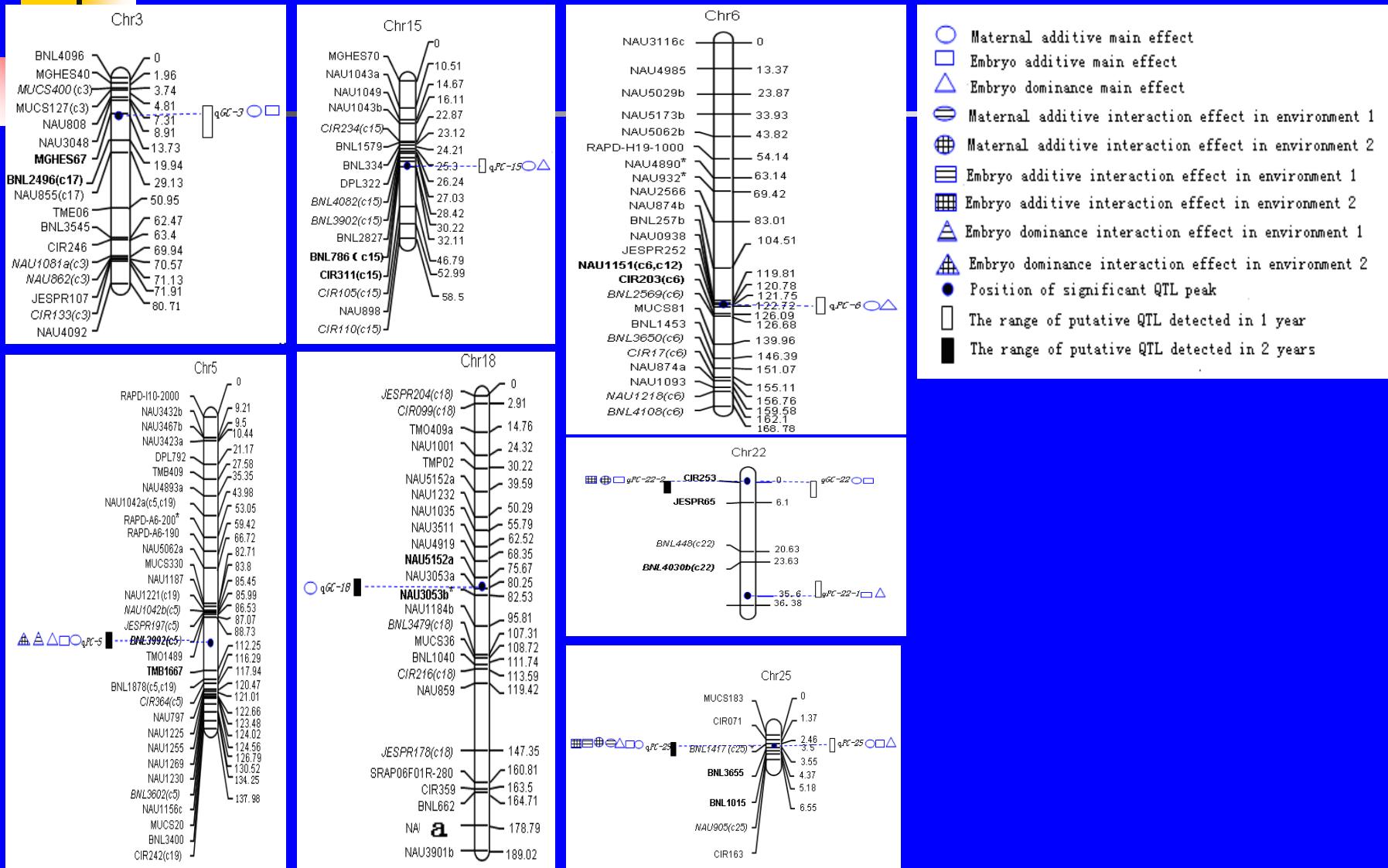
QTL	Lg	Interval	Position	Range
<i>qGC-LG2</i>	lg2	NAU5033-NAU4981b	86.3	85.3-90.5
<i>qGC-LG3</i>	lg3	NAU5146-RAPD-I10-620	63.4	58.4-66.4
<i>qGC-18</i>	chr18	NAU5152a-NAU3053b	78.7	77.7-82.2
<i>qGC-LG4</i>	lg4	TM0409B-NAU4975a	44.3	42.2-46.3
<i>qGC-LG12</i>	lg12	TMB1919a-NAU3590	9.6	7.8-11.6

QTL mapping of gossypol contents (two years jointed analysis)

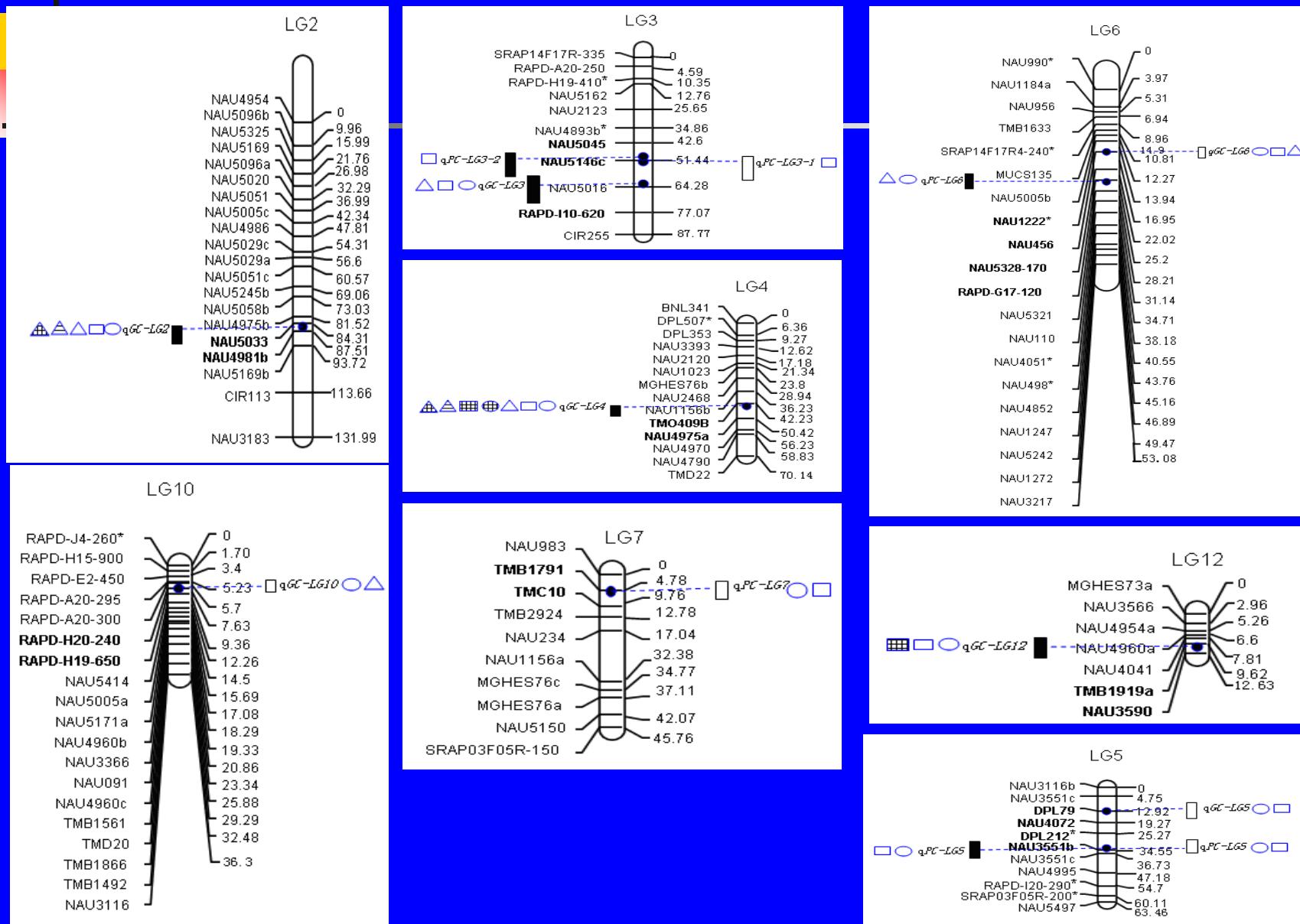
QTL	a^e	d^e	a^m	a^eE_1	d^eE_1	a^mE_1	a^eE_2
<i>qGC-LG2</i>	0.0557**	-0.0737**	-0.0393**	0	-0.0158*	0	-0.0075
<i>qGC-LG3</i>	0.0188**	0.0445**	-0.0273**	0.0013	0.0046	-0.0013	0.0011
<i>qGC-18</i>	0.0062	-0.0017	0.0138**	-0.0001	-0.0041	0.0001	-0.0035
<i>qGC-LG4</i>	-0.0504**	-0.0223*	0.0471**	-0.0104	-0.0258*	0.0103	0.0235**
<i>qGC-LG12</i>	0.0423**	-0.0106	-0.0312**	0.0001	0.0093	0	-0.0075*

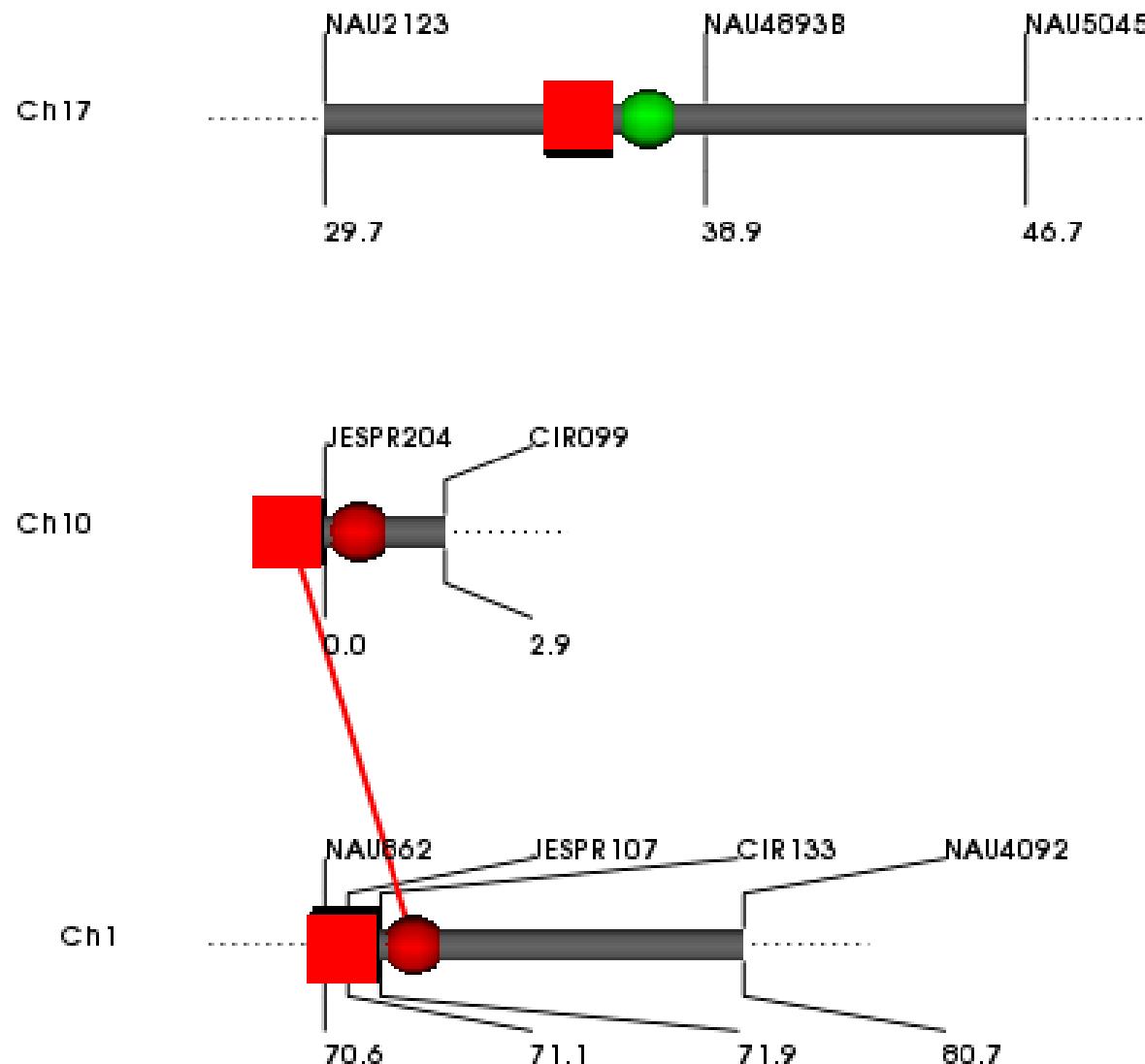
QTL	d^eE_2	a^mE_2	$H^2(a^e)$	$H^2(d^e)$	$H^2(a^m)$	H^2
<i>qGC-LG2</i>	0.0153*	0.0076	0.1736	0.0607	0.0344	0.2727
<i>qGC-LG3</i>	-0.0046	-0.0011	0.0197	0.0221	0.0167	0.0585
<i>qGC-18</i>	0.0041	0.0036	0	0	0.0035	0.0035
<i>qGC-LG4</i>	0.0253**	-0.023**	0.1157	0.0045	0.0405	0.1943
<i>qGC-LG12</i>	-0.0095	0.0074	0.0814	0	0.0178	0.1005

QTL mapping of protein and gossypol

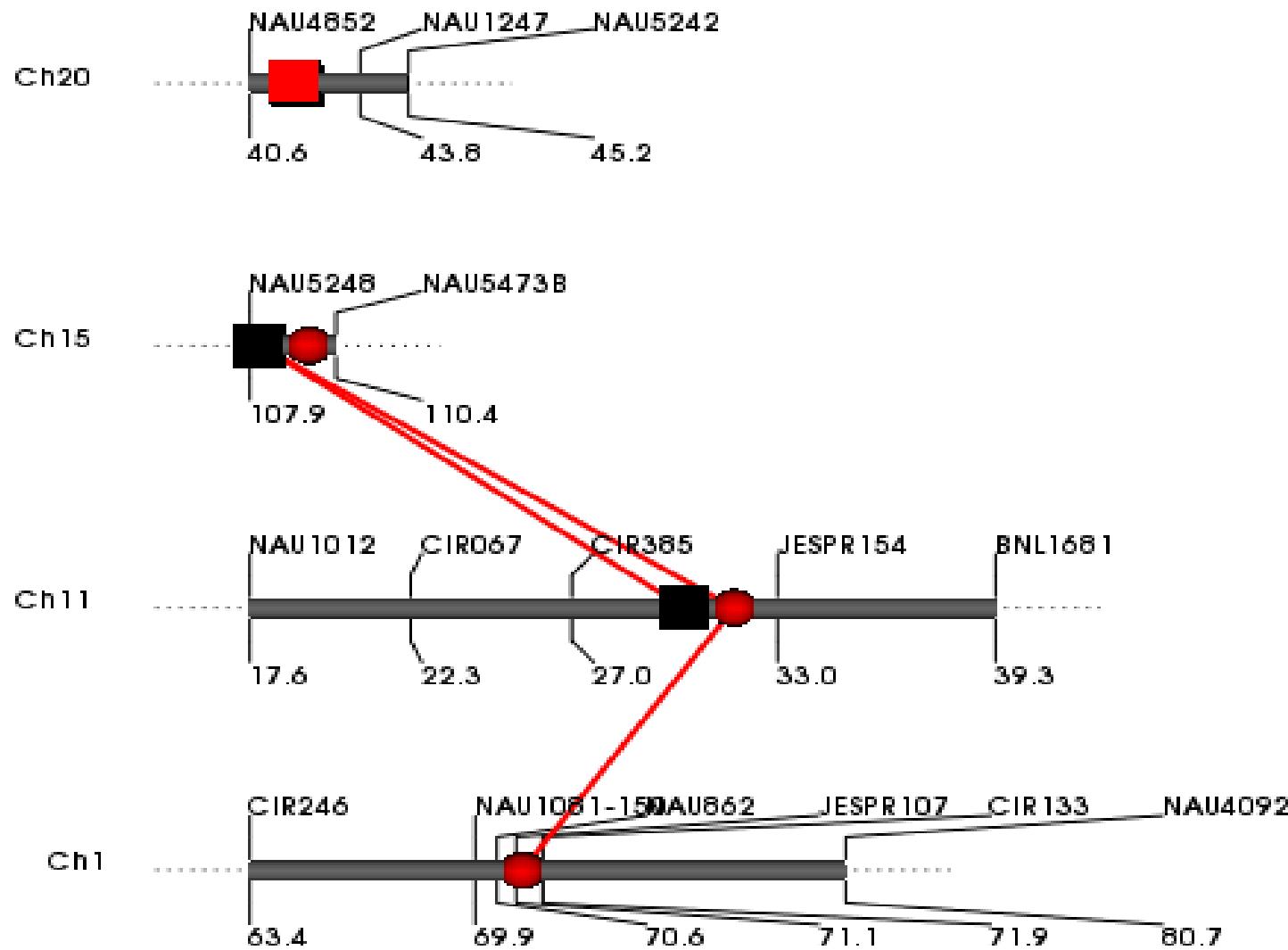


QTL mapping of protein and gossypol

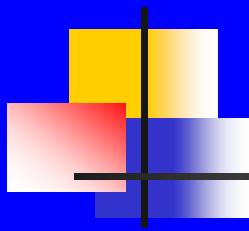




QTL of protein contents in chromosomes



QTL of gossypol contents in chromosomes



Thank you !