

( )

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( // : // : )

DNA

(QTL)

(PHS)

QTL

PHS

QTL

QTL

QTL

QTL

) ( )

QTL (

QTL :

( ) )

( ) (

DNA

)  
( ) ( DNA

QTL ( )

QTL - DNA

QTL ( )

QTL ( ) (SNPs)<sup>۲</sup>

(QTL) SNPs

QTL (PHS) DNA

SNPs

PHS QTL (QTL)<sup>۳</sup>

(IM)<sup>۴</sup> QTL

(ML)<sup>۶</sup> ( )

PHS IM

QTL (Q/q, M/m) QTL ( )

DNA QTL ( )

QTL F<sub>2</sub> ( )

) QTL

QTL ( )

- 
1. Microsatellite
  2. Single nucleotide polymorphisms
  3. Quantitative trait loci
  4. Interval mapping
  5. Marker-bracket
  6. Maximum likelihood

...

	QTL	(r)
α r)	( )	(α) QTL
PHS	QTL	( )
QTL	-----	
QTL	-----	
(M <sub>1</sub> m <sub>1</sub> , Qq, M <sub>2</sub> m <sub>2</sub> )	μ + α	(1-r)/2
M <sub>1</sub> M <sub>2</sub> , )	μ	r/2
(M <sub>1</sub> m <sub>2</sub> , m <sub>1</sub> M <sub>2</sub> , m <sub>1</sub> m <sub>2</sub> )	μ + α	r/2
	μ	(1-r)/2
	=r	= μ
		= α

(Q) QTL

$$P(Q | m_i m_j) = \frac{P(m_i Q m_j)}{P(m_i m_j)}$$

( m M )

Q	P(Q m <sub>i</sub> m <sub>j</sub> )	M
m <sub>i</sub> Qm <sub>j</sub>	P(m <sub>i</sub> Qm <sub>j</sub> )	= μ + α(1-r)
		= μ + αr
		:
m <sub>i</sub> m <sub>j</sub>	P(m <sub>i</sub> m <sub>j</sub> )	$\bar{y}_M - \bar{y}_m = (1-2r)\alpha$

(r)

(r)

(r)

QTL

QTL

( )

QTL

(m M)

( ) QTL

( )

( )

F

QTL

( α r )

QTL

QTL

QTL

QTL

QTL

QTL

p

$$) / <p < /$$

(

$$(pq = \times / \times / = / ) / (h)$$

s

QTL

(h)<sup>s</sup>

/

$$h = /$$

QTL

(Q) QTL

cM	cM		
$r = /$	$r = /$		
$r = /$	$r = /$		
$r_2 = /$	$r_2 = /$		
$/$	$/$	$(1-r_1)(1-r_2) / (1-r_{12})$	P(Q M1M2)
$/$	$/$	$(1-r_1)r_2 / r_{12}$	P(Q M1m2)
$/$	$/$	$r_1(1-r_2) / r_{12}$	P(Q m1M2)
$/$	$/$	$r_1r_2 / (1-r_{12})$	P(Q m1m2)

( )

QTL

$$= r \quad r$$

$$= r$$

QTL

QTL

( )

D

$\sigma$

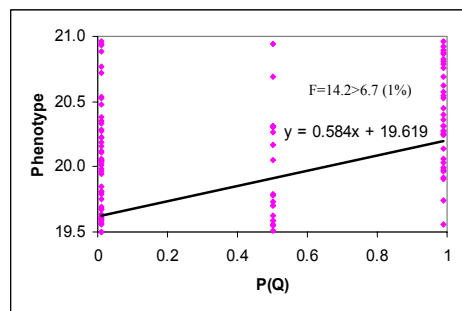
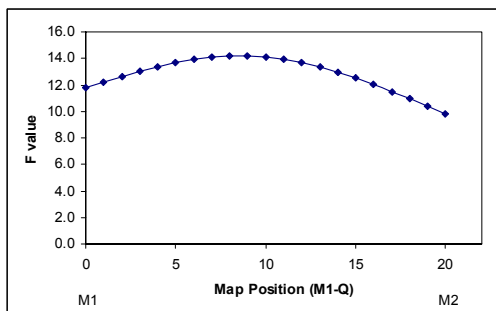
n/

$$Var(D) = \frac{2\sigma^2}{n/2} = \frac{4\sigma^2}{n}$$

:

t

$$\frac{D}{(2\sigma/\sqrt{n})}$$



( )

F

.Q

( )

QTL

( $\alpha$ )

IM

( ) ML

( QTL )

(QTL )

(LR)'

(LOD)'

IM

$y_{ij} = \mu + \alpha X + e_{ij}$

(

$\gamma = 1 - (1 - \alpha)^n$

QTL

(n)

$P(Q | m_1, m_2, r_1, r_2)$

$X$

$e_{ij}$

( )

( )

( )

QTL

QTL

QTL

( $SS_E$ )

QTL

QTL

QTL

LR

F

LR

LR =  $n \ln(RSS_f / RSS_r)$

(

RSS<sub>r</sub>

RSS<sub>f</sub>

QTL

QTL

SS<sub>E</sub>

LR

F

LR

(

RSS<sub>r</sub>

RSS<sub>f</sub>

QTL

QTL

- 
- 3. Multiple testing
  - 4. Permutation test
  - 5. Empirical test

- 
- 1. Likelihood ratio
  - 2. Logarithm of the odds

( ) QTL ( ) QTL

N N QTL

( × ) QTL

( ) QTL

( ) QTL

( ) QTL

/ SD= ) QTL QTL

( / SD= / SD= (

QTL QTL ( / SD= )

y ( ) QTL

( ) QTL ( / SD)

QTL ( )

QTL  
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 QTL  
 (

QTL

QTL	
$\alpha = /$	$\alpha = /$
/	/
/	/
/	/

( ) QTL ( )  
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QTL				QTL			
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/	/	/	/	/	/	/	/
/	/	/	/	/	/	/	/
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= QTL  
 = / SD=

cM cM  
 ) QTL  
 ( )  
 QTL

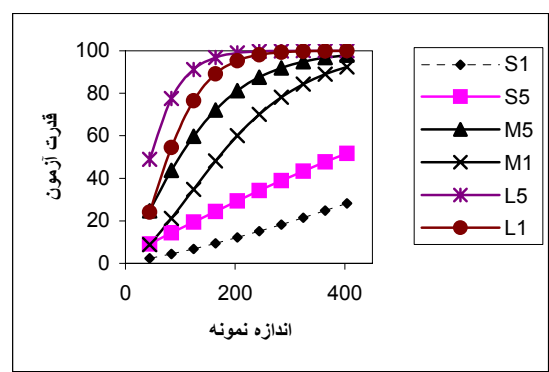
QTL

QTL  
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QTL  
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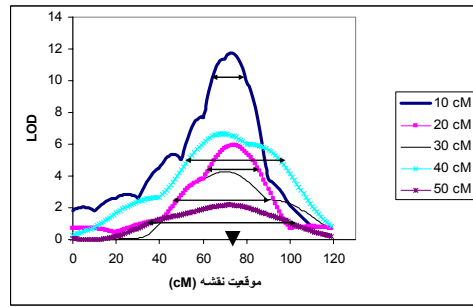
QTL  
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 QTL  
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QTL

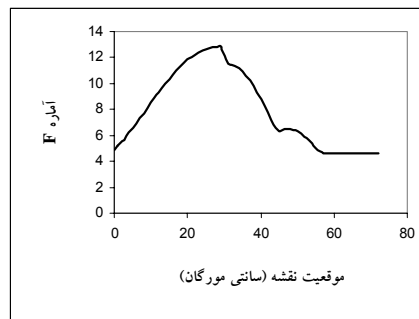
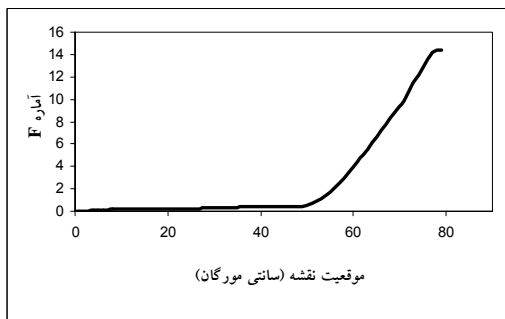


QTL  
 QTL S5.QTL  
 QTL S1 %  
 M1 % QTL M5 %  
 QTL L5 % QTL L1 %  
 .%

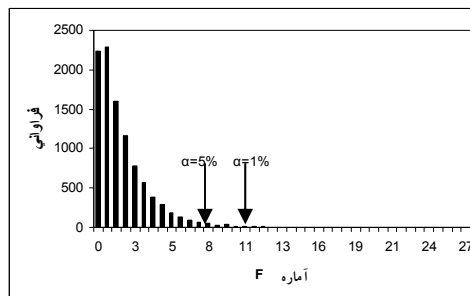
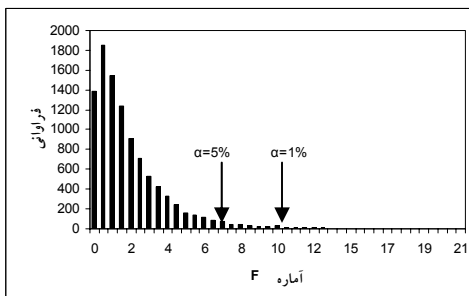
IC  
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.QTL  
 ↔ ↓  
 . QTL QTL  
 QTL  
 QTL  
 F  
 ( )  
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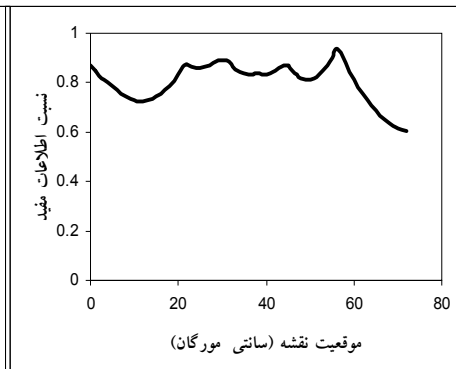
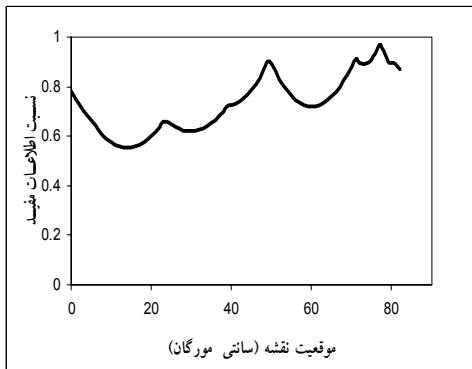
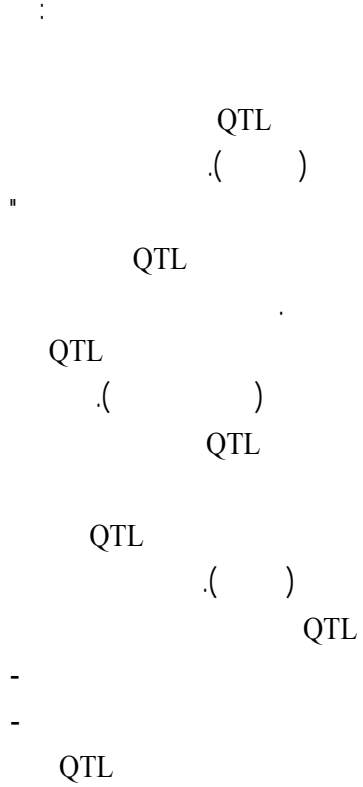
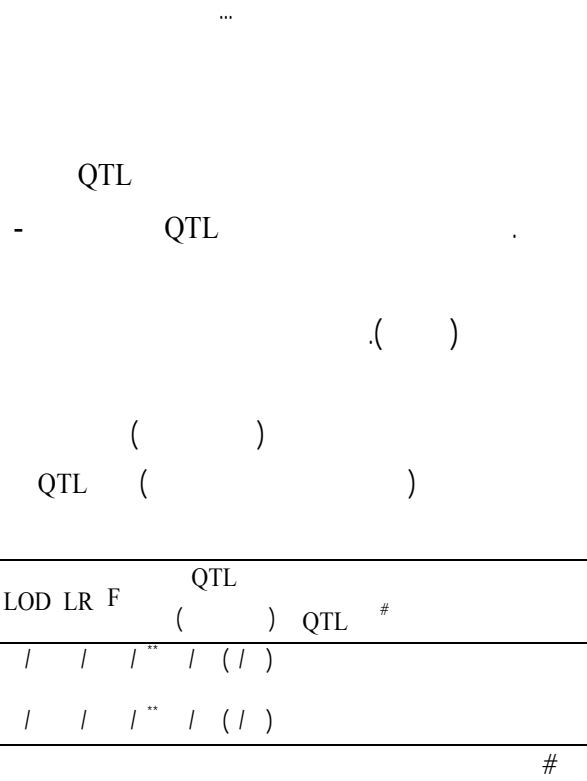


( )  
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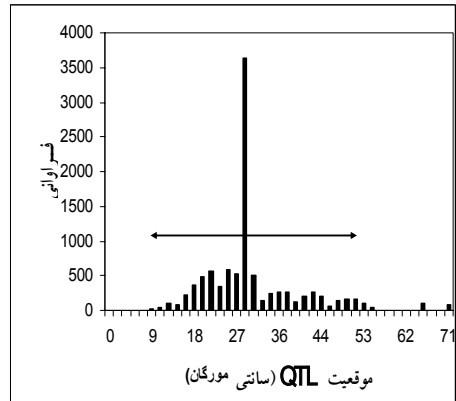
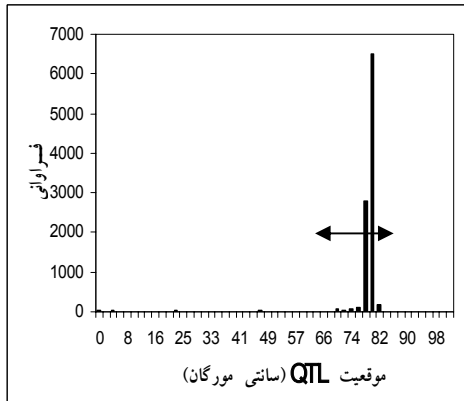


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( )

QTL



QTL

QTL ( ) ( )

QTL ( )

( ) ( ) QTL

QTL Myc

QTL ( ) ( )

( ) ( )

QTL ( )

) QTL ML

(<http://qtl.cap.ed.ac.uk>)

(<http://www.genenetwork.org>) QTL

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