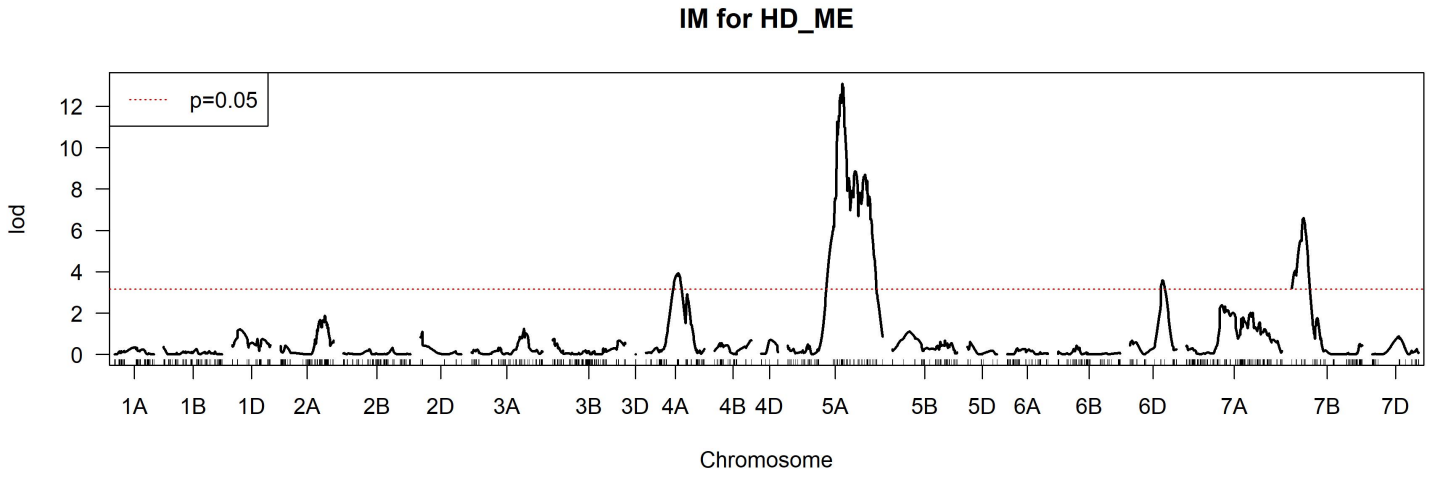
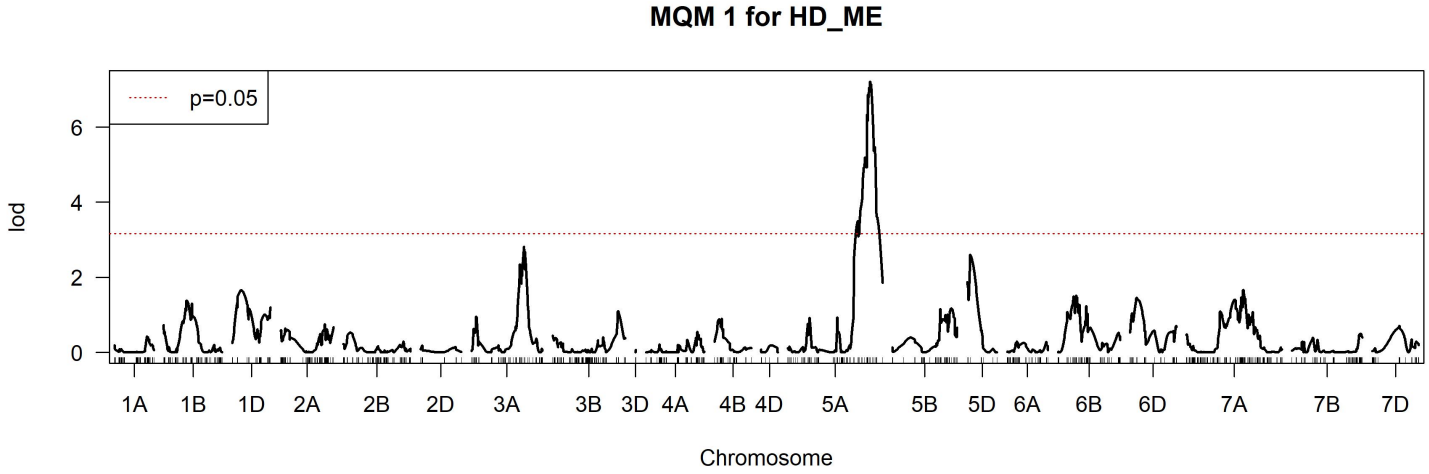
Supplemental Information 3

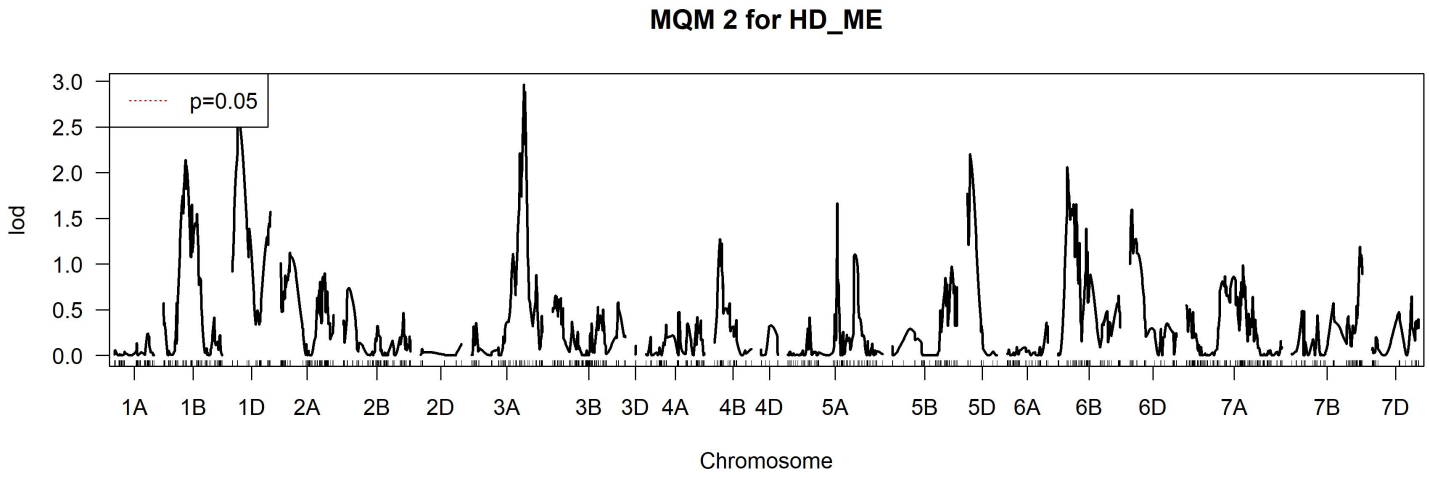
Description

Interval mapping (IM) and multiple quantitative-trait-locus mapping (MQM) scans for heading date (HD) and plant height (PH), Fusarium head blight (FHB) visual ratings (VR), Fusarium-damaged kernels (FDK), and deoxynivalenol (DON) quantitative trait loci (QTL). Presented are the results of scans performed without heading date and plant height marker covariates. In the title of each graph appears the type of scan (IM vs MQM) and the trait which the scan belongs to. Environments assessed include: Kinston, NC 2019 (KIN19) and 2020 (KIN20); Raleigh, NC 2019 (RAL19) and 2020 (RAL20); Warsaw, VA 2019 (WAR19) and 2020 (WAR20); and multi-environment (ME). The number following MQM titles indicates which round of MQM the scan belongs to (e.g., MQM 2 is the second round of multiple QTL mapping). The y-axis displays the likelihood of odds (LOD) score of every position across the genome. The dotted line denotes the 1,000-permutation significance threshold at alpha = 0.05. If the significance threshold is not displayed in the graph, all peaks detected in the QTL scan were below the significance threshold. This is usually apparent in the last MQM scan performed. The x-axis displays each linkage group, designated by their corresponding chromosome names (e.g., 1A, 1B, 1D, etc.). The rug of hash marks denotes the cM position of each marker in the recombination map. All information regarding location, LOD and effect appears at the end of the document.

Heading Date Across All Environments



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0.0
1A
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2B
2D
3A
3B
3D
4A
4B
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5B
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6A
6B
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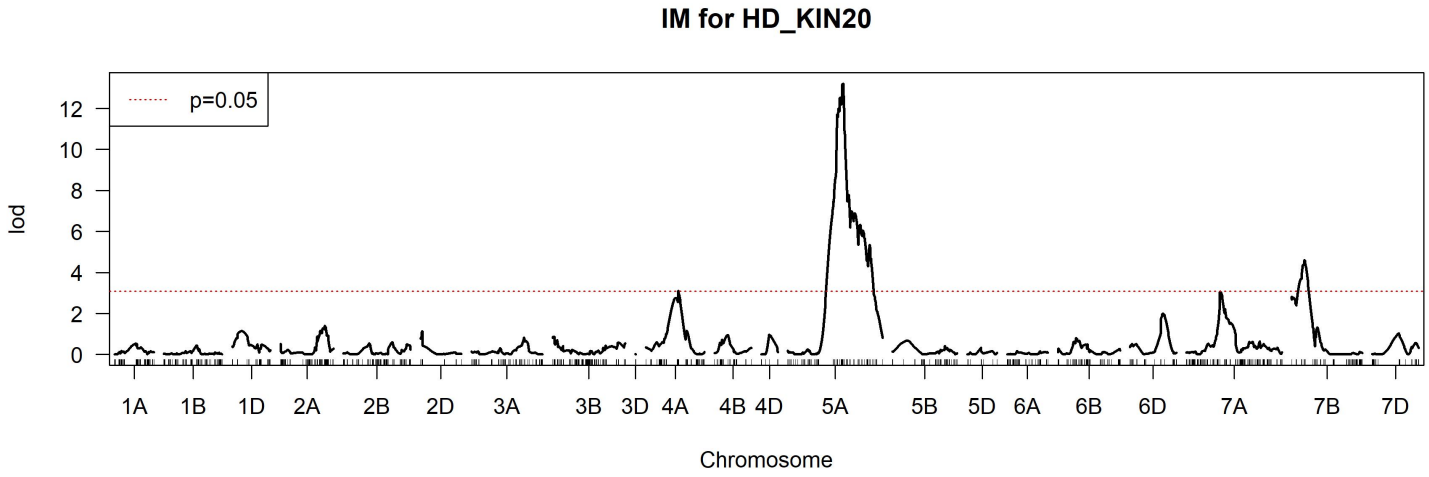
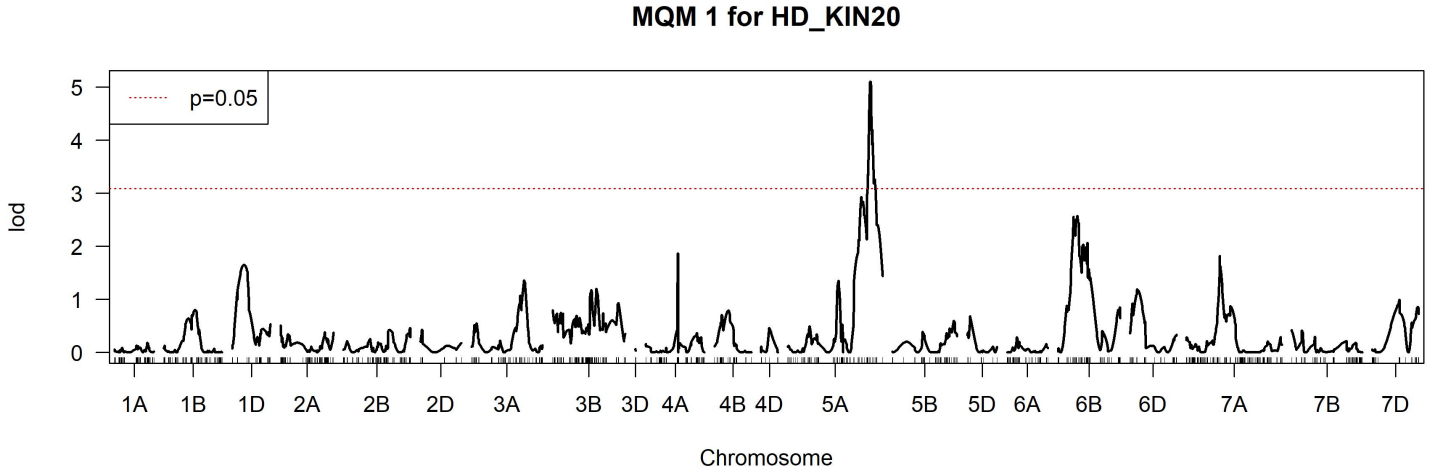
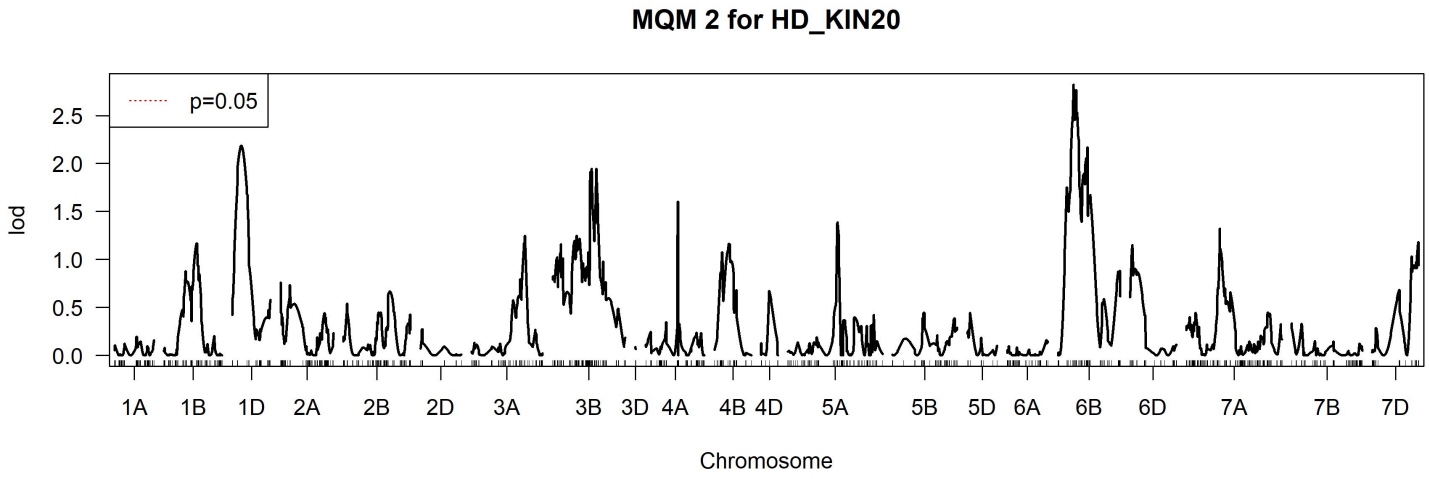
7A
7B
7D
Chromosome

Heading Date in Kinston, NC - 2020



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1B
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3D
4A
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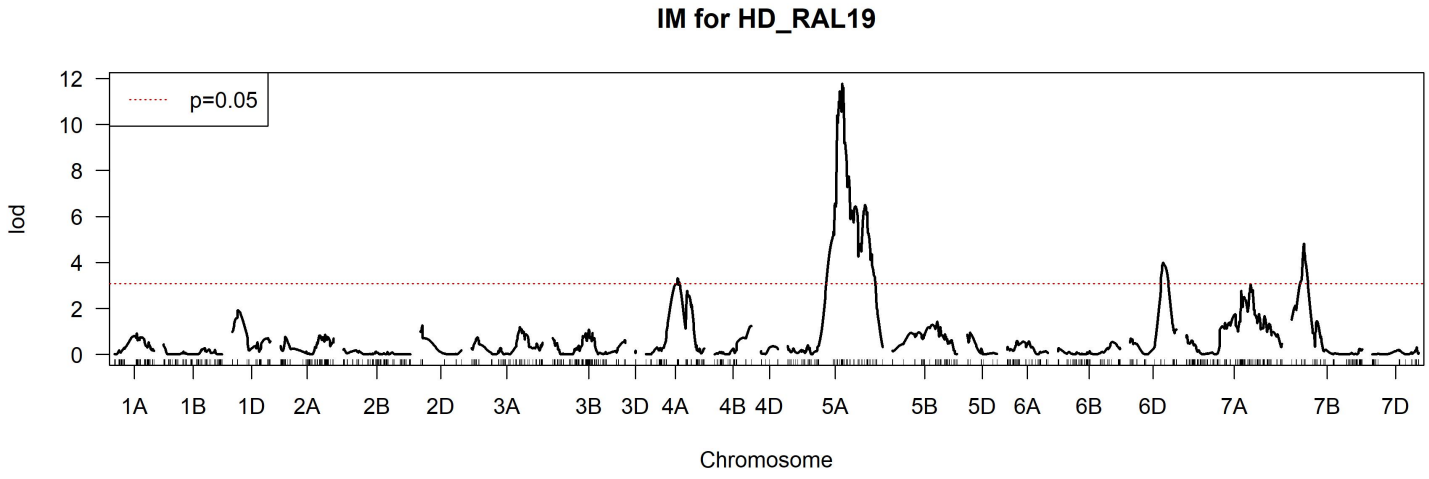
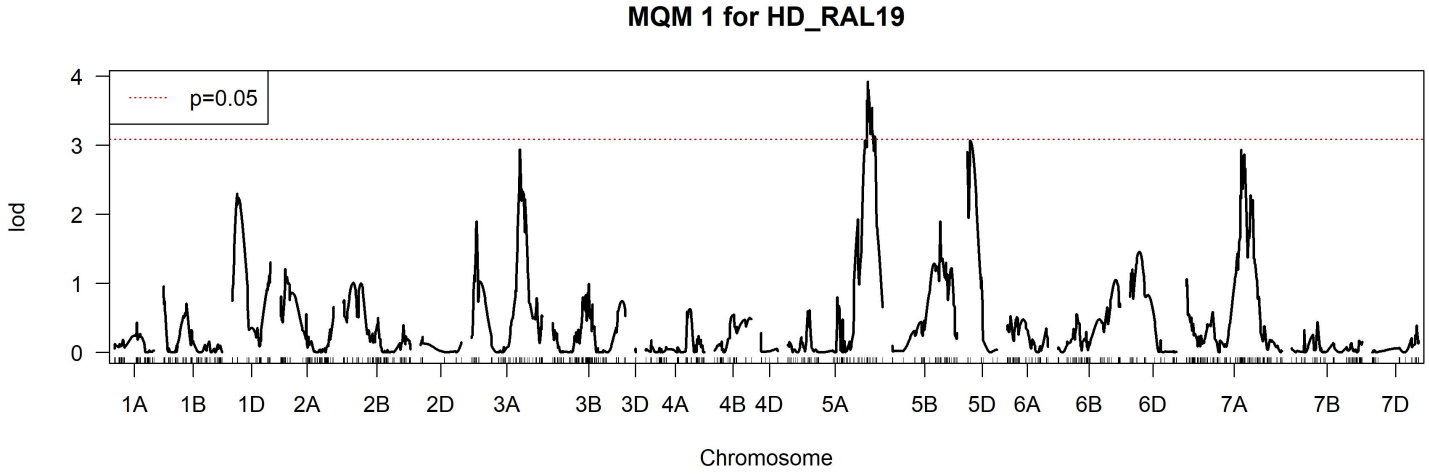
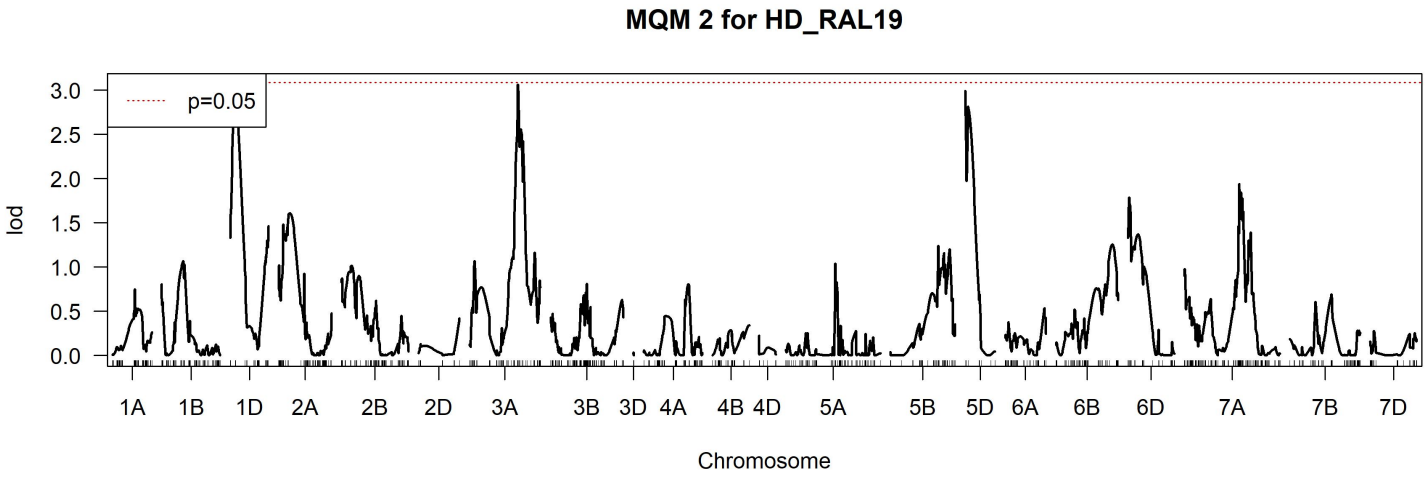
7B
7D
Chromosome

Heading Date in Raleigh, NC - 2019



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2D
3A
3B
3D
4A
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5B
5D
6A
6B
6D
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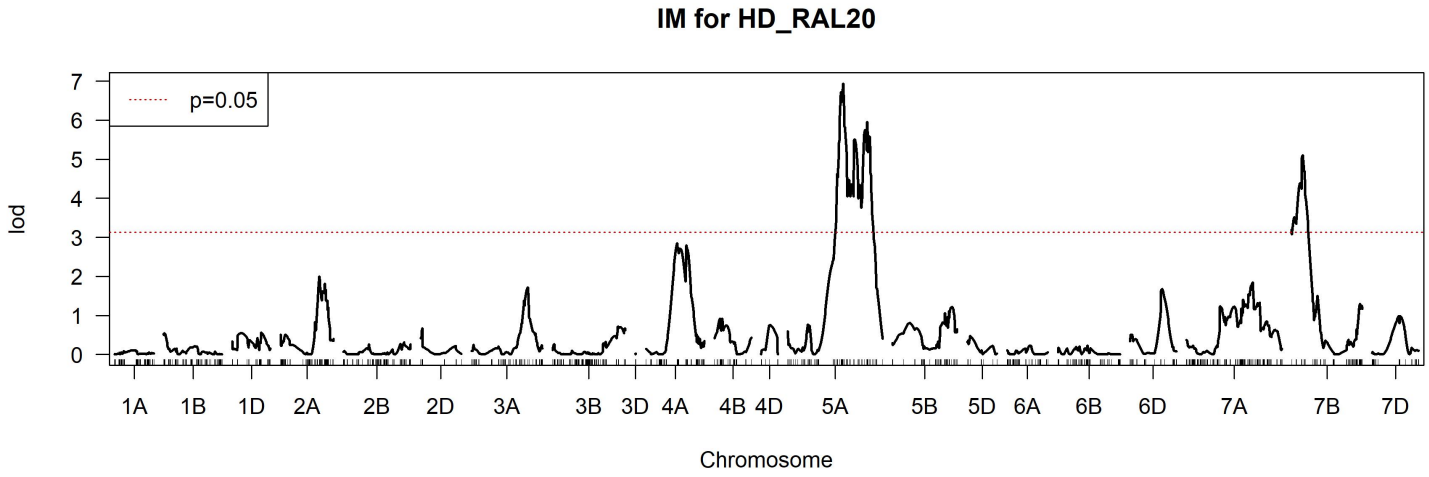
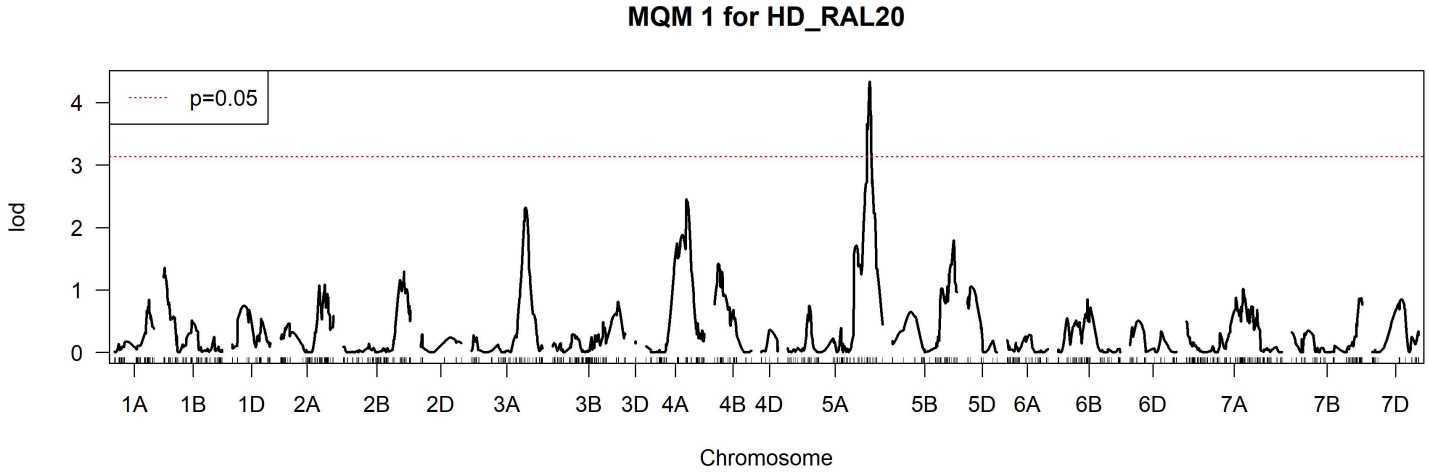
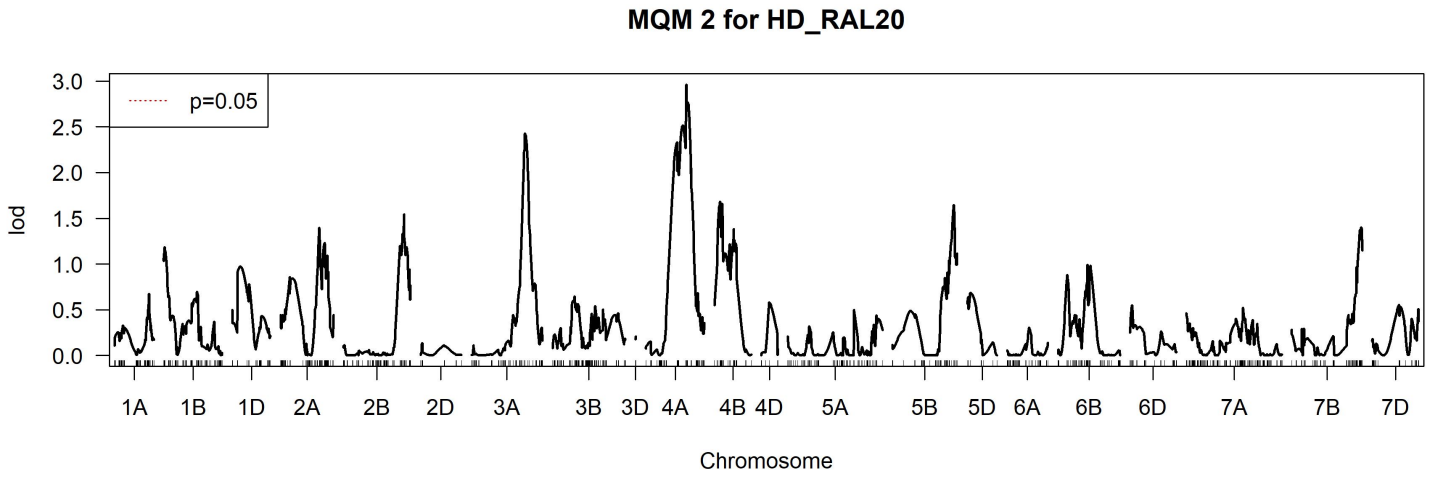
7B
7D
Chromosome

Heading Date in Raleigh, NC - 2020



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2B
2D
3A
3B
3D
4A
4B
4D
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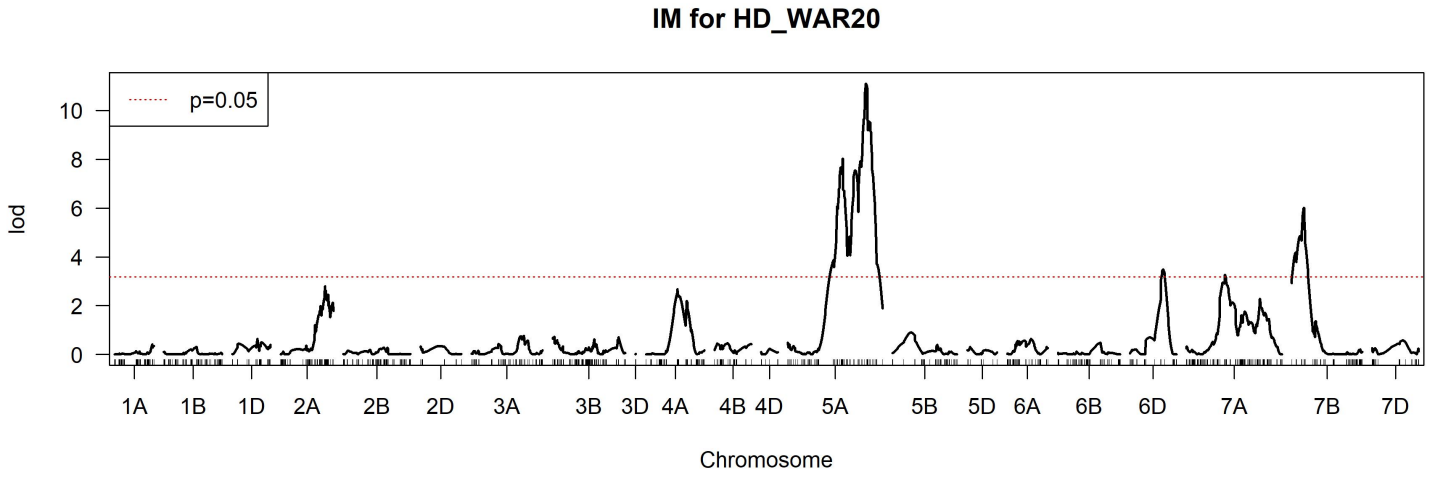
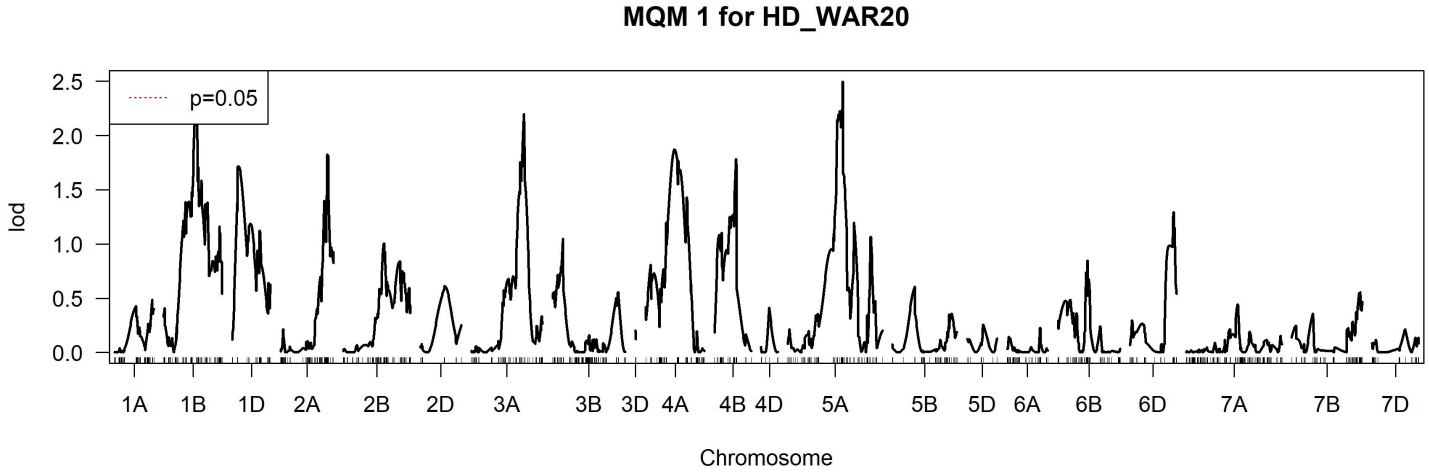
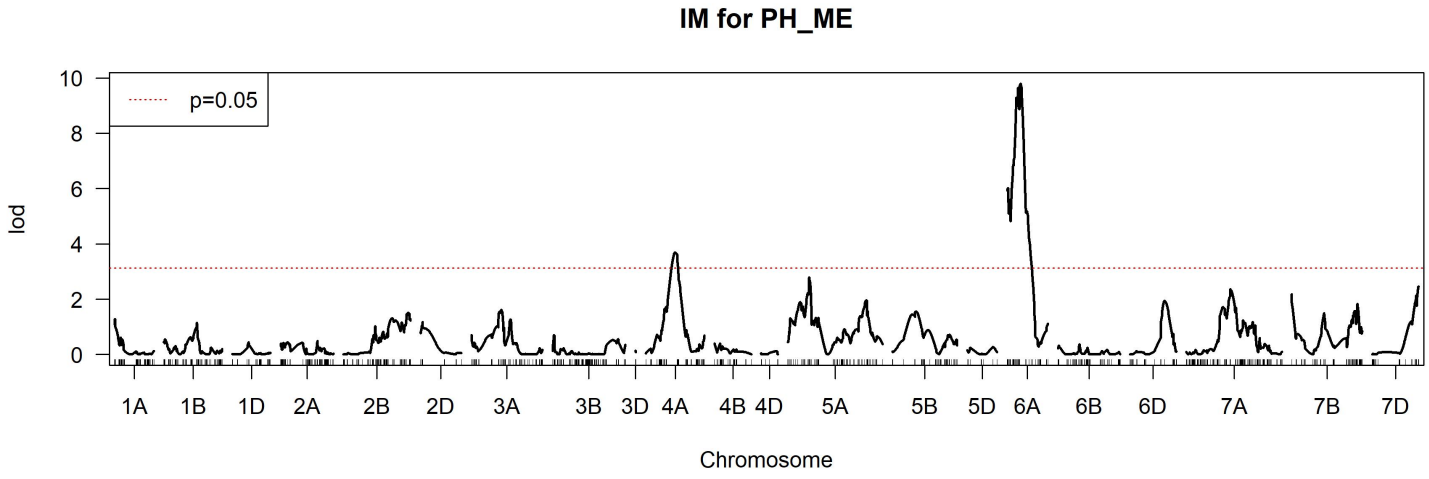
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

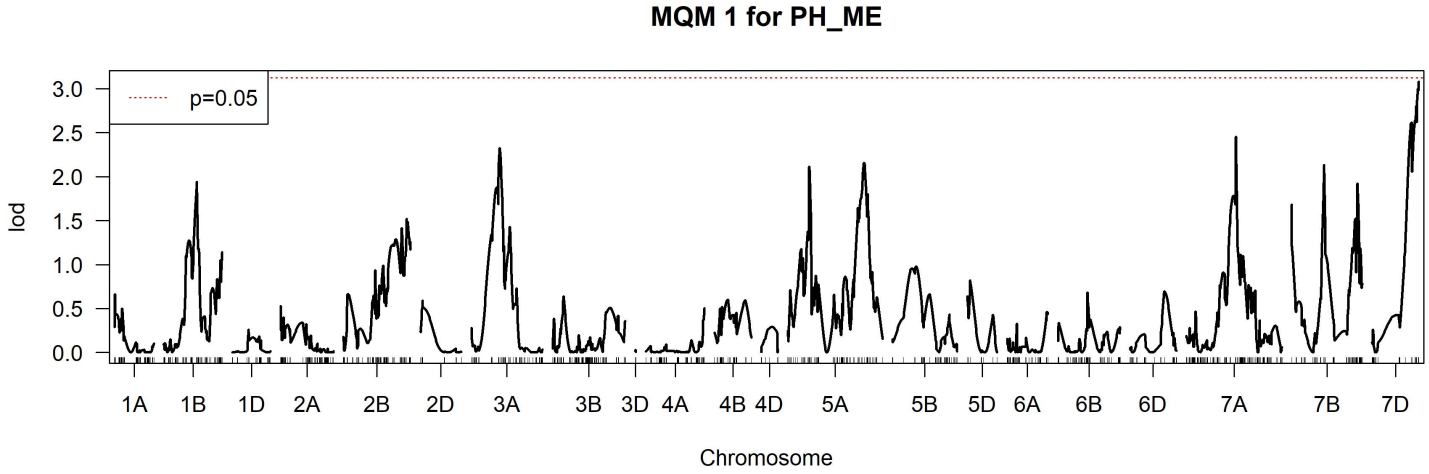
Heading Date in Warsaw, VA - 2020

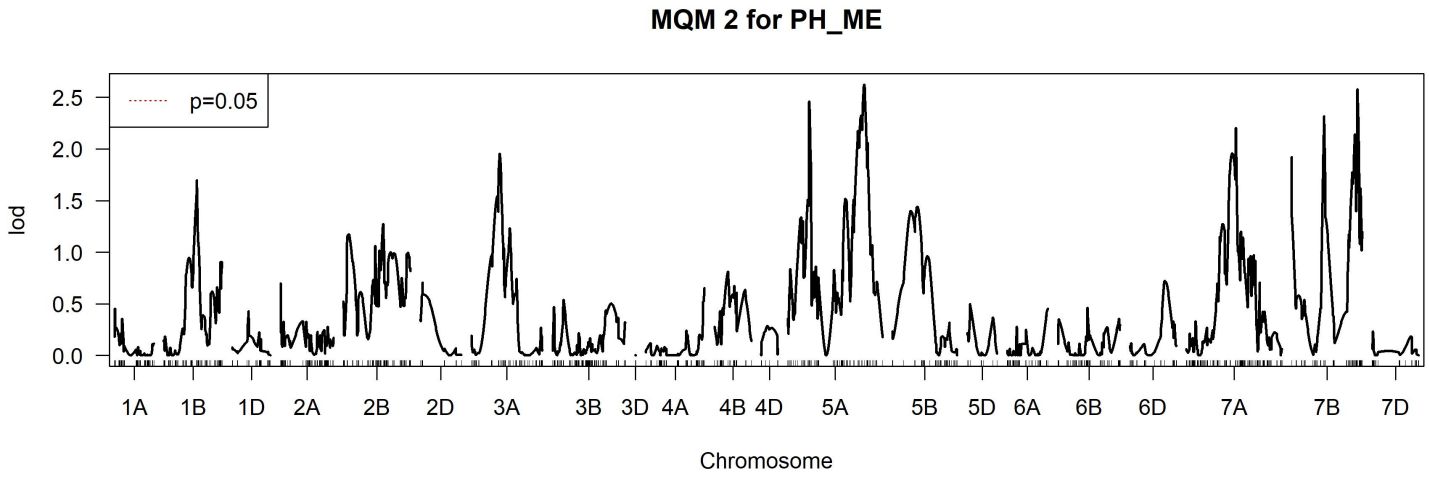




Plant Height Across All Environments



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3B
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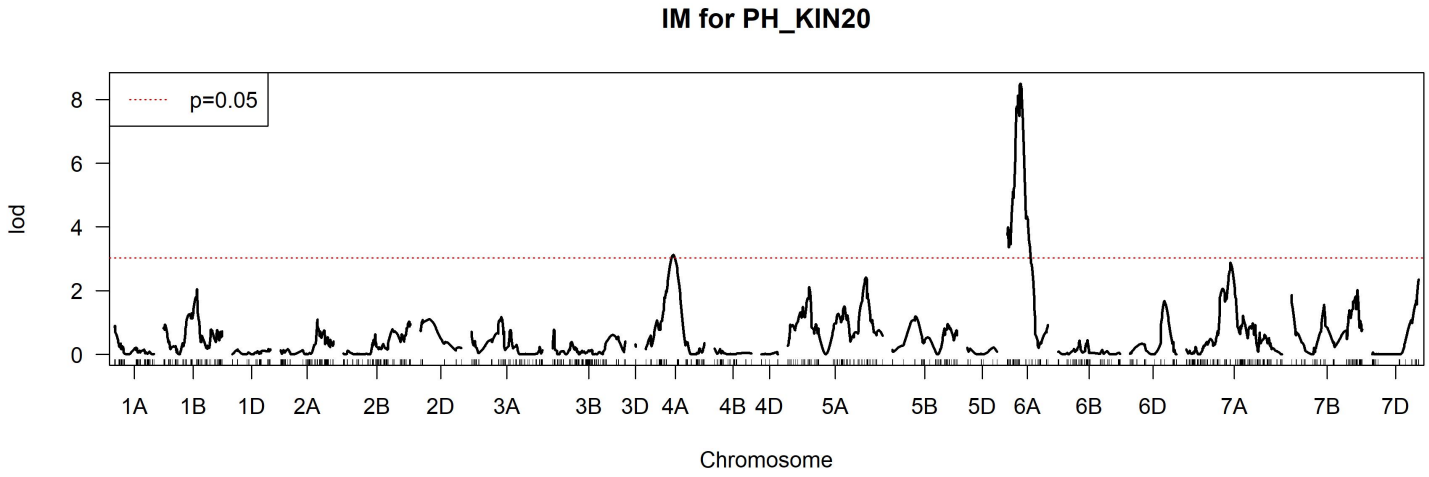
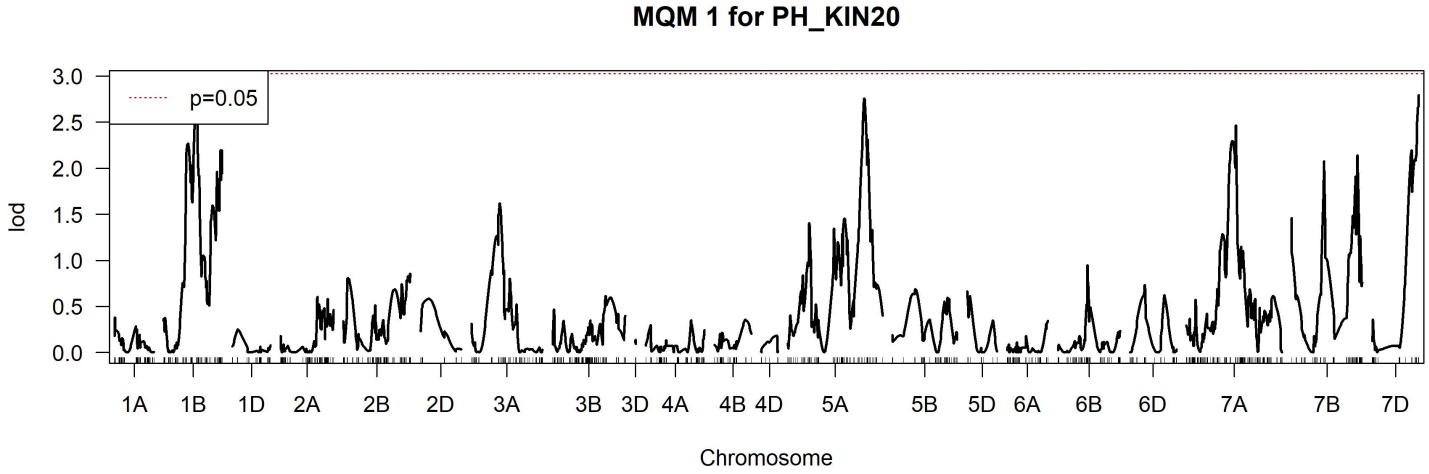
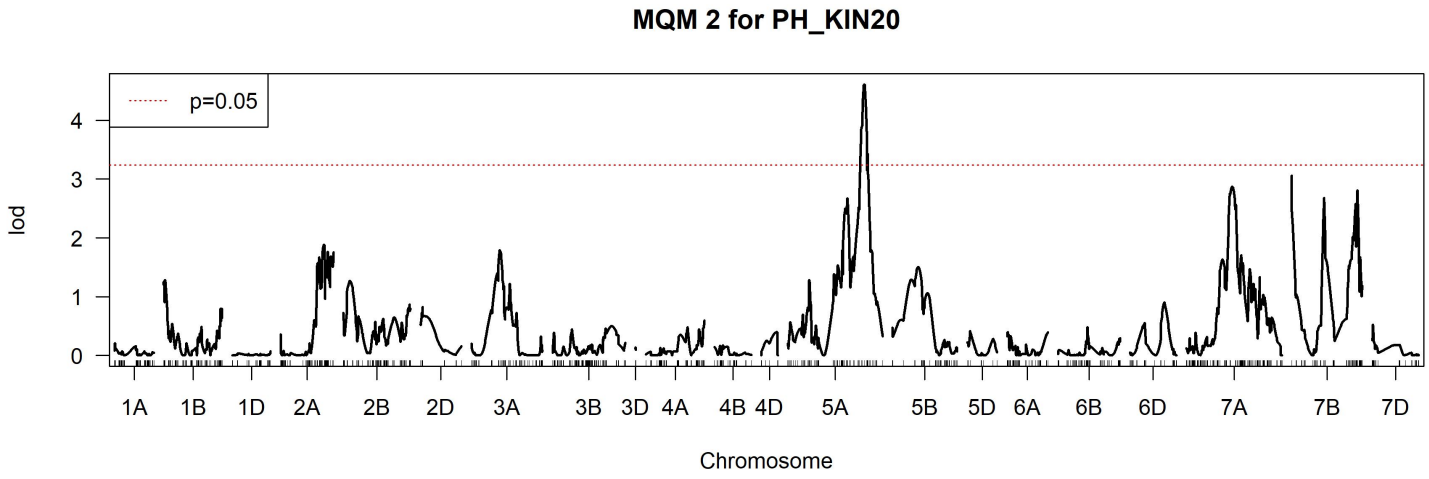
7D
Chromosome

Plant Height in Kinston, NC - 2020



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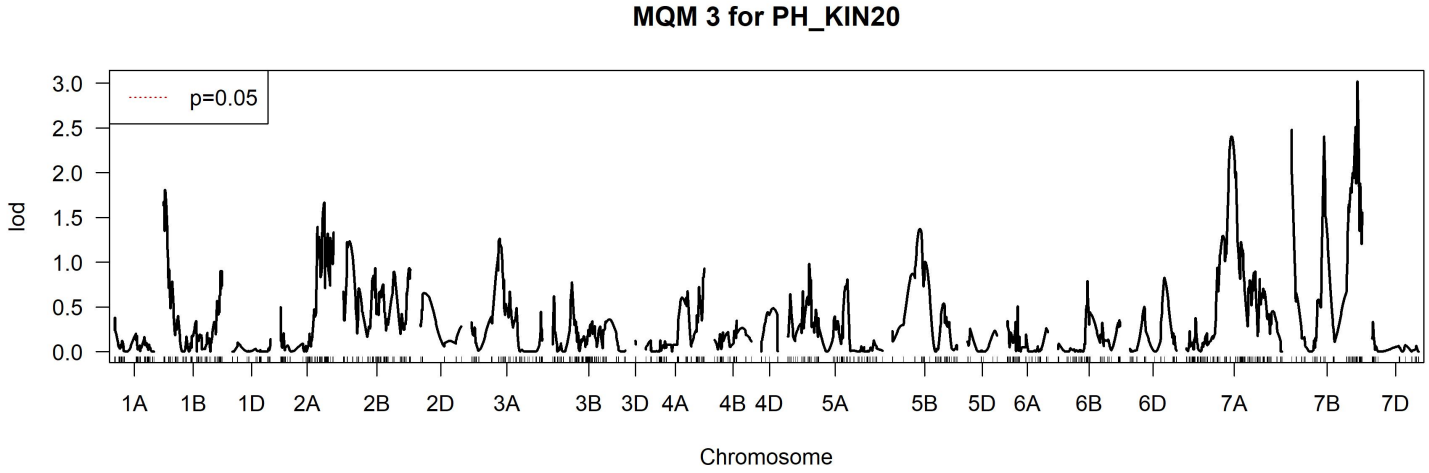
Chromosome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3D
4A
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6D
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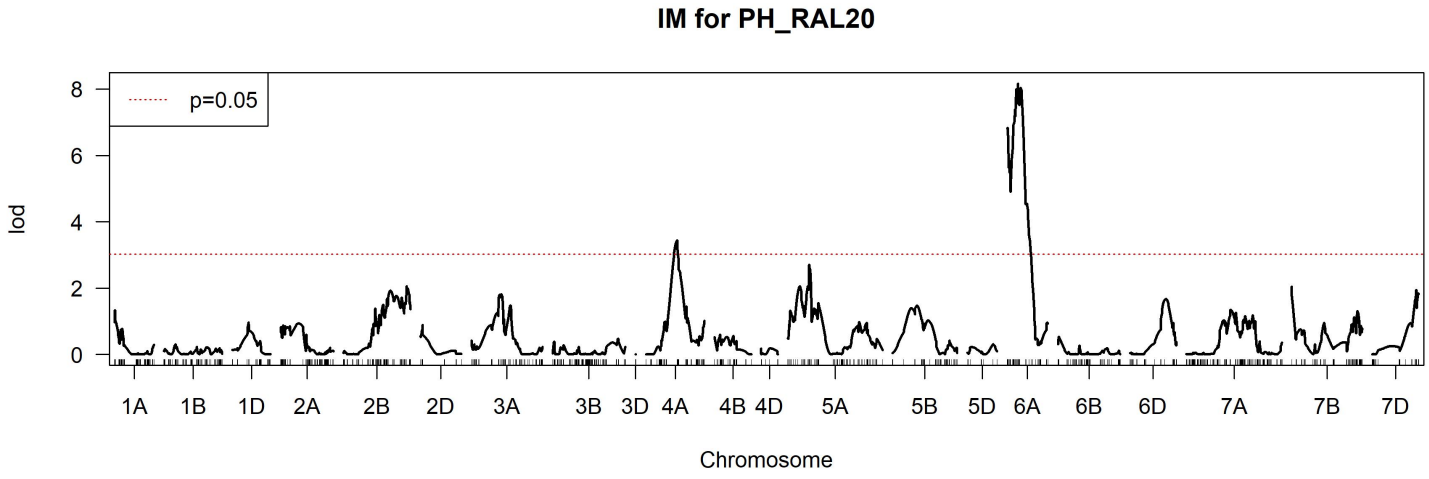
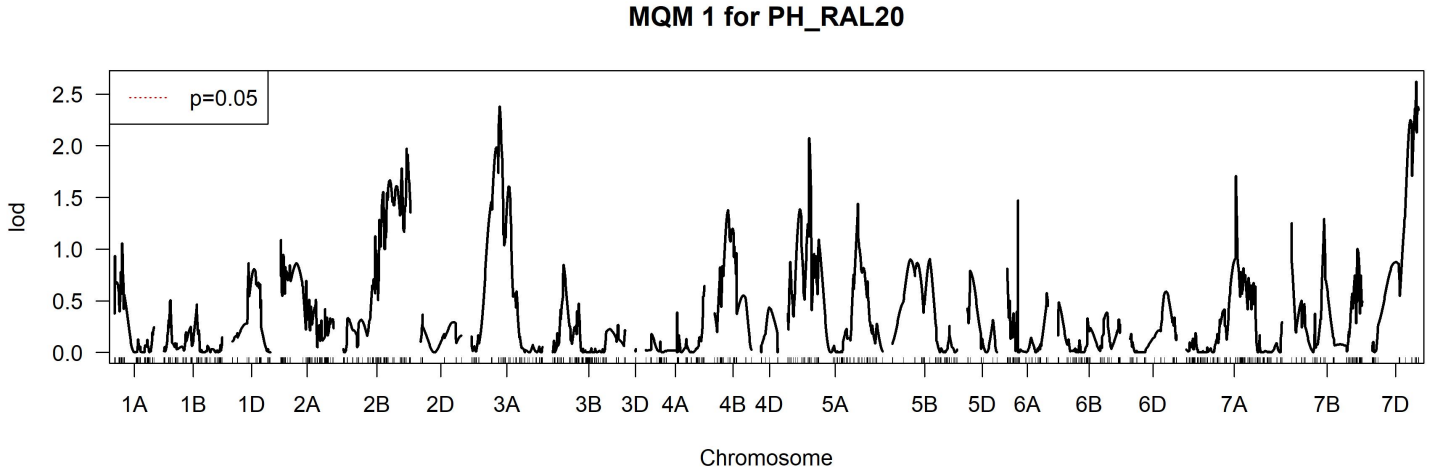
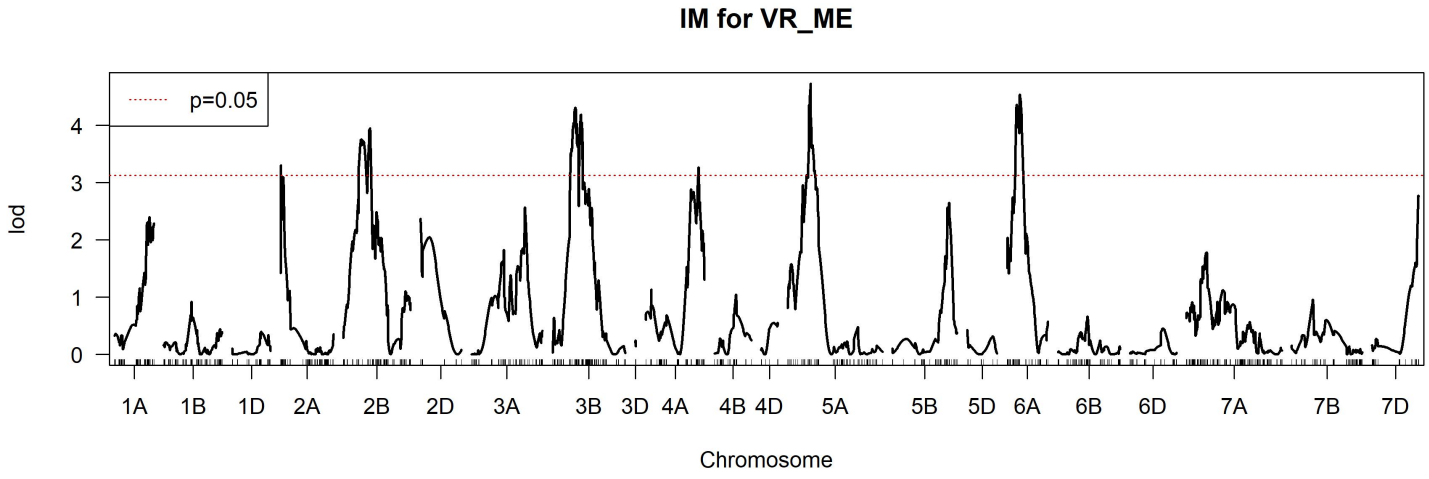
7B
7D
Chromosome

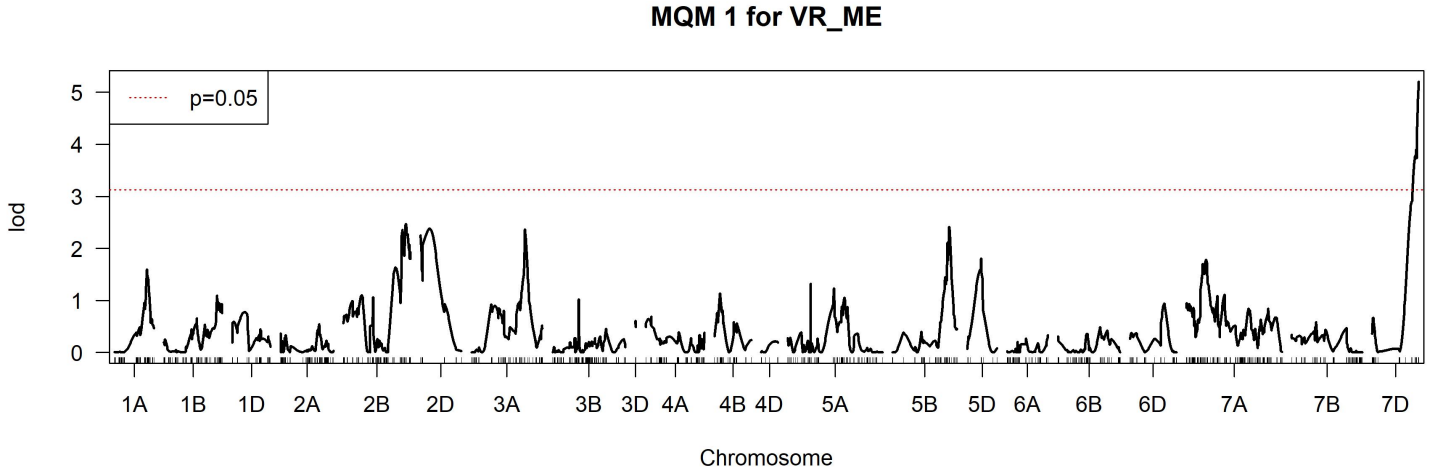
Plant Height in Raleigh, NC - 2020

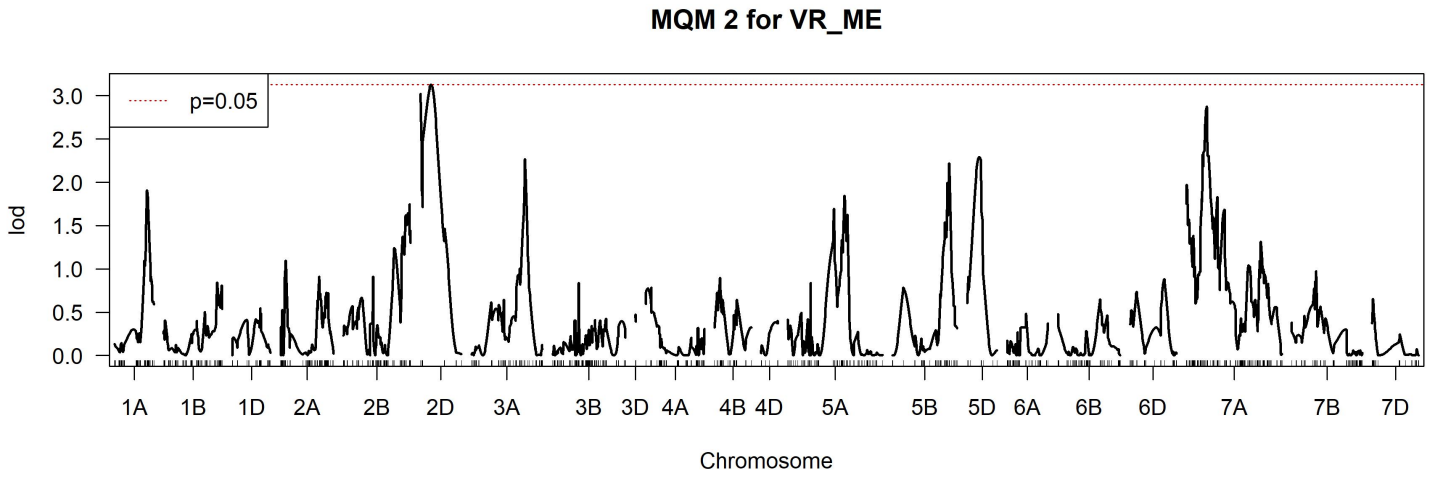




Visual Ratings Across All Environments



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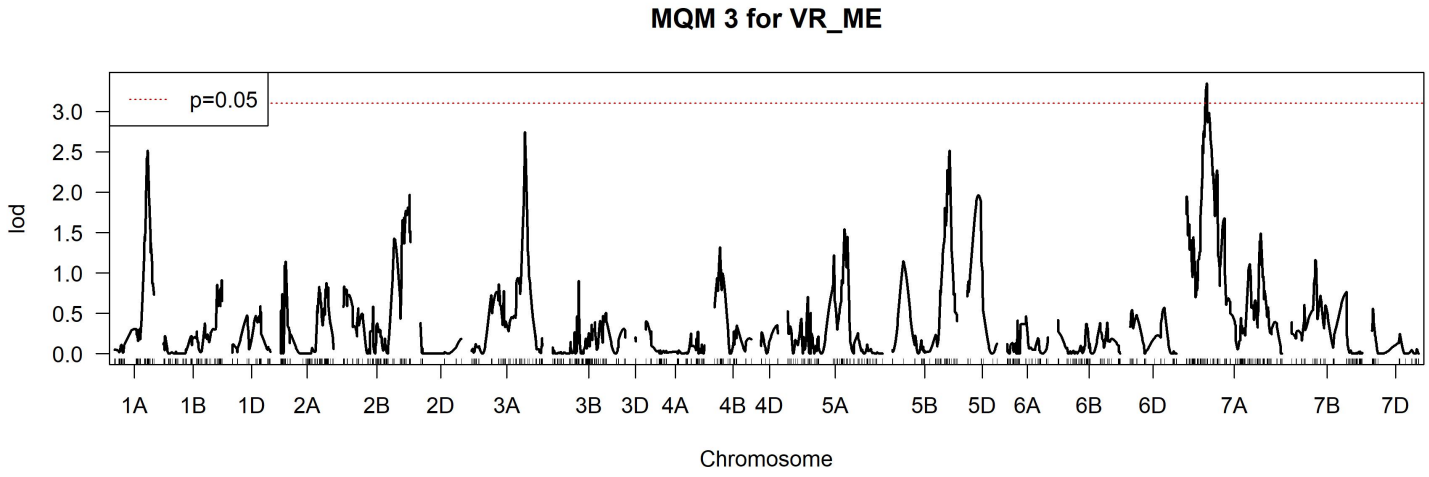
Chromosome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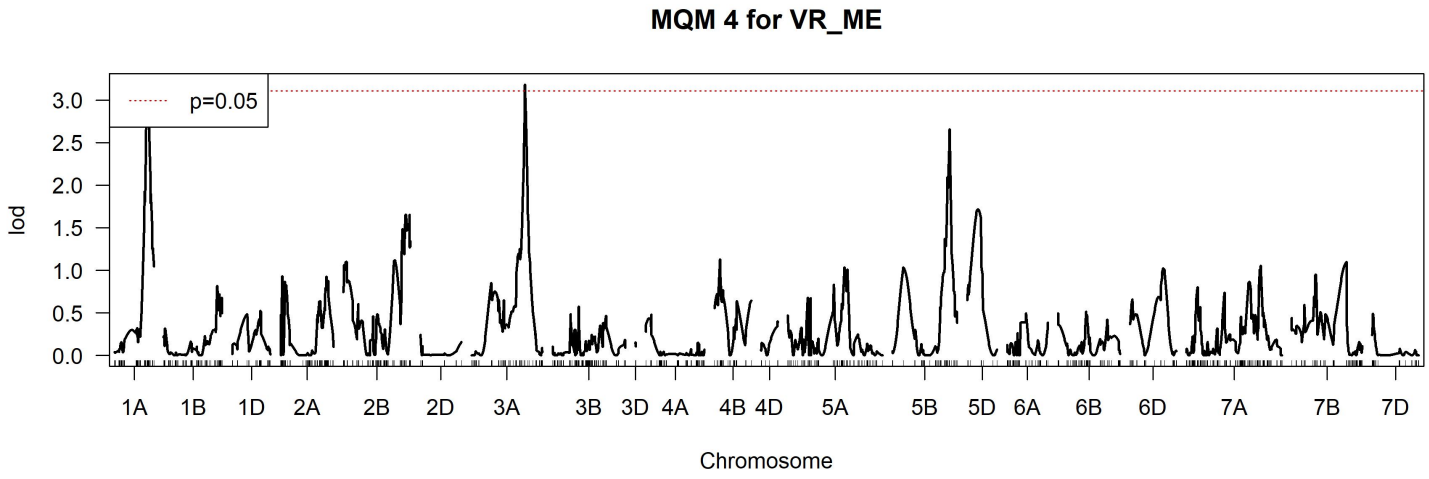
Chromosome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1.0
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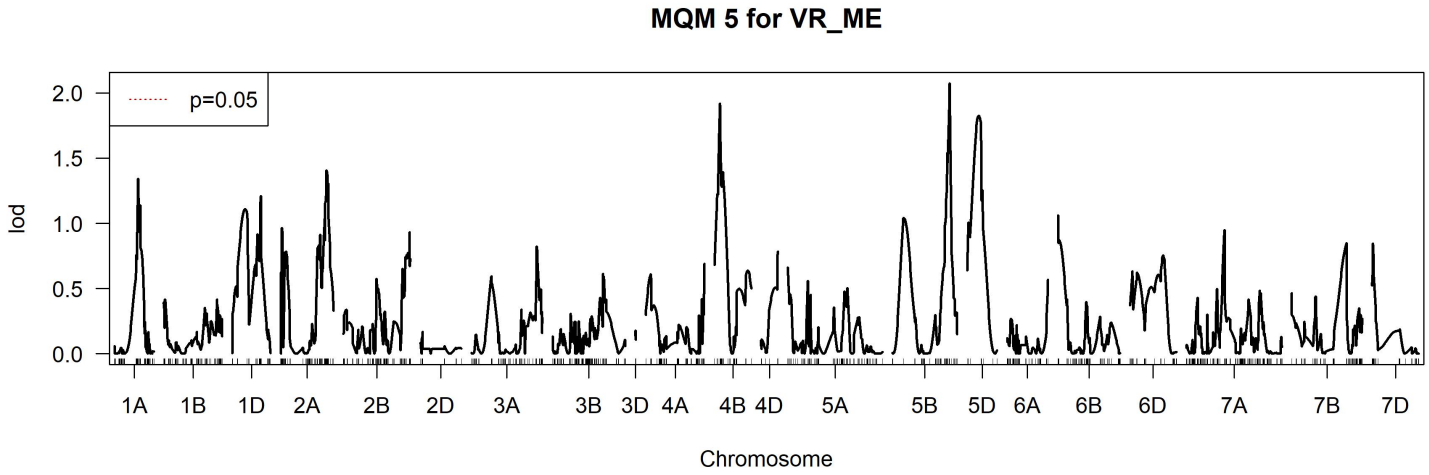
Chromosome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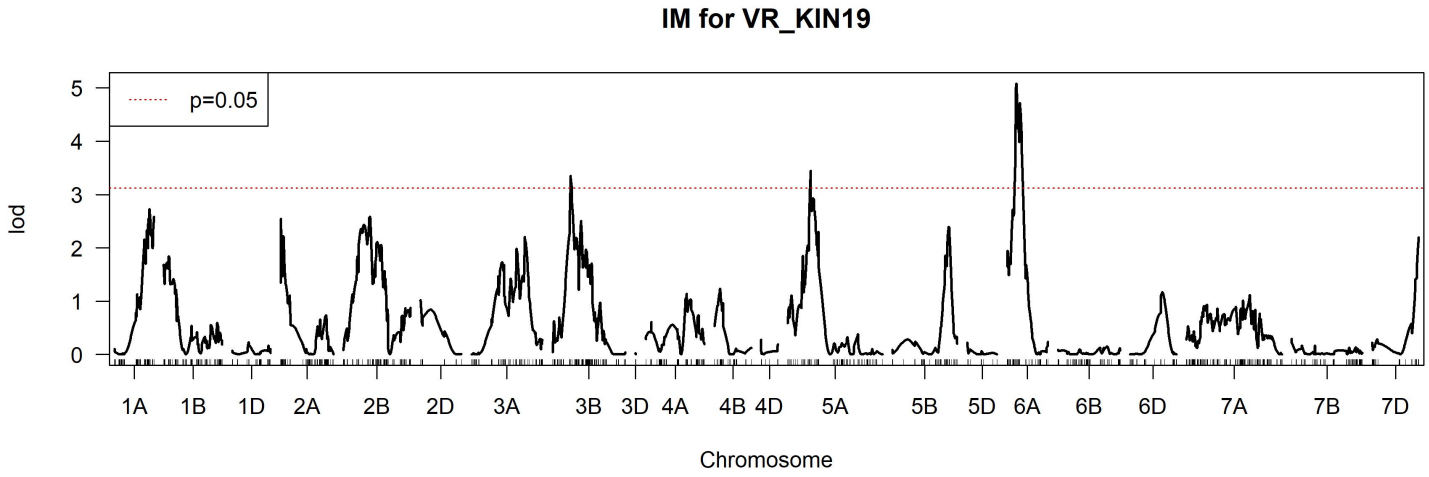
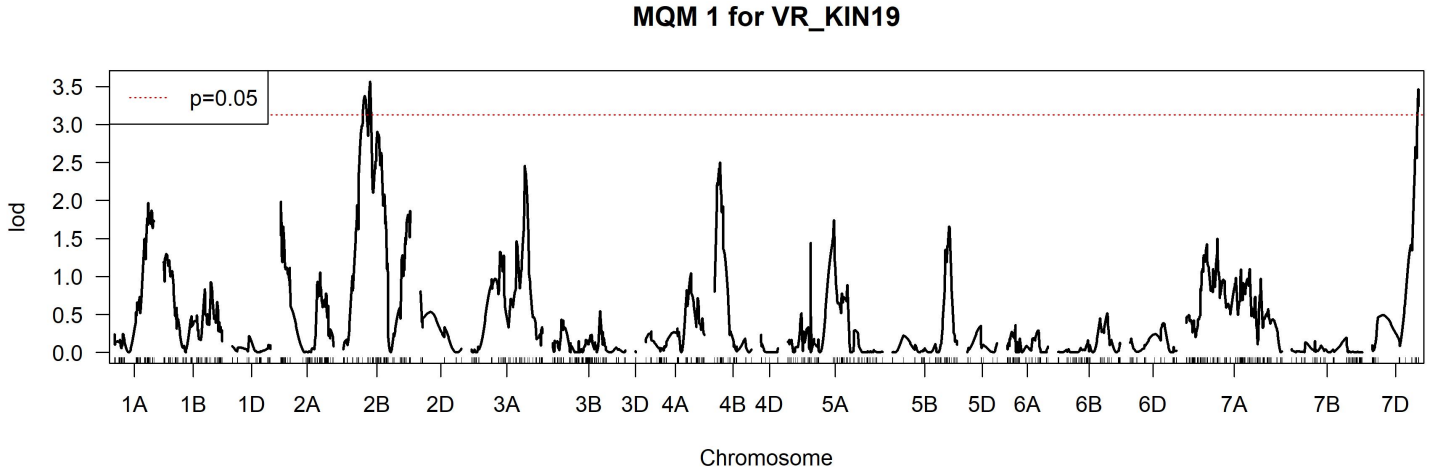
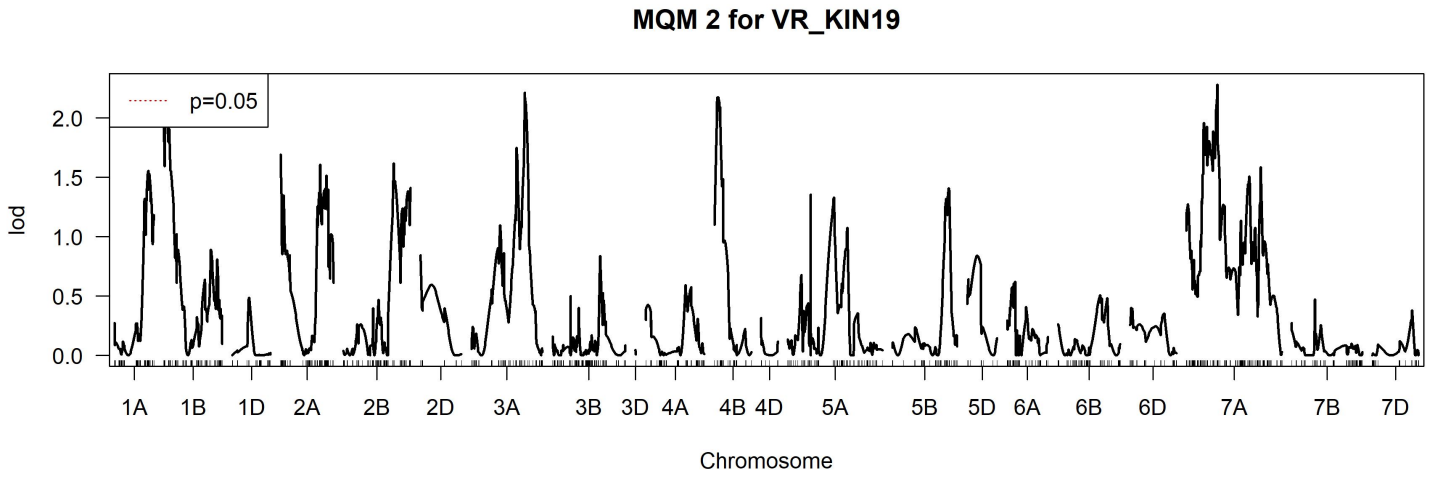
Chromosome

Visual Ratings in Kinston, NC - 2019



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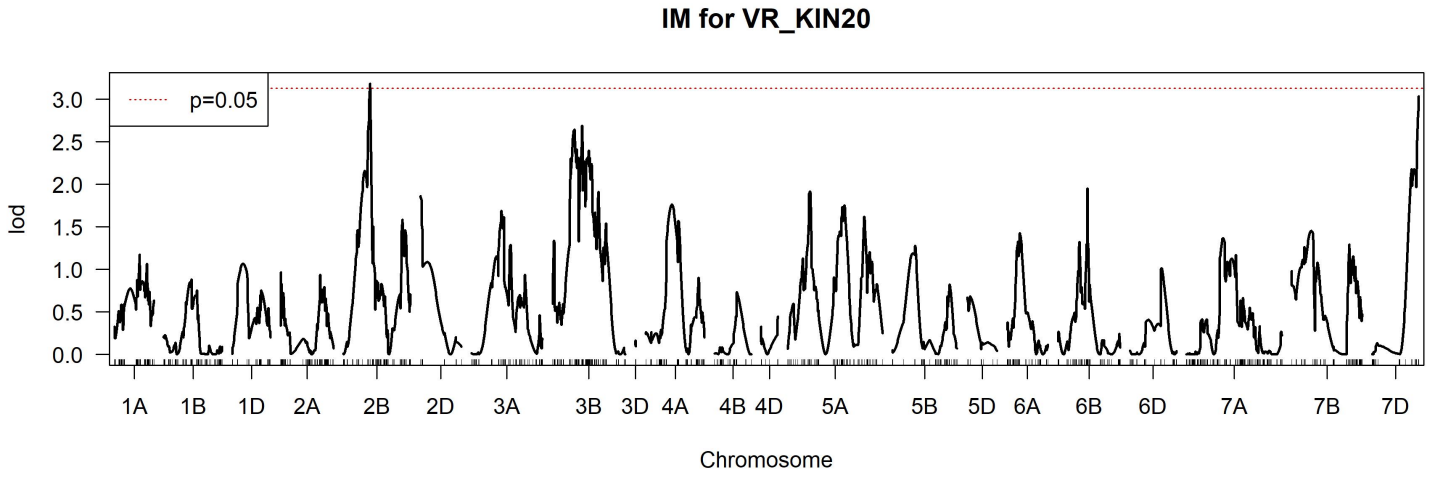
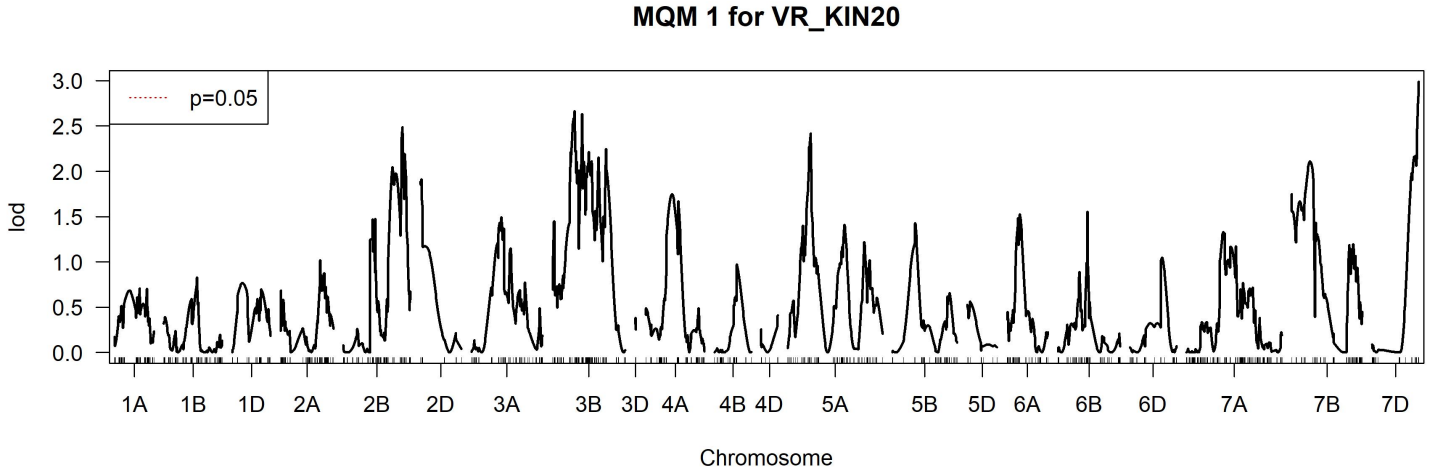
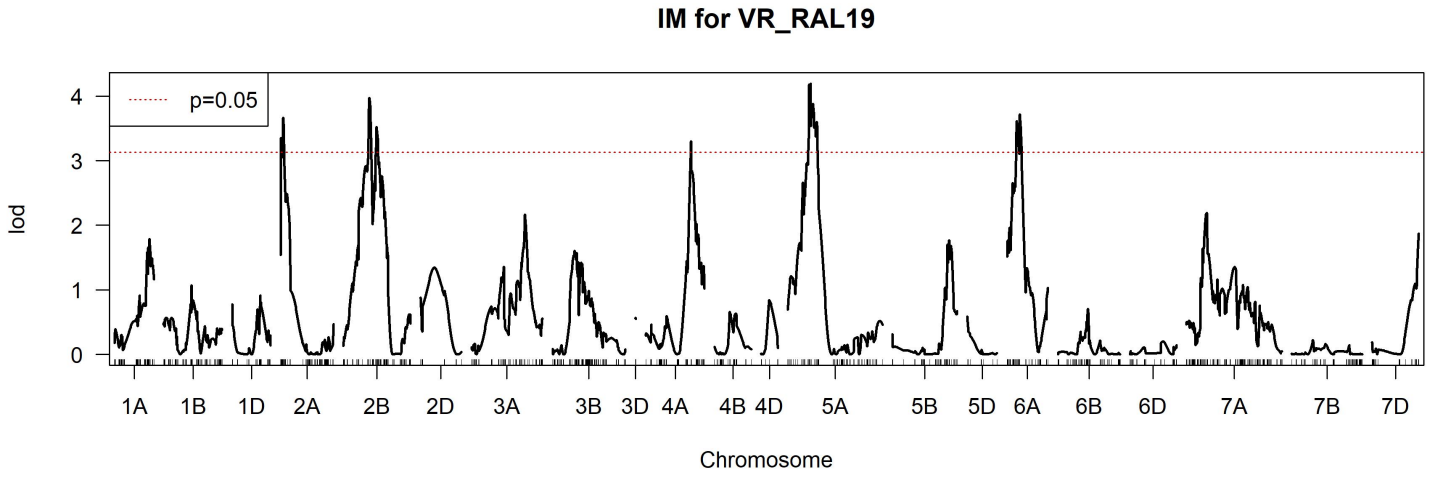
7A
7B
7D
Chromosome

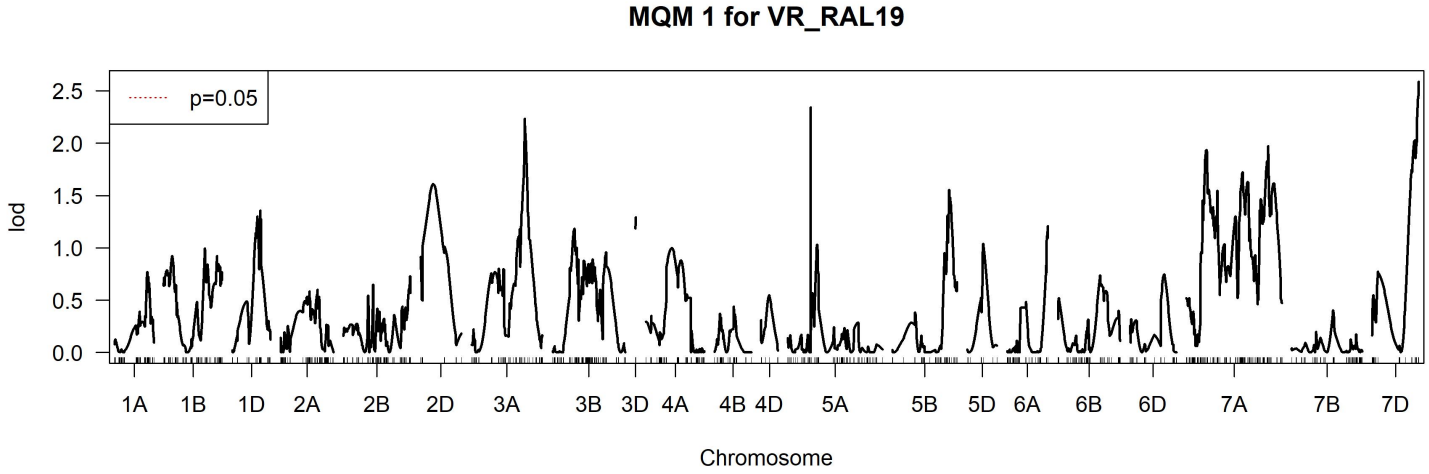
Visual Ratings in Kinston, NC - 2020



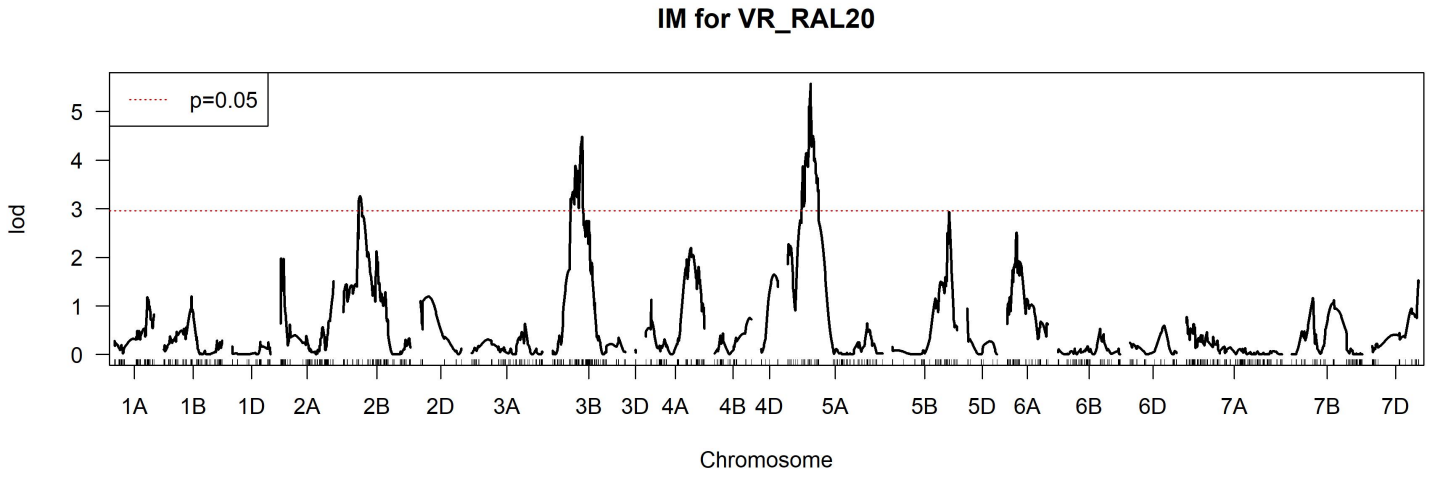


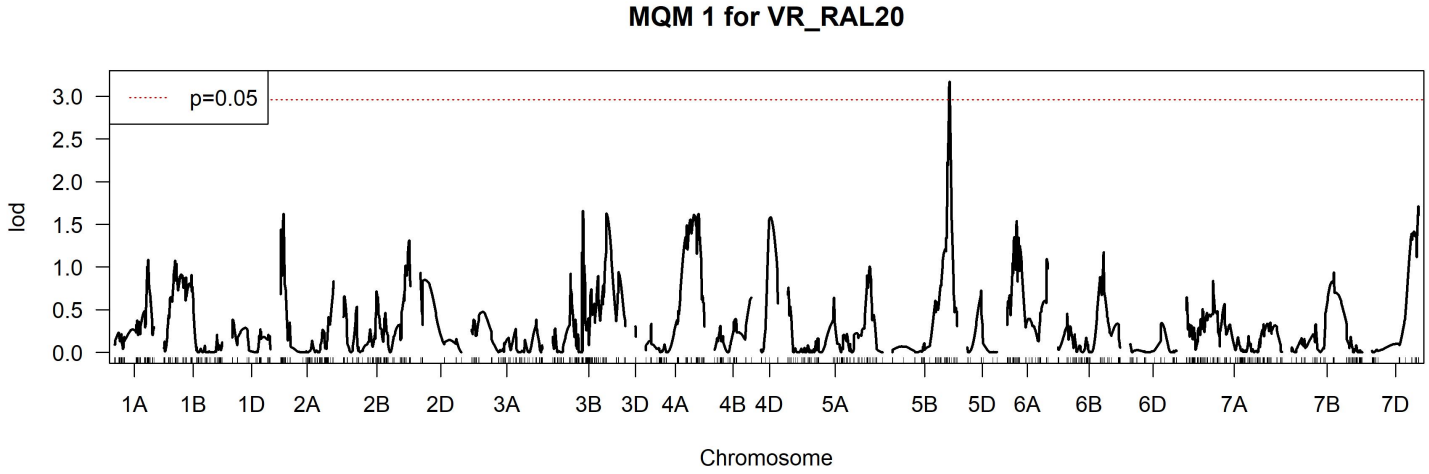
Visual Ratings in Raleigh, NC - 2019

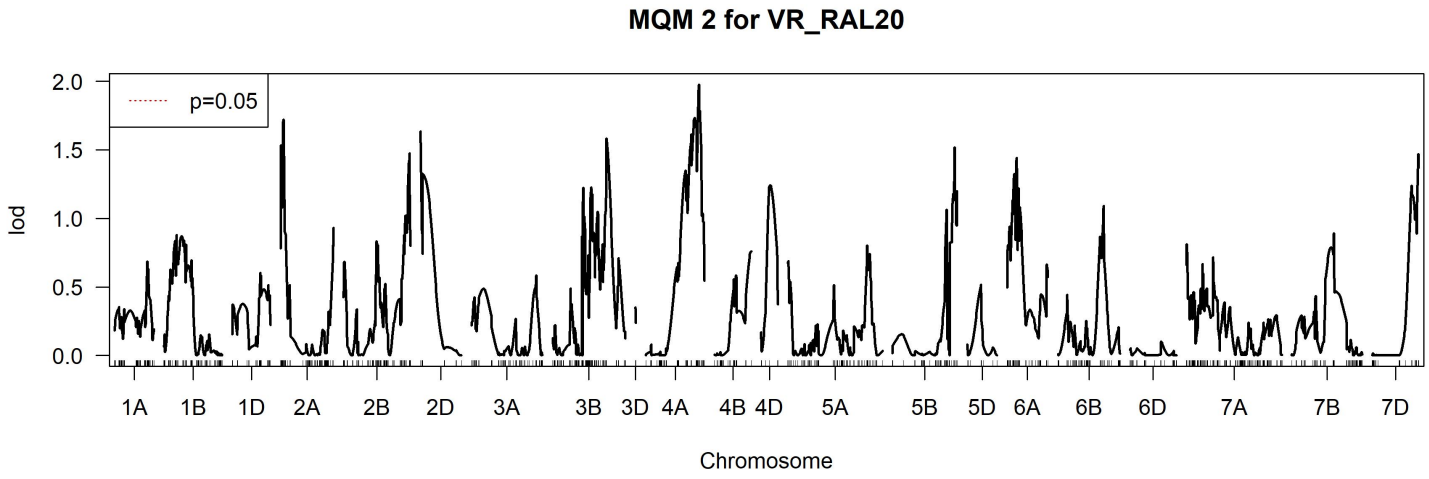




Visual Ratings in Raleigh, NC - 2020






MQM 2 for VR_RAL20
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3B
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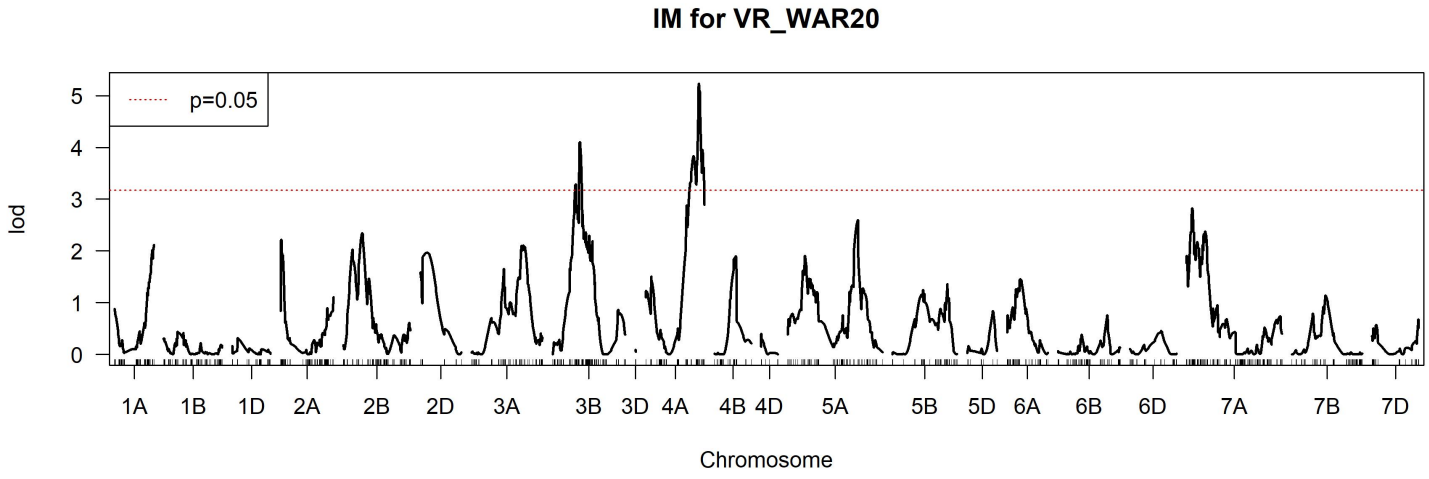
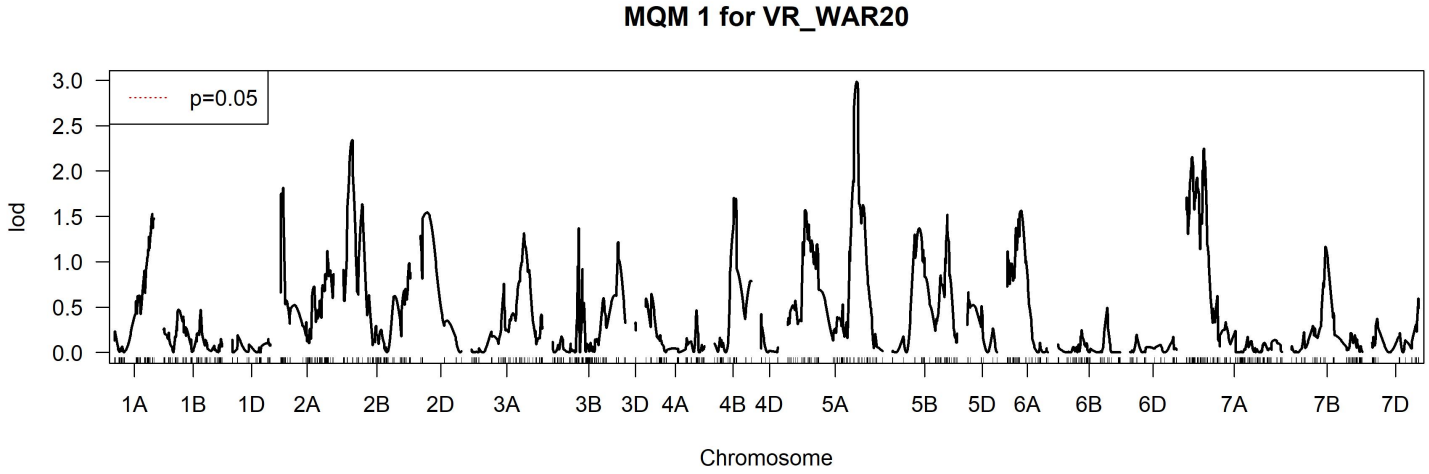
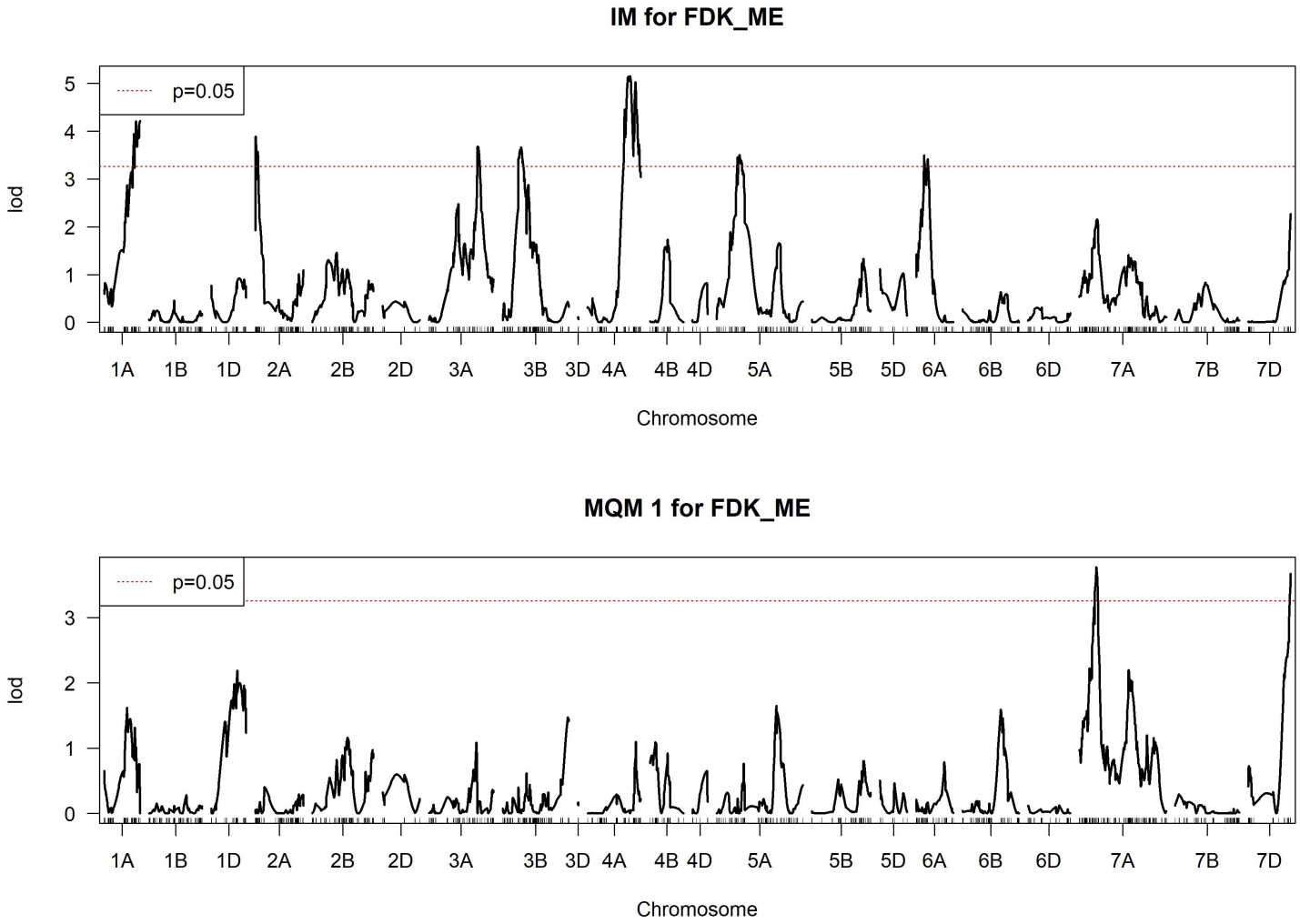
7A
7B
7D
Chromosome

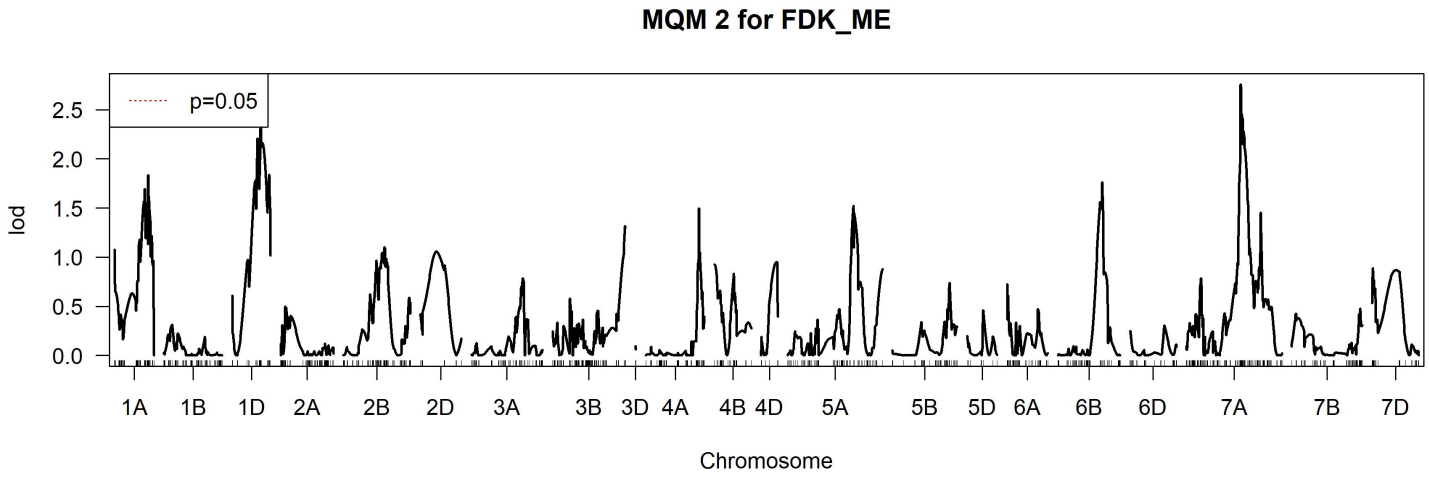
Visual Ratings in Warsaw, VA - 2020





Fusarium Damaged Kernels Across All Environments

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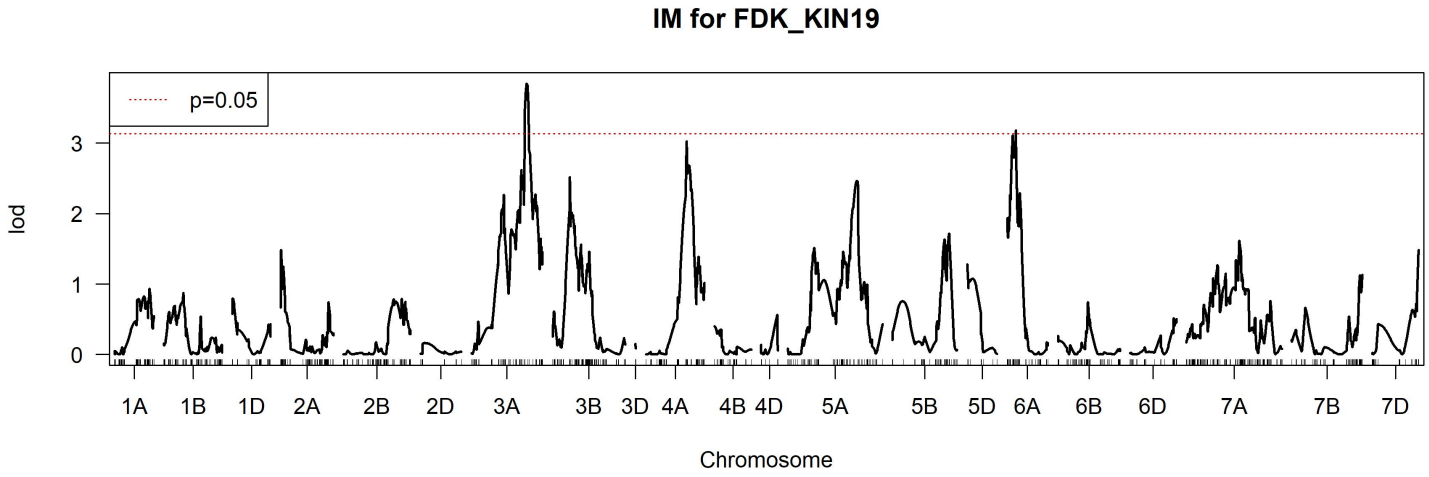
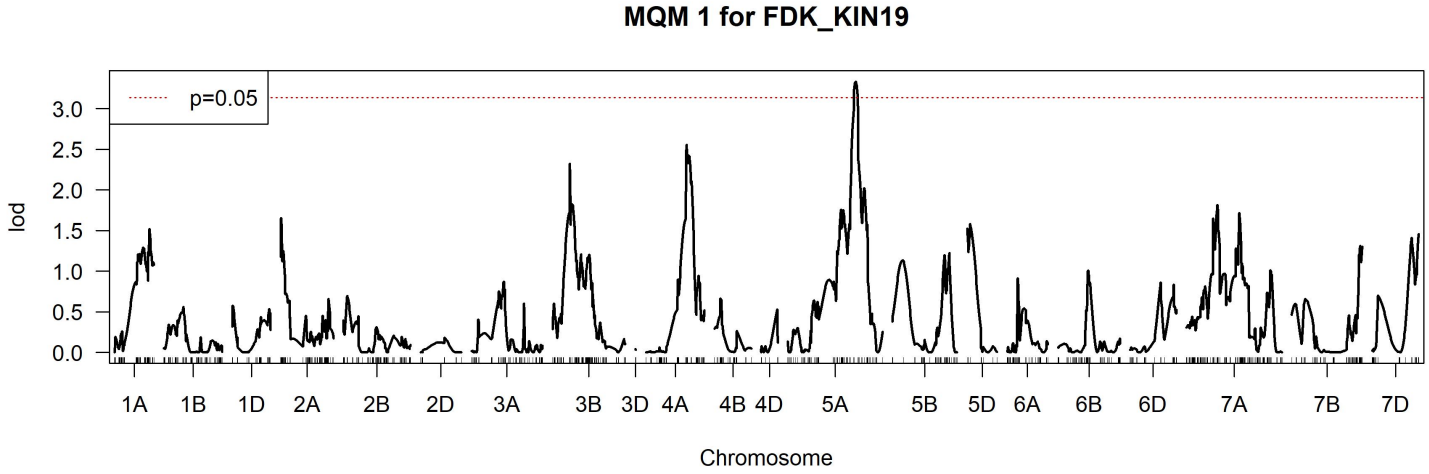
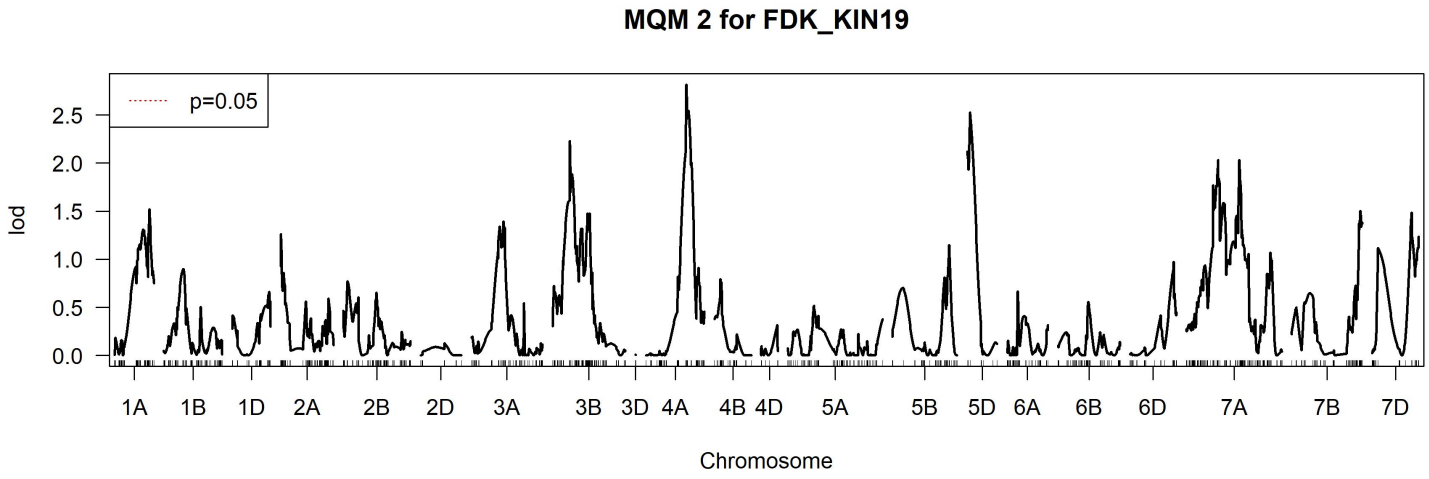
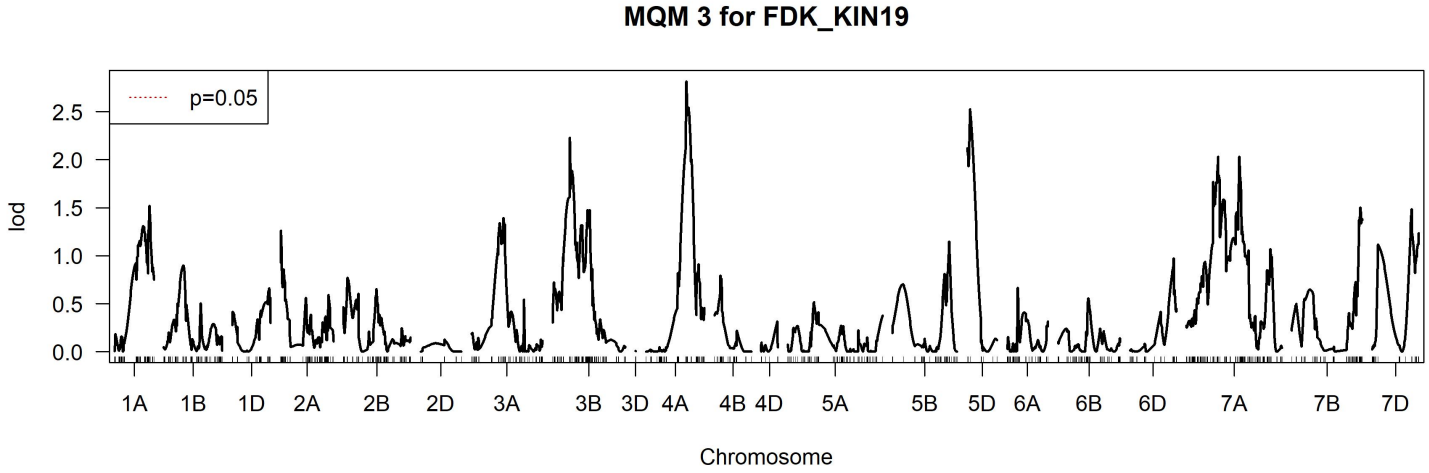
7D
Chromosome

Fusarium Damaged Kernels in Kinston, NC - 2019






MQM 2 for FDK_KIN19
p=0.05
lod
0.0
0.5
1.0
1.5
2.0
2.5
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome


MQM 3 for FDK_KIN19
p=0.05
lod
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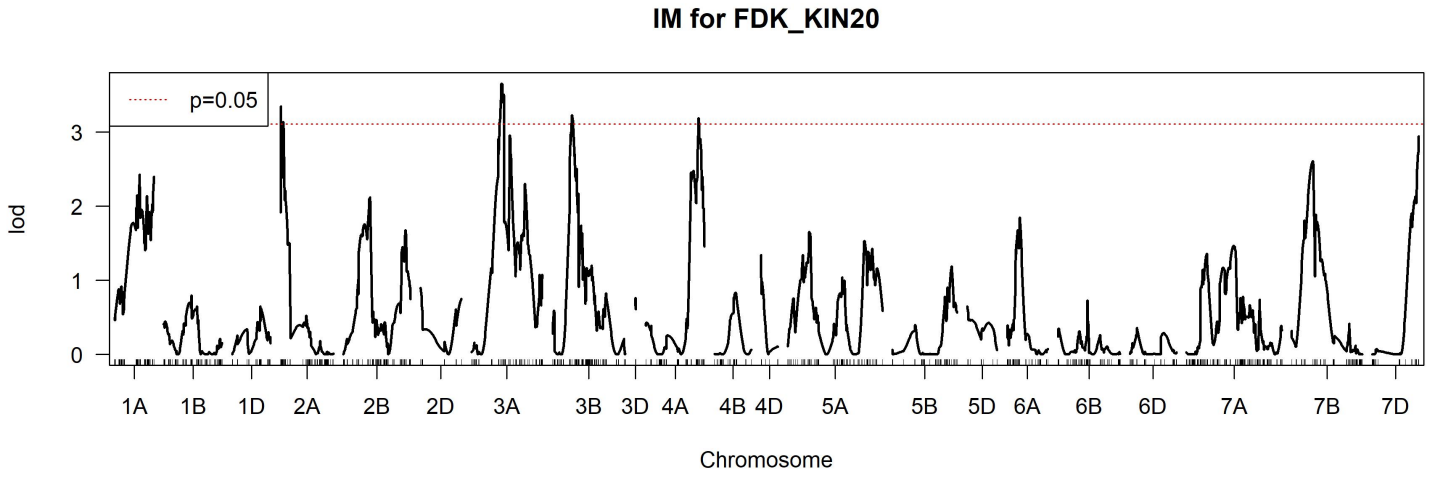
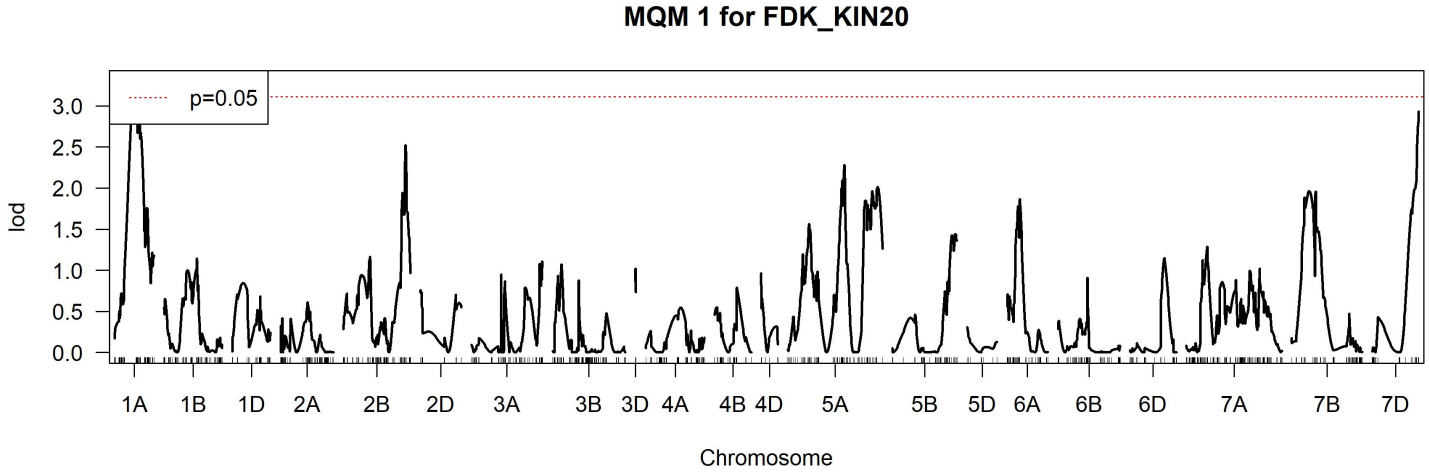
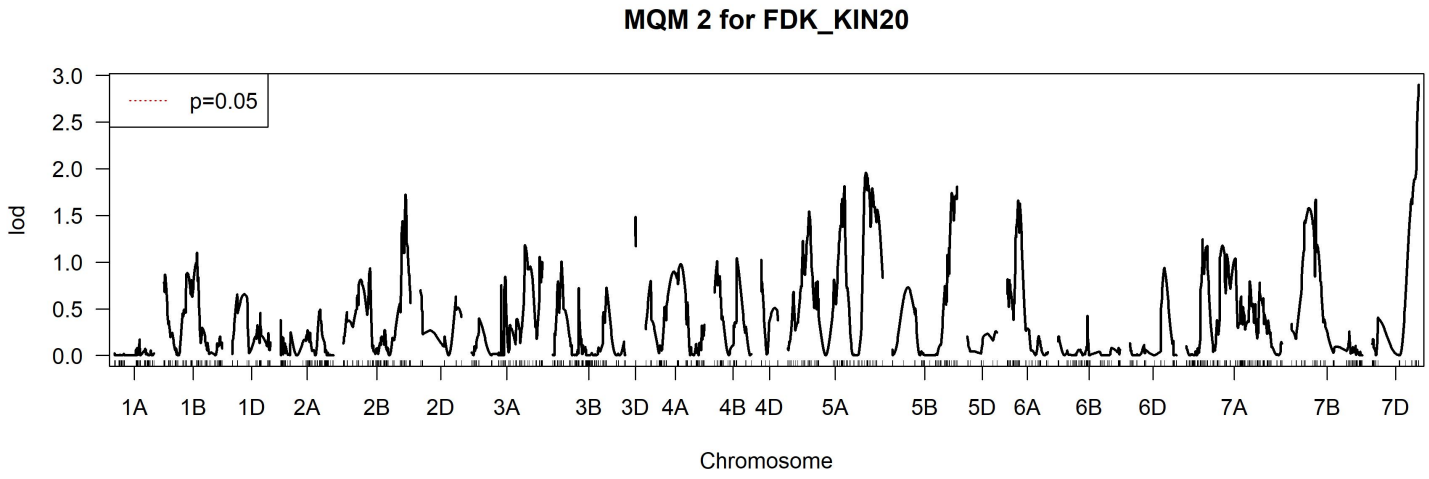
0.5
1.0
1.5
2.0
2.5
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome

Fusarium Damaged Kernels in Kinston, NC - 2020






MQM 2 for FDK_KIN20
p=0.05
lod
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1.5
1.0
0.5
0.0
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1B
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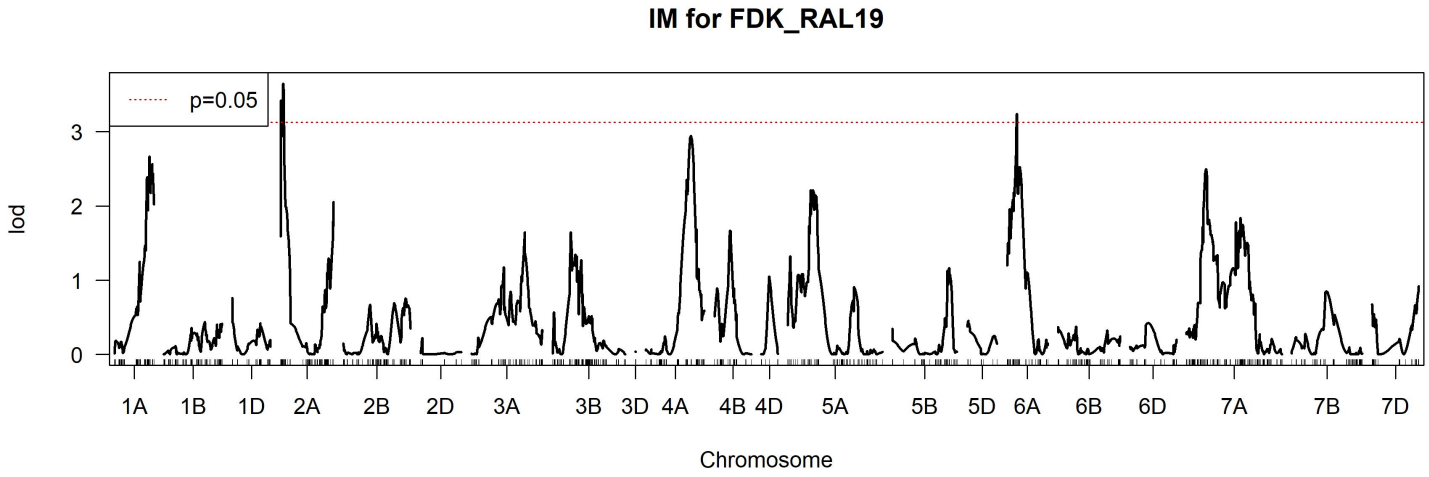
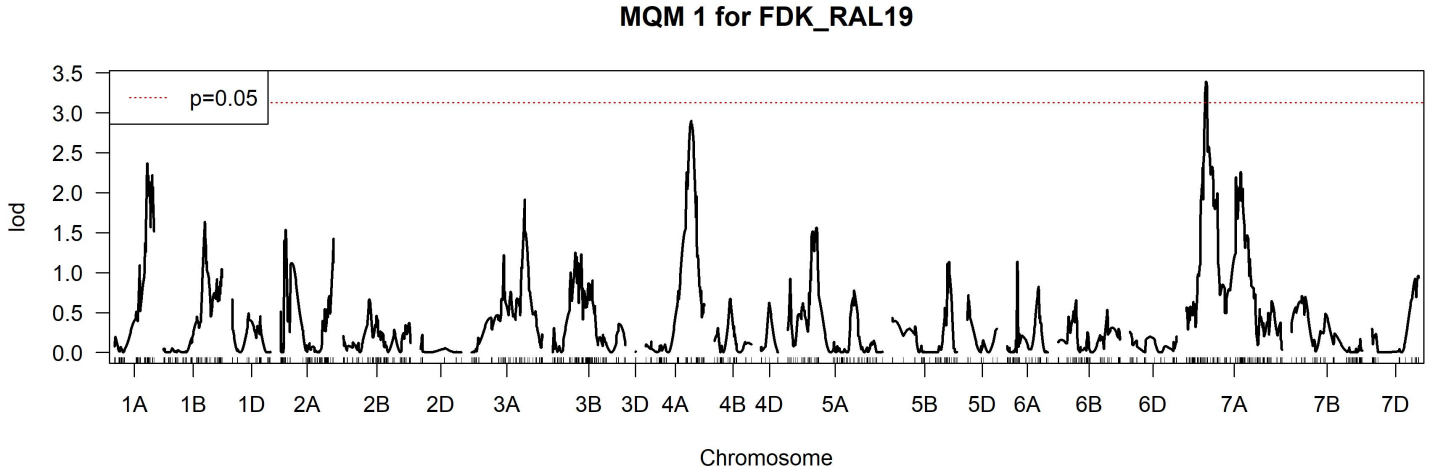
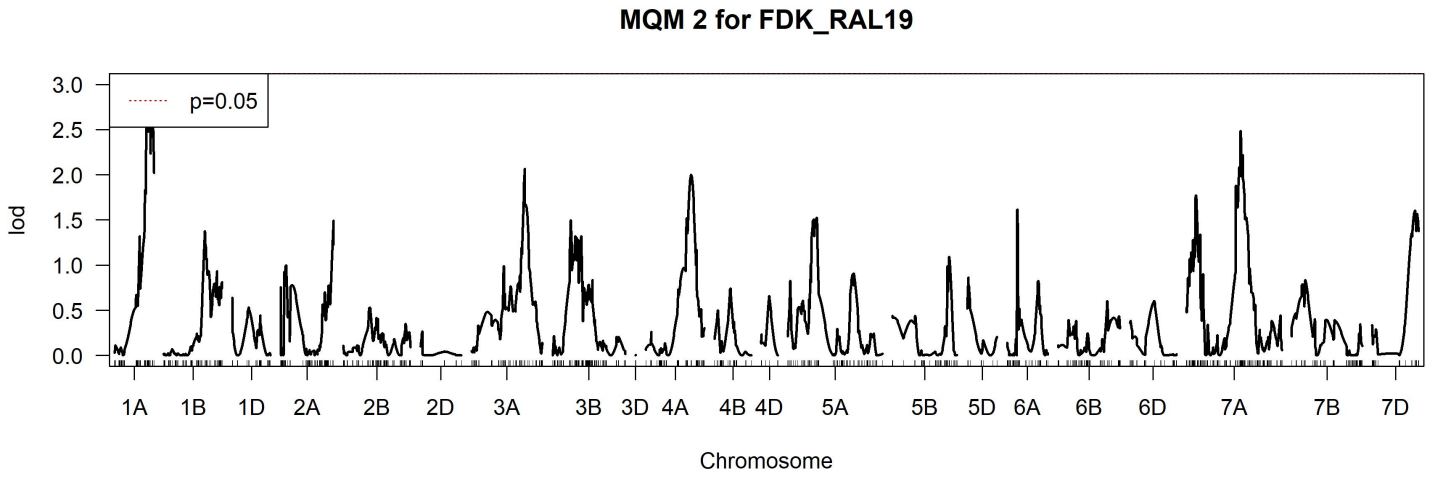
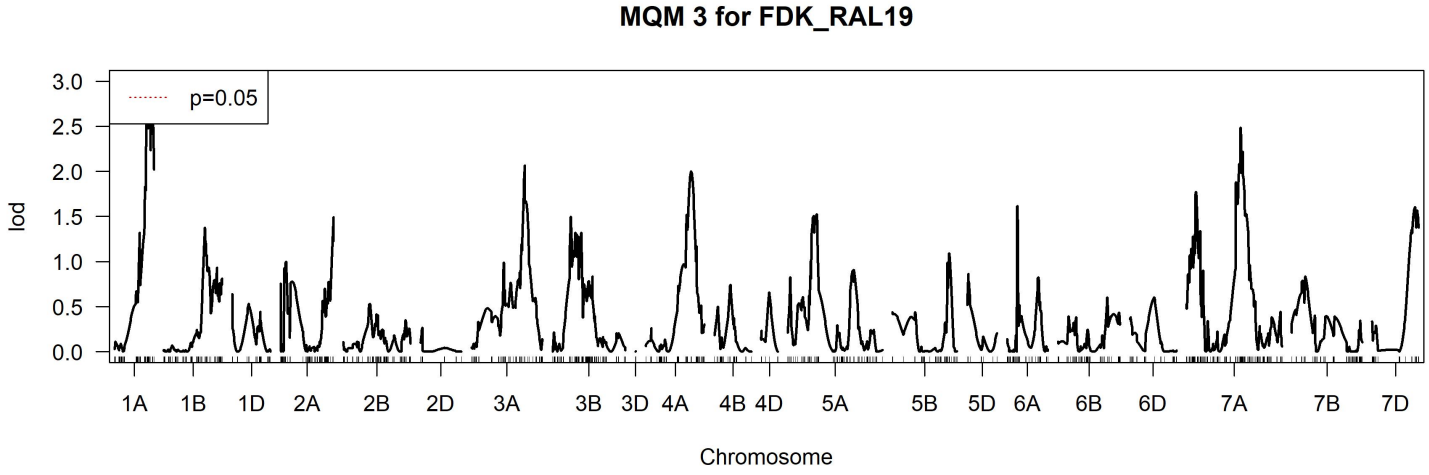
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

Fusarium Damaged Kernels in Raleigh, NC - 2019






MQM 2 for FDK_RAL19
p=0.05
lod
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome


MQM 3 for FDK_RAL19
p=0.05
lod
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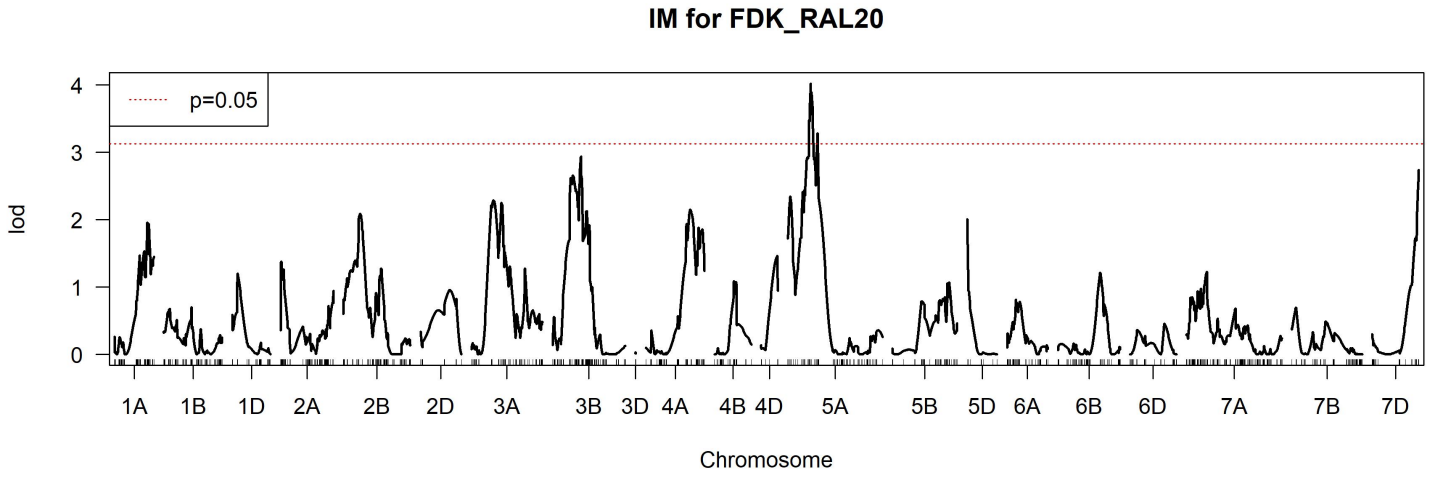
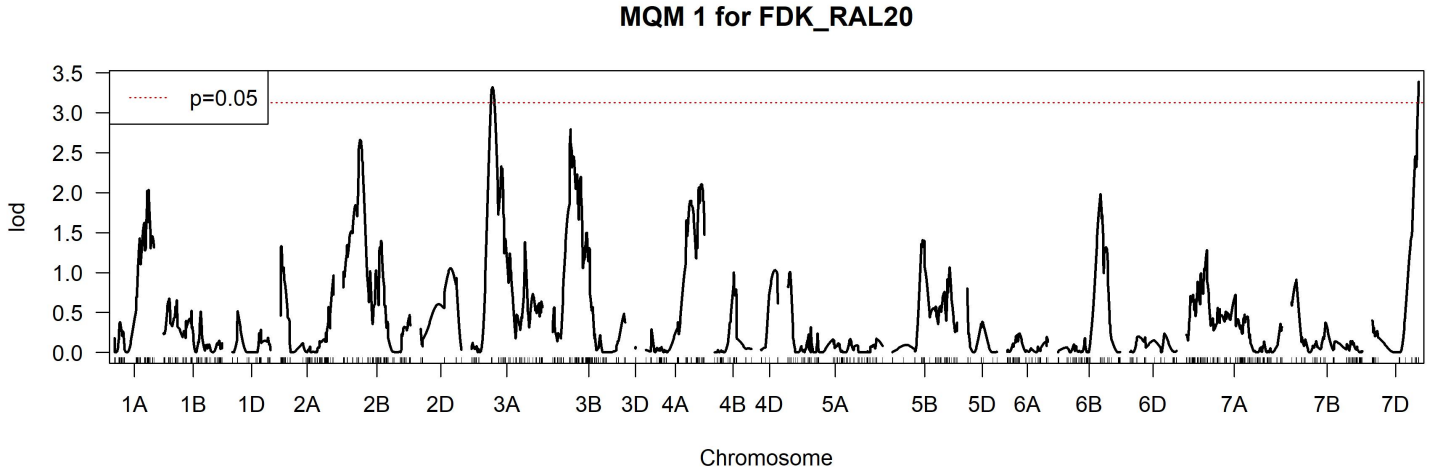
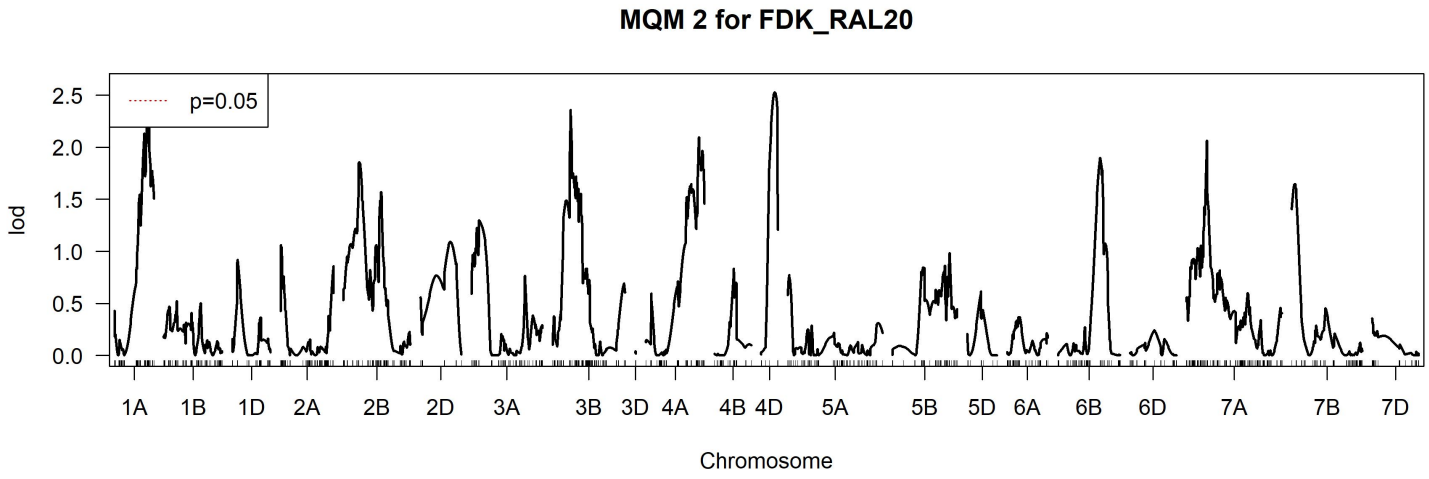
2.5
2.0
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome

Fusarium Damaged Kernels in Raleigh, NC - 2020






MQM 2 for FDK_RAL20
p=0.05
lod
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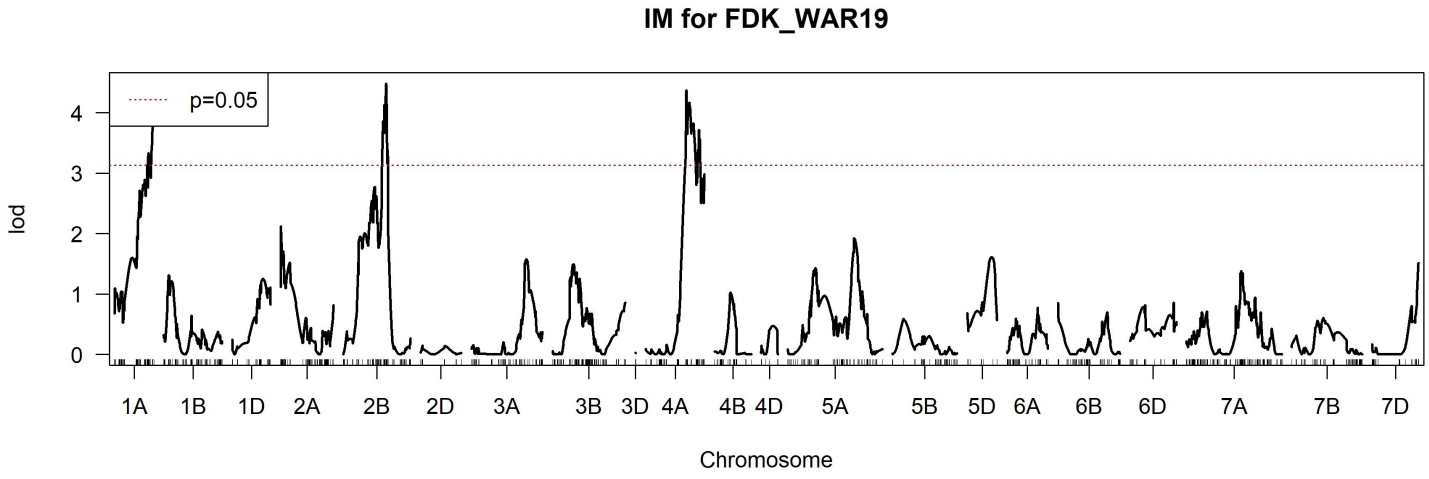
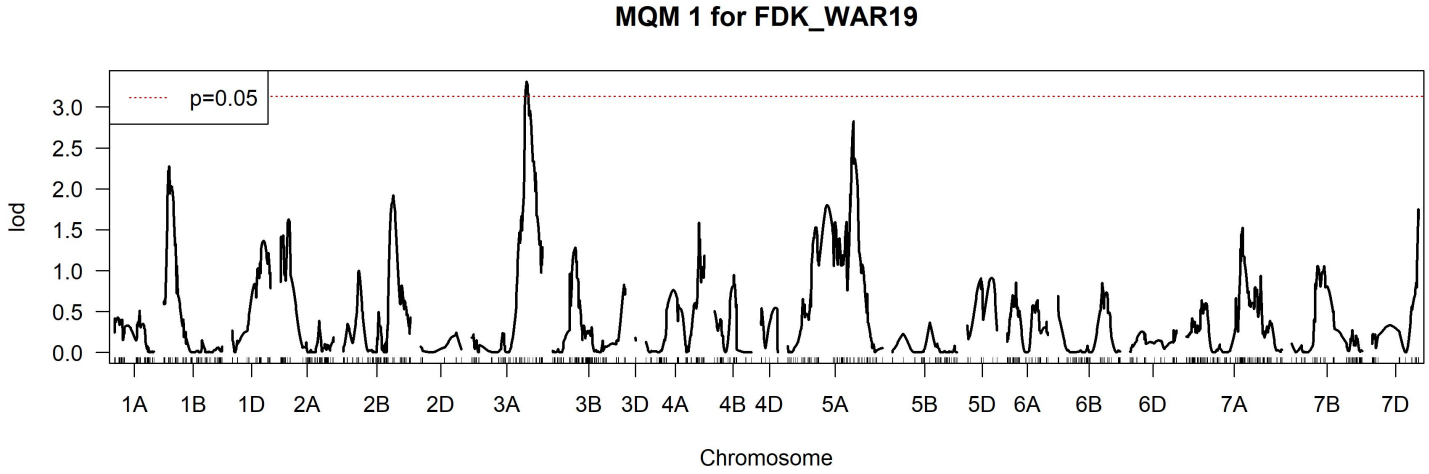
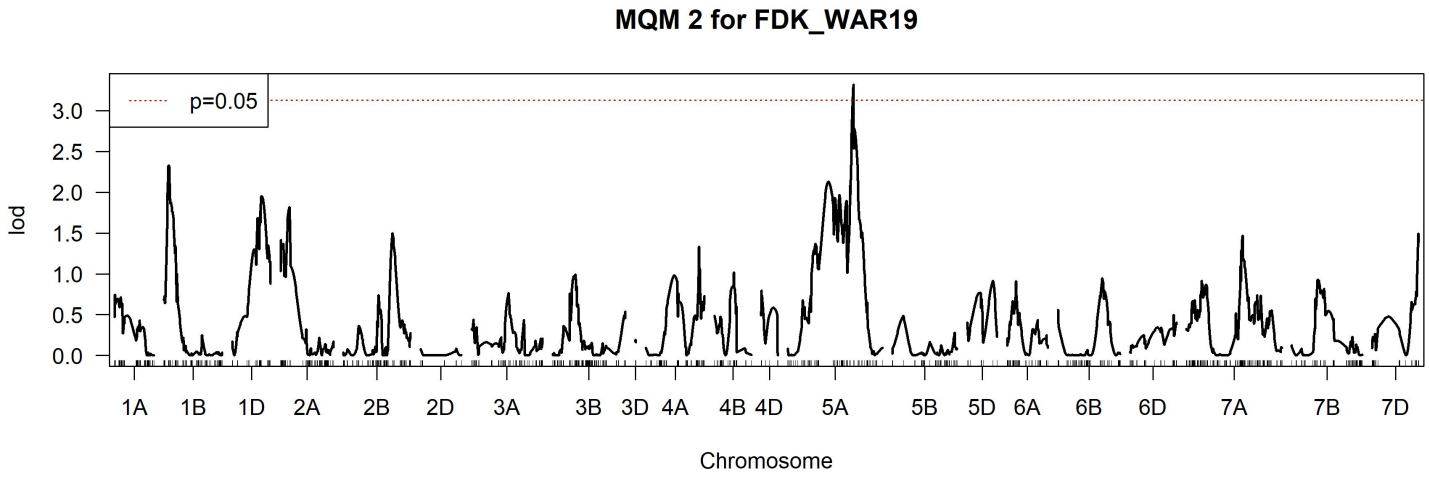
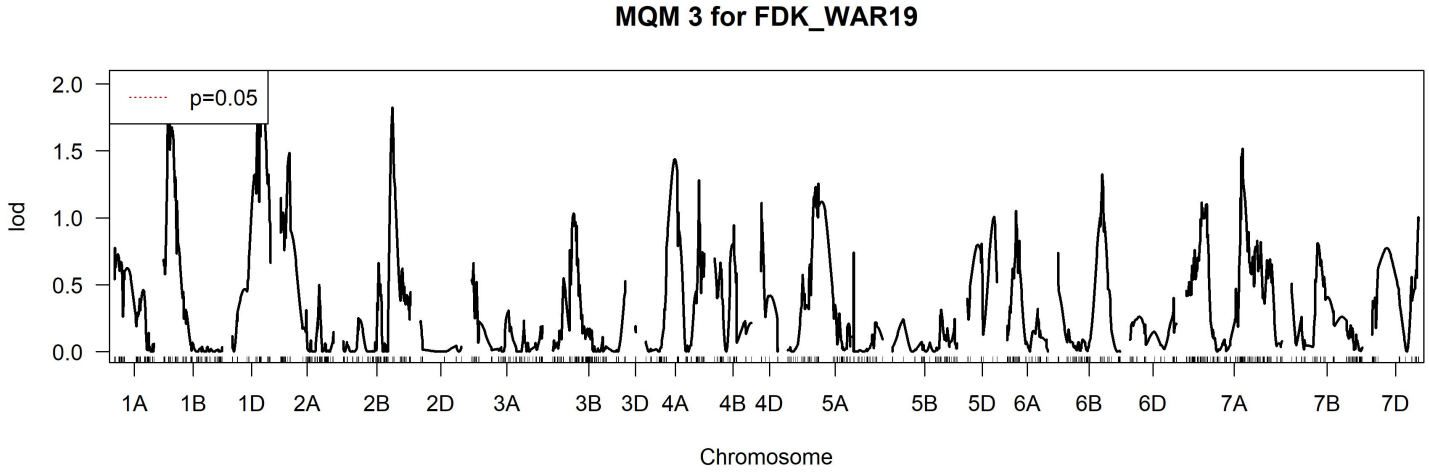
2.0
1.5
1.0
0.5
0.0
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

Fusarium Damaged Kernels in Warsaw, VA - 2019

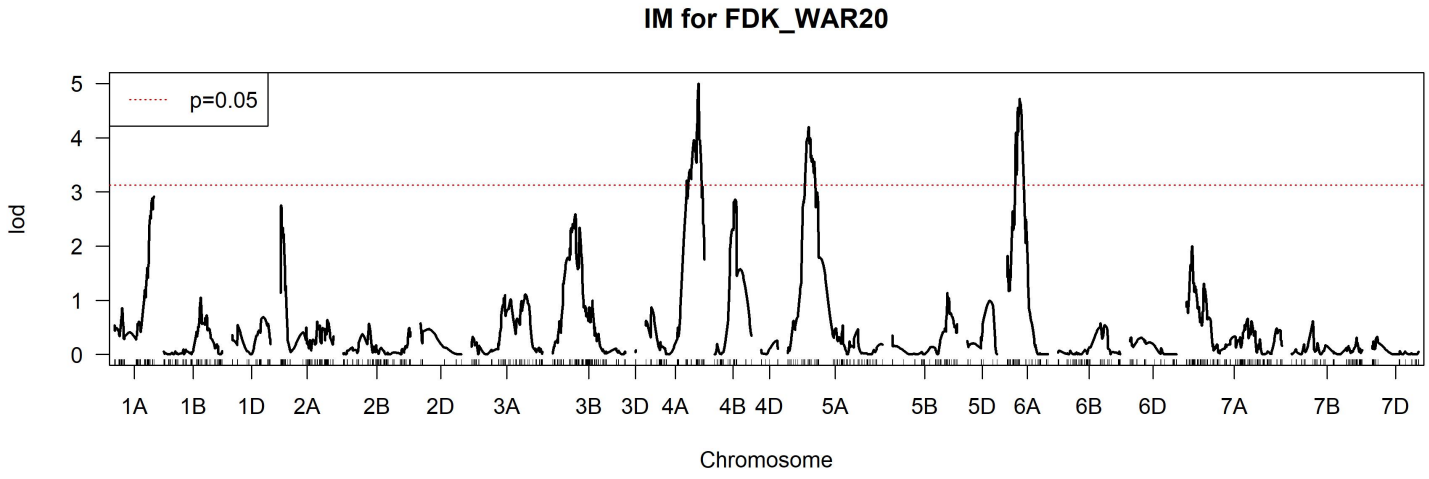


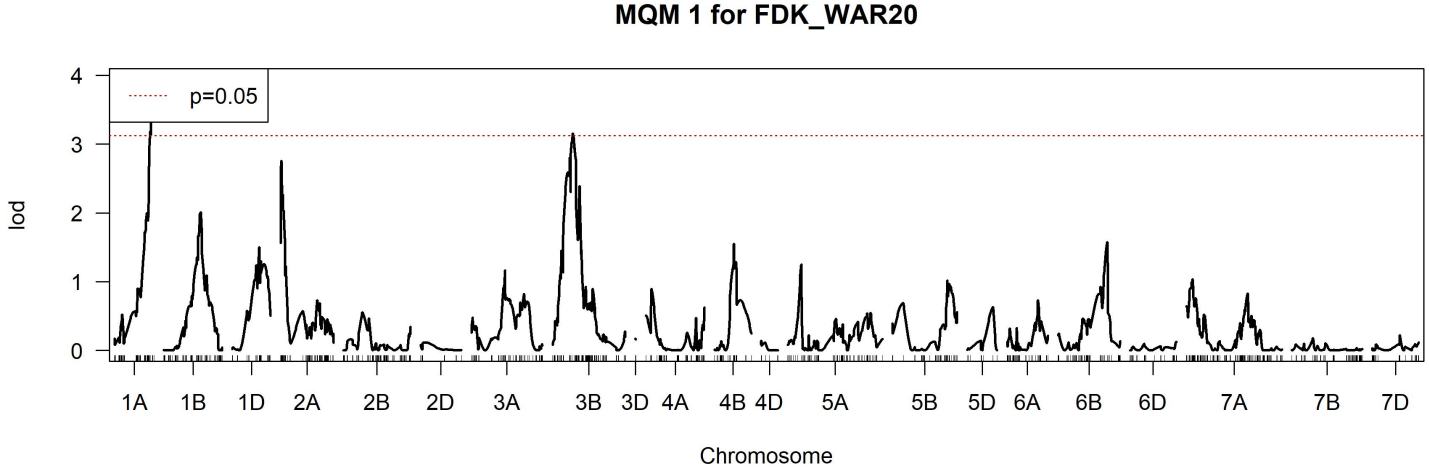


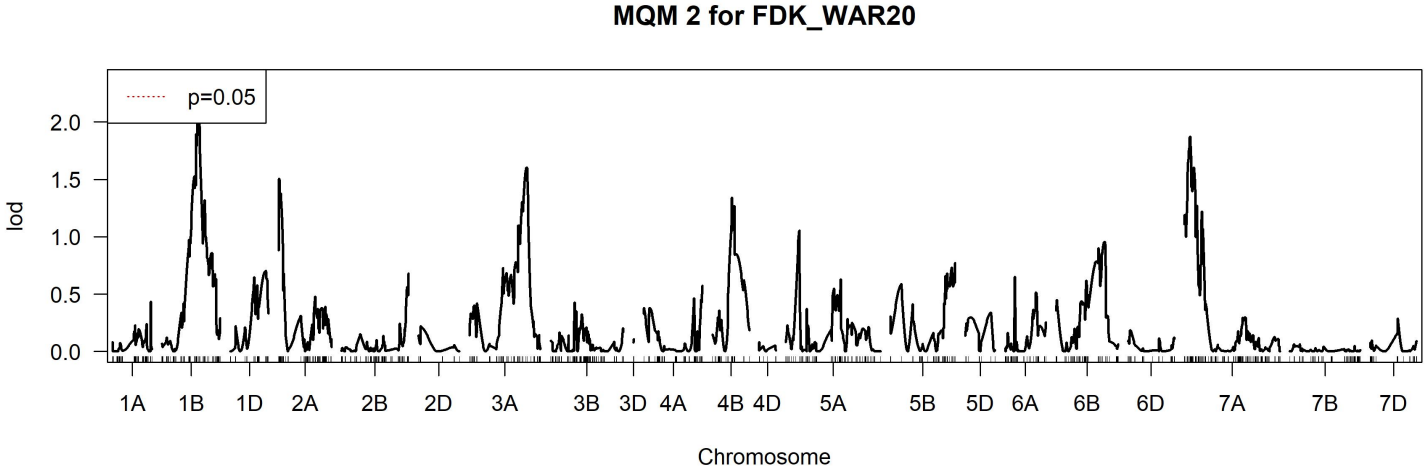

MQM 2 for FDK_WAR19
p=0.05
lod
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome


MQM 3 for FDK_WAR19
p=0.05
lod
2.0
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome

Fusarium Damaged Kernels in Warsaw, VA - 2020






MQM 2 for FDK_WAR20
p=0.05
lod
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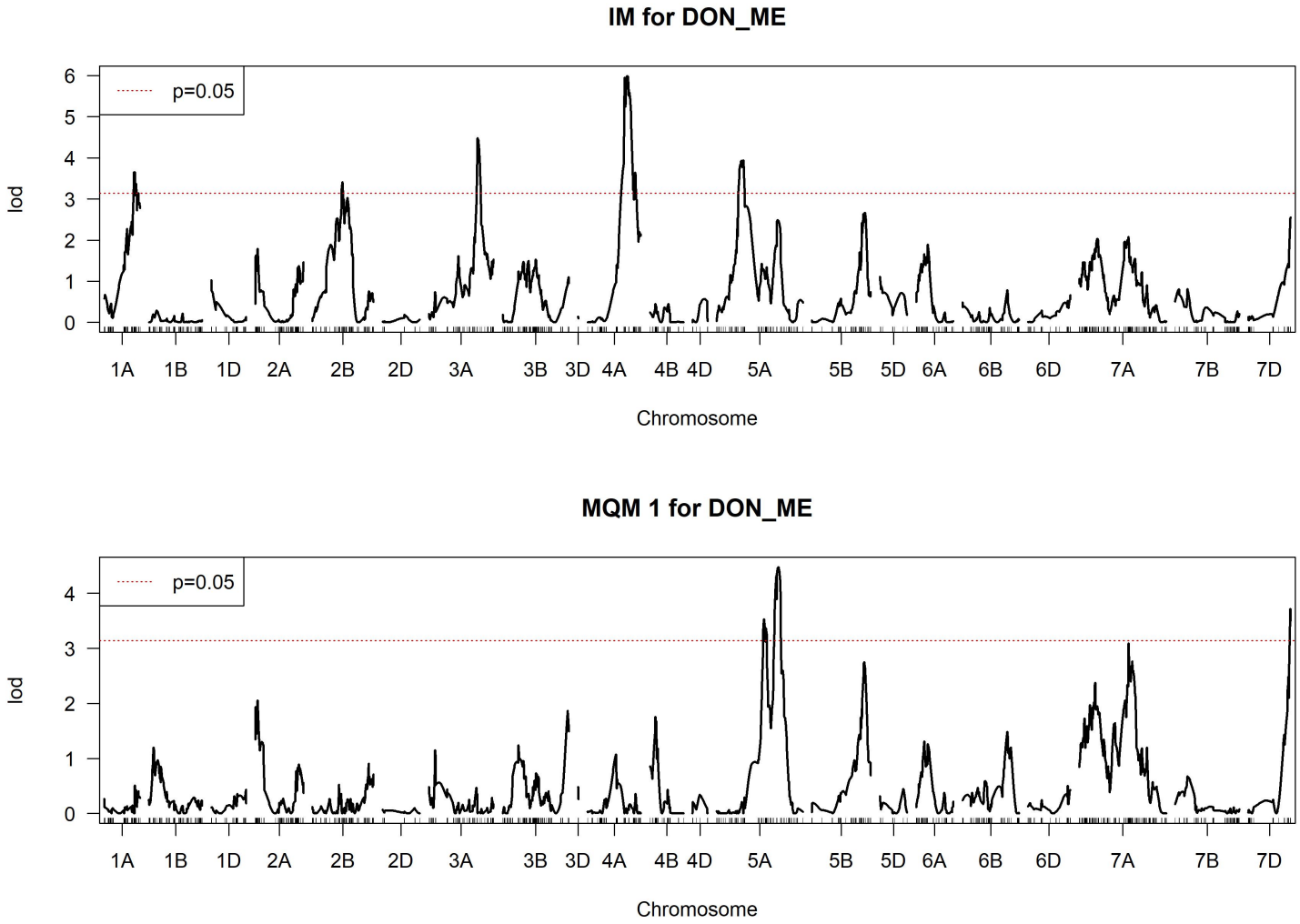
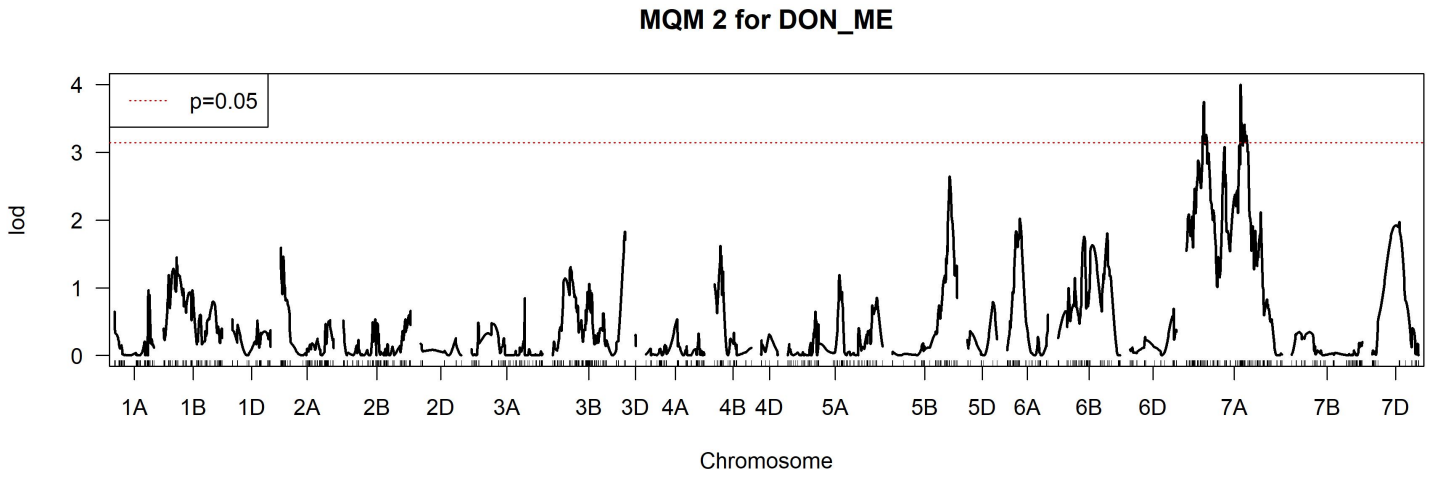
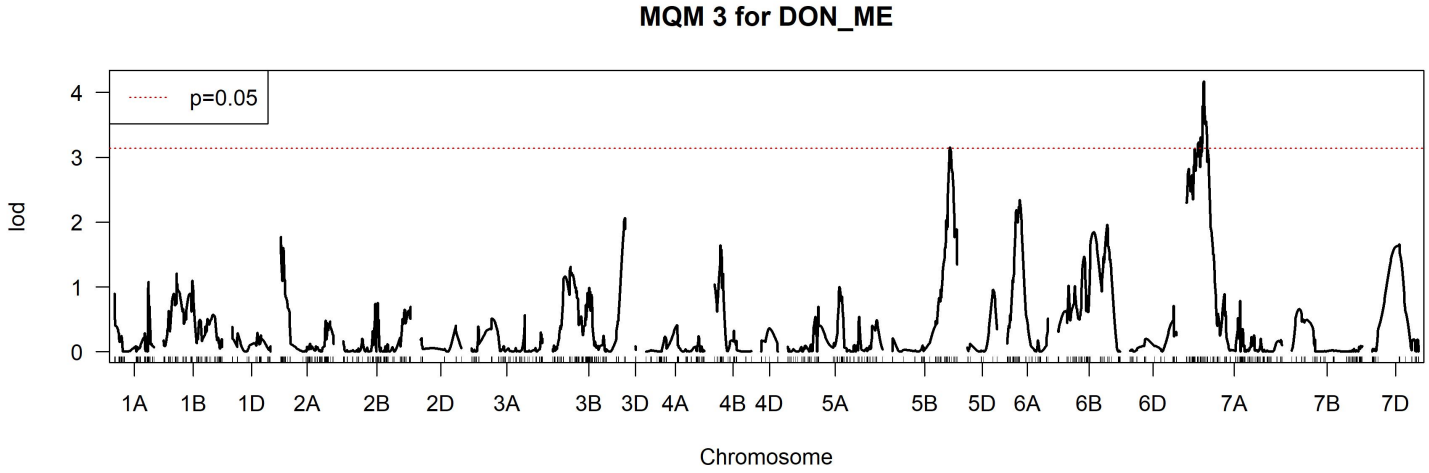
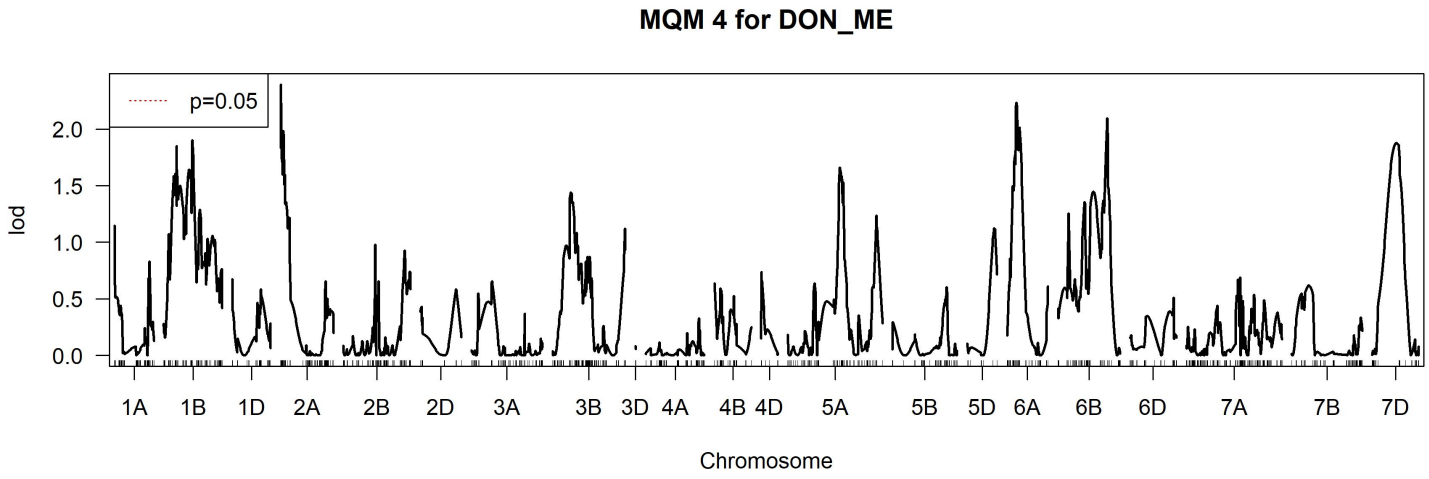
1.5
1.0
0.5
0.0
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

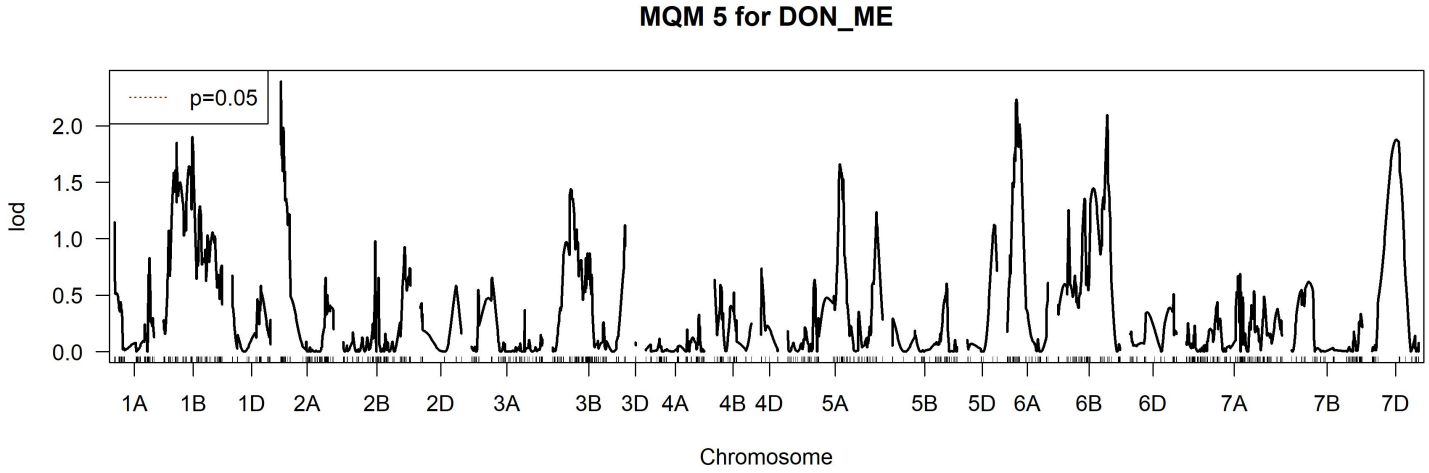
Deoxynivalenol Content Across All Environments




MQM 2 for DON_ME
p=0.05
lod
0
1
2
3
4
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome


MQM 3 for DON_ME
p=0.05
lod
0
1
2
3
4
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome


MQM 4 for DON_ME
p=0.05
lod
2.0
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome


MQM 5 for DON_ME
p=0.05
lod
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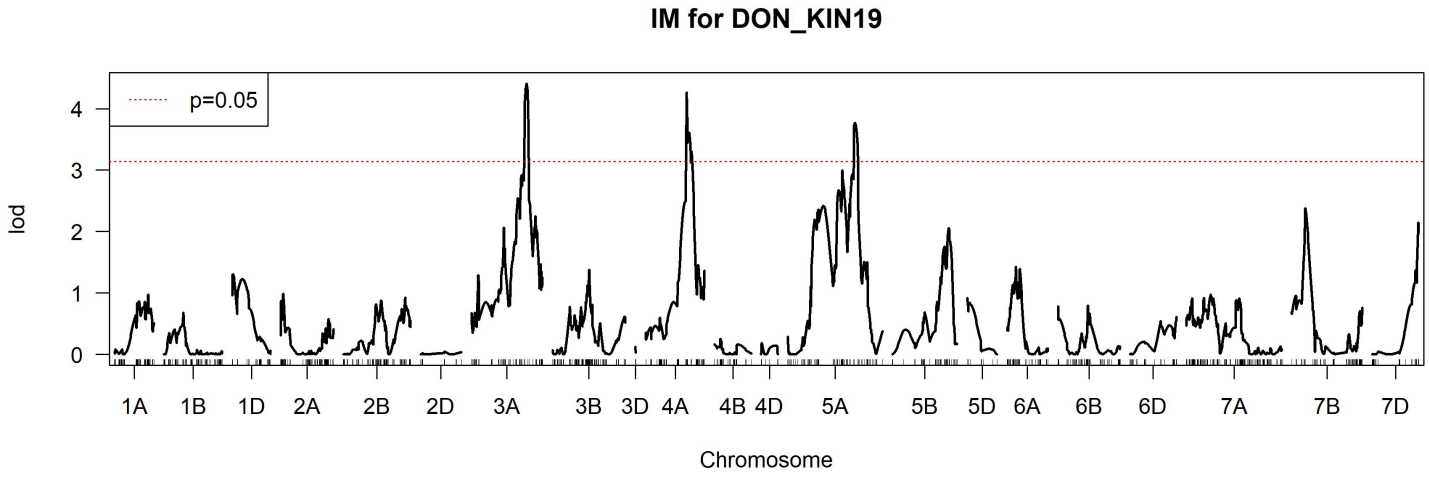
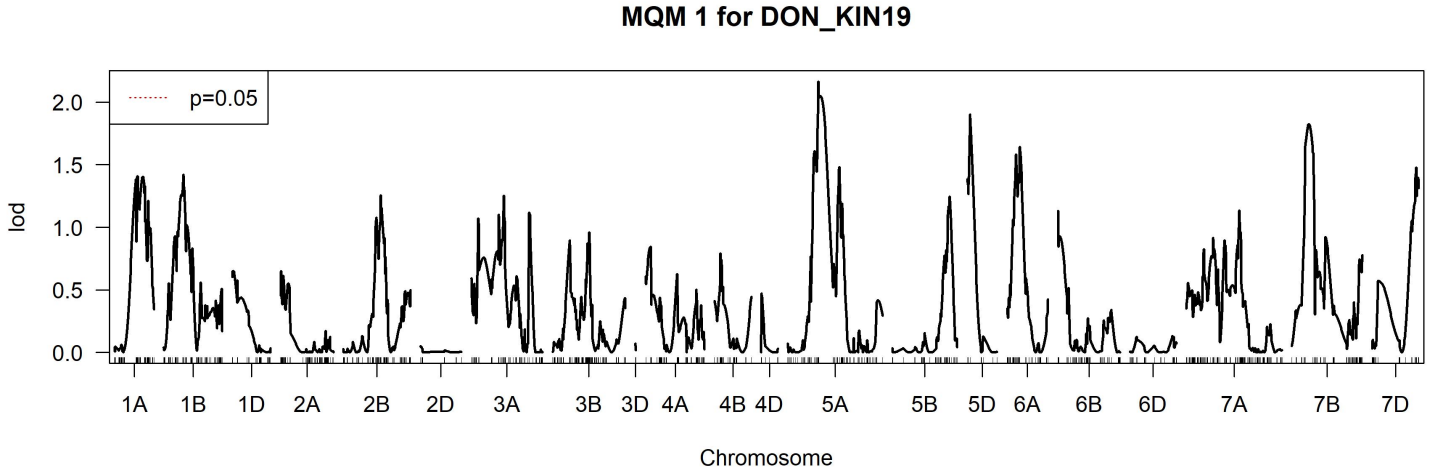
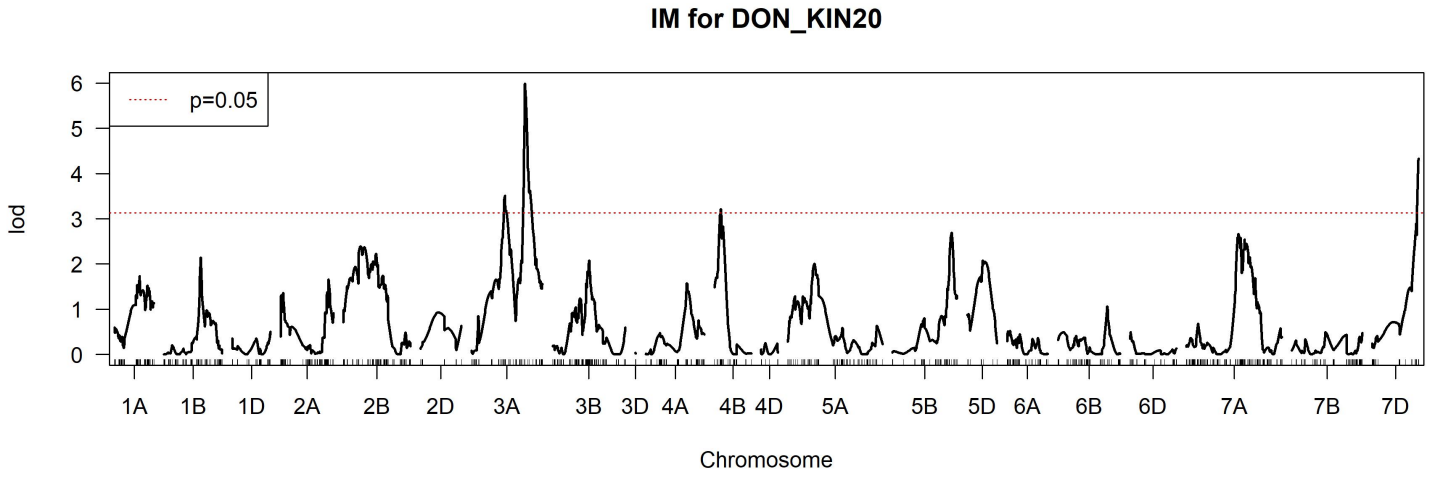
1.5
1.0
0.5
0.0
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome

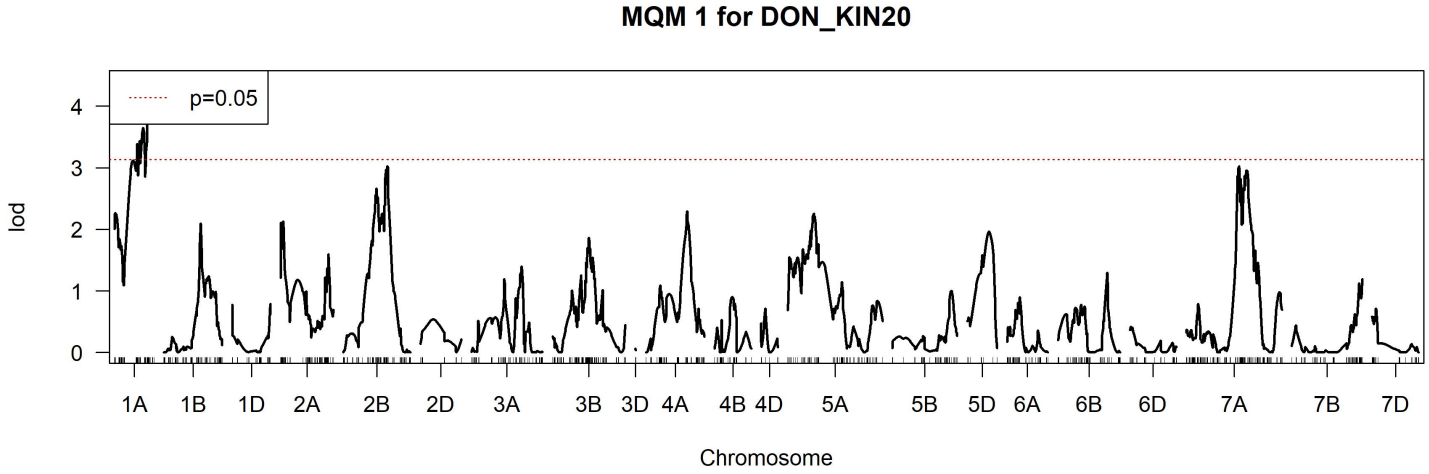
Deoxynivalenol Content in Kinston, NC - 2019

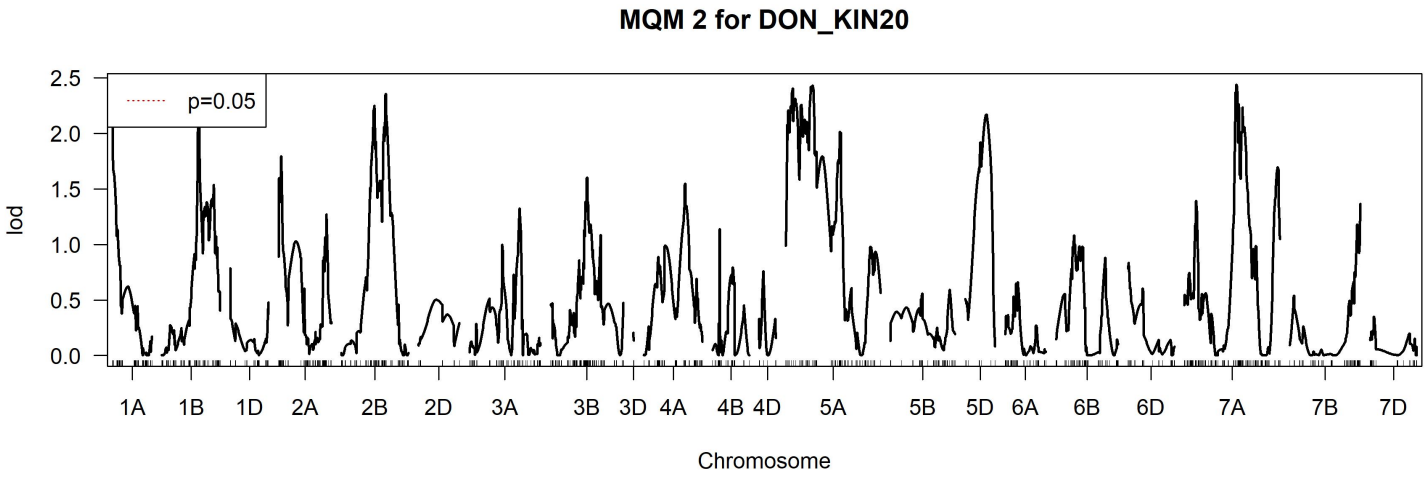




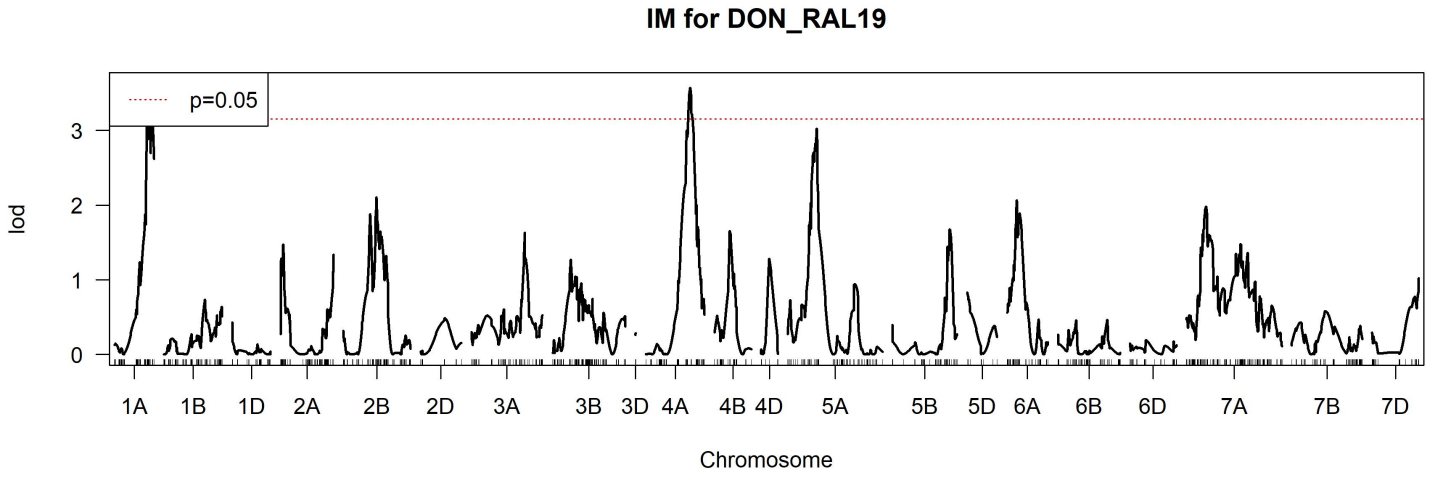
Deoxynivalenol Content in Kinston, NC - 2020

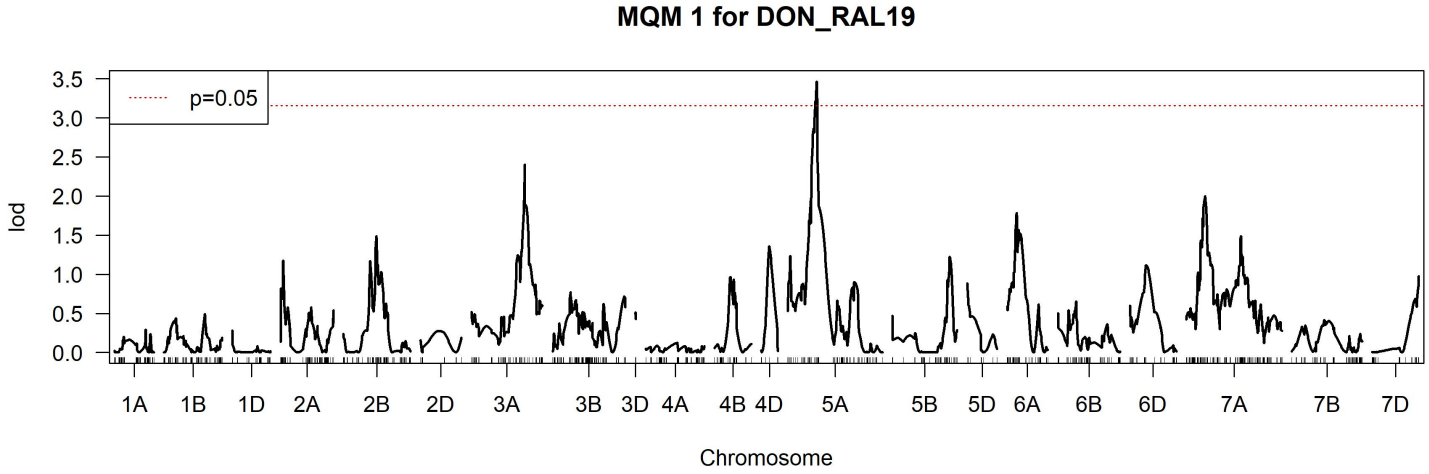


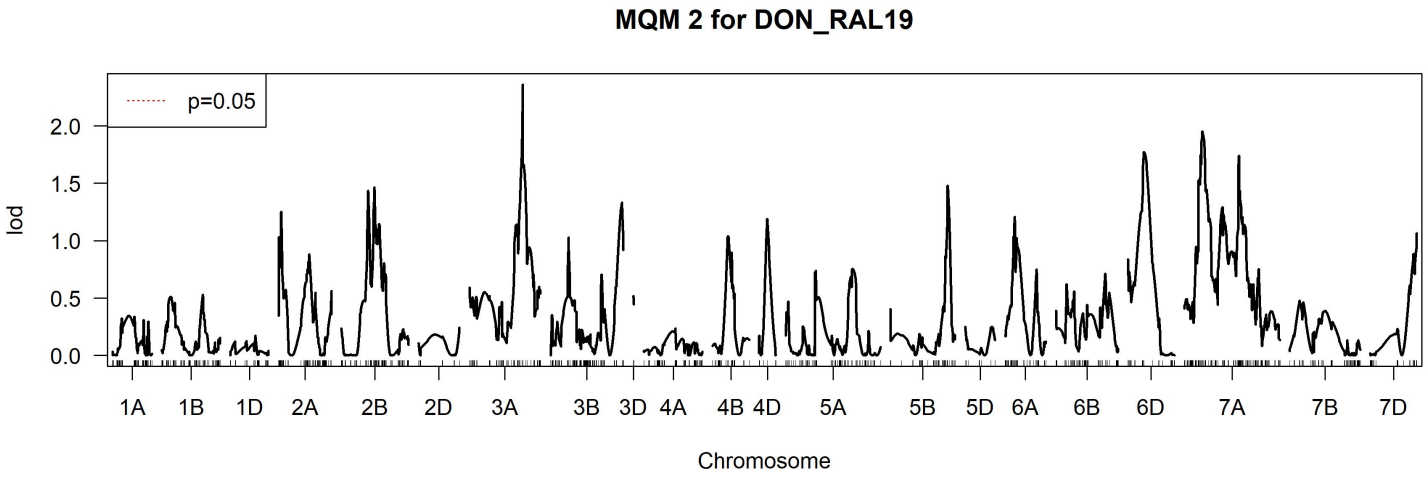



MQM 2 for DON_KIN20
p=0.05
lod
2.5
2.0
1.5
1.0
0.5
0.0
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

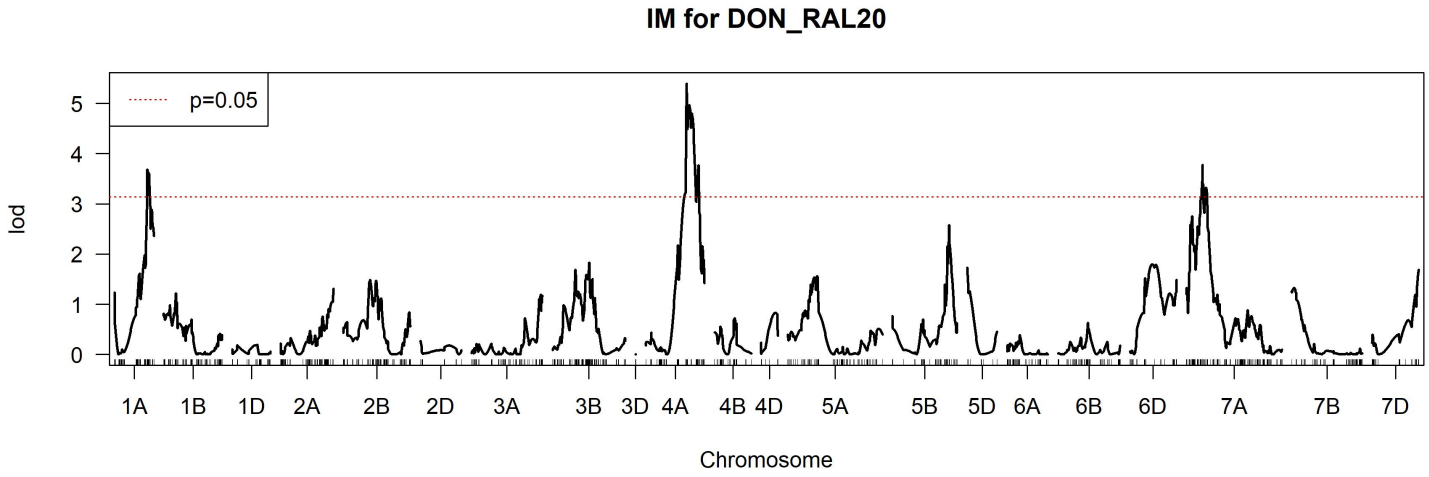
Deoxynivalenol Content in Raleigh, NC - 2019

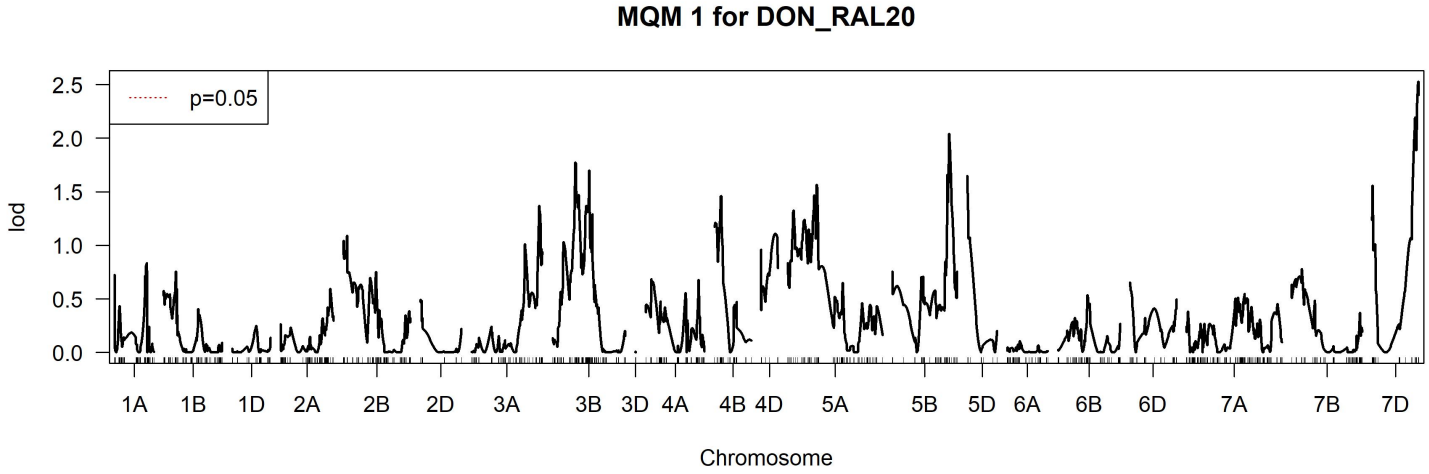




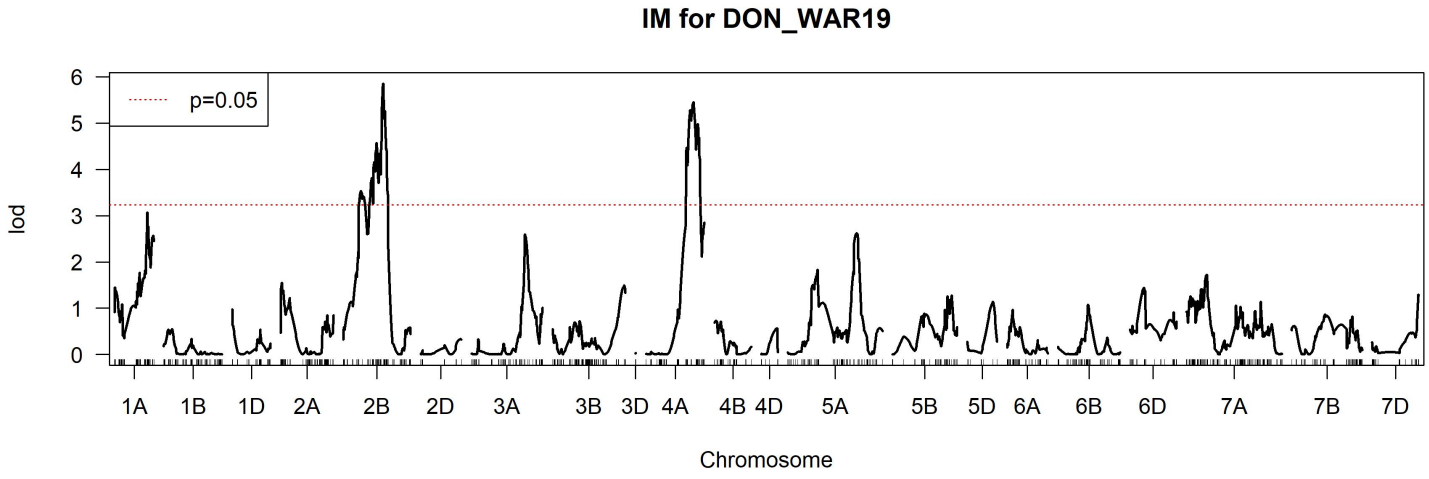

MQM 2 for DON_RAL19
p=0.05
lod
2.0
1.5
1.0
0.5
0.0
1A
1B
1D
2A
2B
2D
3A
3B
3D
4A
4B
4D
5A
5B
5D
6A
6B
6D
7A
7B
7D
Chromosome

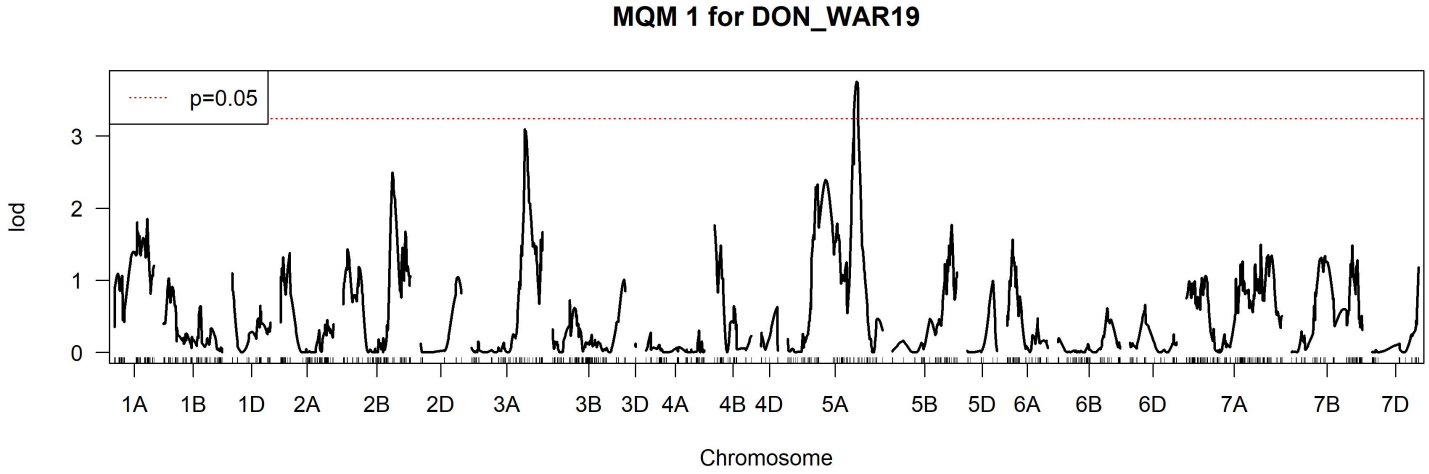
Deoxynivalenol Content in Raleigh, NC - 2020

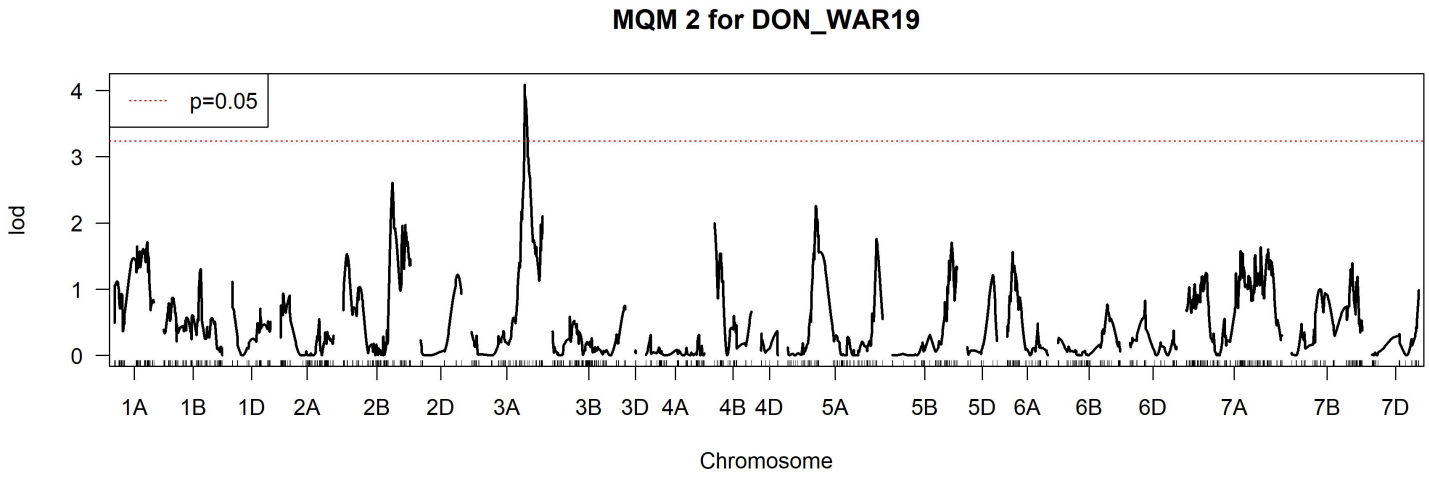


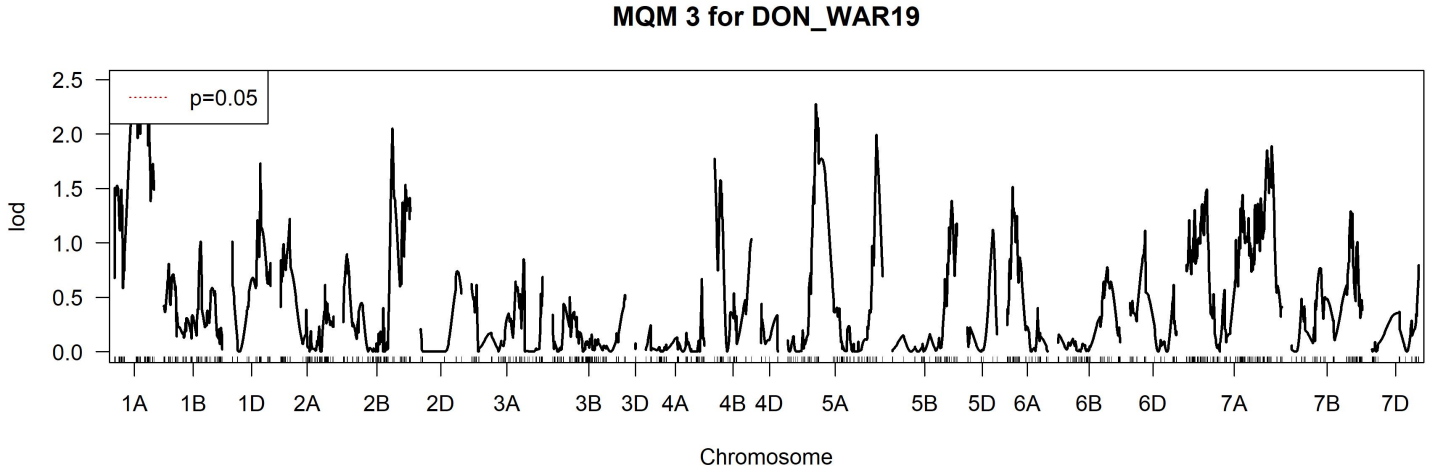


Deoxynivalenol Content in Warsaw, VA - 2019

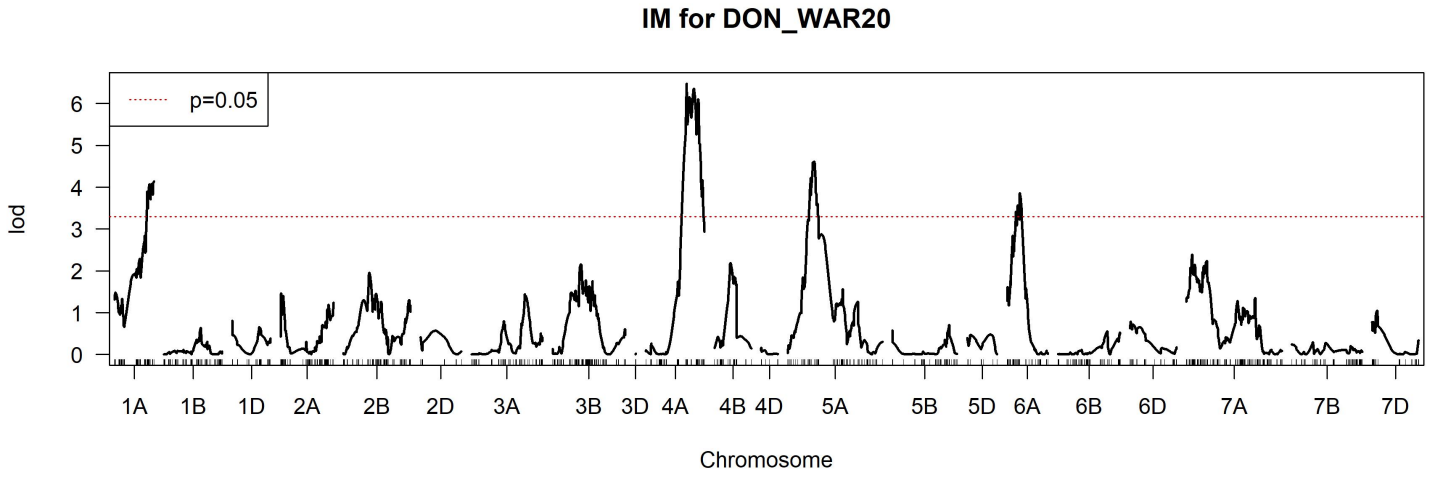


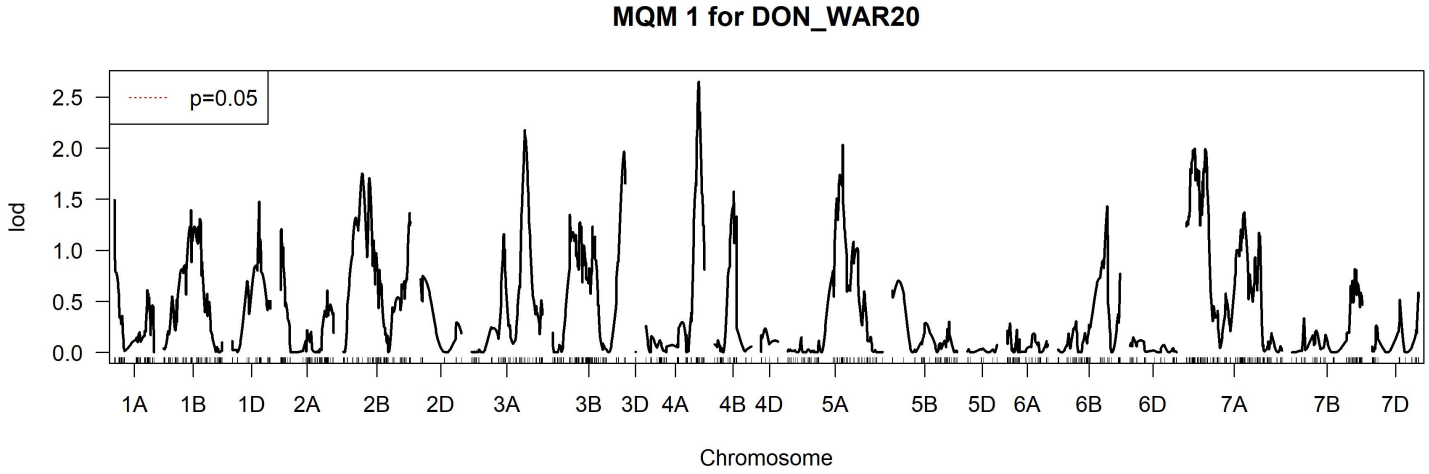



MQM 2 for DON_WAR19
p=0.05
lod
0
1
2
3
4
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome


MQM 3 for DON_WAR19
p=0.05
lod
0.0
0.5
1.0
1.5
2.0
2.5
1A 1B 1D 2A 2B 2D 3A 3B 3D 4A 4B 4D 5A 5B 5D 6A 6B 6D 7A 7B 7D
Chromosome

Deoxynivalenol Content in Warsaw, VA - 2020





QTL Scan Information

The following table displays the output results of each scan from each environment by trait combination. Traits assessed are heading date (HD) and plant height (PH), Fusarium head blight (FHB) visual ratings (VR), Fusarium-damaged kernels (FDK), and deoxynivalenol (DON). Environments assessed are Kinston, NC 2018-2019 (KIN19) and 2019-2020 (KIN20); Raleigh, NC 2018-2019 (RAL19) and 2019-2020 (RAL20); and Warsaw, VA 2018-2019 (WAR19) and 2019-2020 (WAR20). Multi-environment scans are denoted "ME". The column "QTL" column denotes the name of the QTL, the trait to which it belongs (e.g., Hd=HD, Pht=PH, Fvr=VR, Fdk=FDK, Don=DON) and the chromosome on which the QTL is located.

QTL	Environment	Left Position (cM)	Peak Position (cM)	Right Position (cM)	LOD	PV	Effect
QDon.nc-1A	ME	61.8	83.0	99.6	6.41	5.87	-0.12
QDon.nc-2B	ME	62.2	83.8	110.3	6.88	6.35	-0.12
QDon.nc-3A	ME	128.2	136.2	146.1	9.02	8.59	-0.14
QDon.nc-4A	ME	100.1	110.0	127.2	5.39	4.86	-0.11
QDon.nc-5A.1	ME	55.0	74.0	177.9	8.30	7.81	-0.13
QDon.nc-5A.2	ME	126.6	172.0	180.7	6.67	6.14	-0.12
QDon.nc-5B	ME	134.3	146.0	164.1	3.44	3.02	-0.08
QDon.nc-7A.1	ME	1.6	44.4	62.1	4.81	4.31	-0.10
QDon.nc-7A.2	ME	23.4	137.8	159.8	4.75	4.25	-0.10
QDon.nc-7D	ME	108.6	117.2	118.0	4.52	4.03	0.10
QDon.nc-3A	KIN19	123.8	140.0	146.1	5.32	10.99	-0.24
QDon.nc-4A	KIN19	100.1	103.6	127.2	4.76	9.75	-0.23
QDon.nc-5A	KIN19	73.5	170.0	180.7	5.62	11.65	-0.26
QDon.nc-1A	KIN20	25.1	88.1	99.6	4.62	8.26	-0.15
QDon.nc-3A	KIN20	133.7	136.2	143.5	8.84	16.83	-0.22
QDon.nc-4B	KIN20	6.8	16.0	34.3	4.89	8.79	-0.16
QDon.nc-7D	KIN20	109.6	118.0	118.0	4.58	8.19	0.15
QDon.nc-1A	RAL19	78.5	88.1	99.6	3.42	7.60	-0.18
QDon.nc-4A	RAL19	83.2	112.0	127.2	3.02	6.67	-0.17
QDon.nc-5A	RAL19	58.5	73.5	78.7	3.51	7.81	-0.18
QDon.nc-1A	RAL20	78.5	83.0	99.6	3.84	8.44	-0.21
QDon.nc-4A	RAL20	100.1	103.6	127.2	3.18	6.92	-0.19
QDon.nc-7A	RAL20	9.0	41.1	62.1	3.58	7.85	-0.20
QDon.nc-2B	WAR19	80.2	100.7	110.3	8.74	15.93	-0.22
QDon.nc-3A	WAR19	128.2	135.8	155.4	4.09	6.97	-0.15
QDon.nc-4A	WAR19	100.1	120.0	139.8	6.26	11.01	-0.20
QDon.nc-5A	WAR19	66.9	174.0	186.4	4.80	8.26	-0.17
QDon.nc-1A	WAR20	66.4	99.6	99.6	5.36	9.34	-0.15
QDon.nc-4A	WAR20	83.2	103.6	139.8	7.89	14.26	-0.19
QDon.nc-5A	WAR20	43.0	66.9	78.7	5.12	8.90	-0.15
QDon.nc-6A	WAR20	9.0	32.4	47.1	2.59	4.34	-0.11
QFdk.nc-1A	ME	61.8	99.6	99.6	9.32	9.48	-0.13
QFdk.nc-2A	ME	0.0	0.8	12.1	5.88	5.68	-0.10
QFdk.nc-3A	ME	75.5	136.2	155.4	7.61	7.55	-0.12
QFdk.nc-3B	ME	28.0	52.0	75.6	4.07	3.84	-0.08
QFdk.nc-4A	ME	100.1	118.0	145.3	6.14	5.96	-0.10
QFdk.nc-5A	ME	43.0	64.0	115.0	5.95	5.76	-0.10
QFdk.nc-6A	ME	9.0	22.4	47.1	4.02	3.78	-0.08
QFdk.nc-7A	ME	34.7	47.4	62.1	6.97	6.84	-0.11
QFdk.nc-7D	ME	101.0	118.0	118.0	6.48	6.32	0.10
QFdk.nc-3A	KIN19	123.8	140.0	155.4	4.73	10.62	-0.19
QFdk.nc-5A	KIN19	158.0	172.0	200.1	3.33	7.33	-0.16
QFdk.nc-6A	KIN19	0.0	22.4	47.1	3.67	8.12	-0.16
QFdk.nc-1A	KIN20	25.1	52.0	75.9	3.58	6.97	-0.13
QFdk.nc-2A	KIN20	0.0	0.8	18.7	2.27	4.34	-0.10
QFdk.nc-3A	KIN20	52.1	76.3	143.5	2.89	5.56	-0.11
QFdk.nc-3B	KIN20	28.0	50.0	72.9	2.33	4.45	-0.10
QFdk.nc-4A	KIN20	105.8	133.3	148.6	4.39	8.64	-0.14
QFdk.nc-2A	RAL19	0.0	7.0	12.1	4.52	10.11	-0.13
QFdk.nc-6A	RAL19	4.7	25.1	47.1	3.54	7.80	-0.12
QFdk.nc-7A	RAL19	36.6	50.0	143.8	3.39	7.46	-0.12
QFdk.nc-3A	RAL20	19.6	54.0	81.2	3.09	6.82	-0.16

QTL	Environment	Left Position (cM)	Peak Position (cM)	Right Position (cM)	LOD	PV	Effect
QFdk.nc-5A	RAL20	43.0	57.9	78.7	5.76	13.20	-0.21
QFdk.nc-7D	RAL20	101.0	118.0	118.0	2.79	6.13	0.14
QFdk.nc-1A	WAR19	61.8	98.0	99.6	4.87	8.90	-6.31
QFdk.nc-2B	WAR19	95.6	107.8	113.5	5.00	9.15	-6.35
QFdk.nc-3A	WAR19	128.2	140.0	165.4	3.86	6.95	-5.66
QFdk.nc-4A	WAR19	83.2	102.7	148.6	4.36	7.91	-5.66
QFdk.nc-5A	WAR19	78.7	166.4	180.7	3.12	5.56	-4.75
QFdk.nc-1A	WAR20	86.6	96.3	99.6	3.11	5.25	-0.13
QFdk.nc-3B	WAR20	26.7	52.0	72.8	2.59	4.34	-0.13
QFdk.nc-4A	WAR20	115.5	133.3	141.7	6.27	11.06	-0.19
QFdk.nc-5A	WAR20	37.9	53.1	77.7	4.42	7.60	-0.16
QFdk.nc-6A	WAR20	18.5	32.0	47.1	4.06	6.94	-0.16
QHd.nc-4A	ME	52.0	82.0	114.4	5.47	6.36	-0.51
QHd.nc-5A.1	ME	130.5	138.0	143.2	13.77	18.07	-0.82
QHd.nc-5A.2	ME	200.1	208.0	217.7	9.41	11.59	-0.66
QHd.nc-6D	ME	61.2	82.0	107.6	1.71	1.89	-0.26
QHd.nc-7B	ME	11.4	30.0	53.7	7.69	9.24	-0.59
QHd.nc-4A	KIN20	52.0	82.0	100.1	3.19	4.61	-0.62
QHd.nc-5A.1	KIN20	121.9	140.0	143.2	13.44	22.59	-1.36
QHd.nc-5A.2	KIN20	203.4	209.7	217.7	5.40	8.06	-0.81
QHd.nc-7B	KIN20	11.4	32.0	53.7	5.26	7.83	-0.82
QHd.nc-4A	RAL19	52.0	80.0	127.2	3.72	5.26	-0.64
QHd.nc-5A.1	RAL19	121.9	137.7	143.2	8.94	13.63	-0.90
QHd.nc-5A.2	RAL19	188.0	203.0	224.2	5.37	7.77	-0.68
QHd.nc-6D	RAL19	61.2	84.0	107.6	2.55	3.54	0.44
QHd.nc-7B	RAL19	24.9	30.8	53.7	5.73	8.34	-0.68
QHd.nc-5A.1	RAL20	126.6	140.0	209.7	5.68	10.87	-0.67
QHd.nc-5A.2	RAL20	200.1	206.9	213.4	4.40	8.27	-0.58
QHd.nc-7B	RAL20	11.4	28.0	53.7	5.67	10.86	-0.66
QHd.nc-5A	WAR20	188.0	198.0	203.0	11.66	20.13	-0.67
QHd.nc-6D	WAR20	61.2	84.0	107.6	3.12	4.76	0.34
QHd.nc-7A	WAR20	85.0	98.1	193.9	3.05	4.64	0.32
QHd.nc-7B	WAR20	11.4	30.8	53.7	5.17	8.12	-0.44
QPht.nc-4A	ME	52.0	74.0	100.1	3.94	8.00	-1.82
QPht.nc-6A	ME	21.7	34.0	47.1	10.02	22.23	2.68
QPht.nc-4A	KIN20	44.8	70.0	100.1	3.31	7.04	-2.04
QPht.nc-6A	KIN20	21.7	34.0	47.1	8.66	19.86	2.92
QPht.nc-4A	RAL20	52.0	79.0	100.1	3.94	8.46	-1.63
QPht.nc-6A	RAL20	0.0	27.6	47.1	8.44	19.33	2.48
QFvr.nc-2A	ME	0.0	0.8	12.1	3.88	4.99	-0.07
QFvr.nc-2B	ME	35.0	67.9	86.1	5.34	7.01	-0.09
QFvr.nc-3B	ME	43.7	58.0	93.0	5.27	6.91	-0.08
QFvr.nc-4A	ME	105.8	133.3	148.6	3.48	4.45	-0.07
QFvr.nc-5A	ME	50.9	57.9	57.9	5.22	6.84	-0.09
QFvr.nc-6A	ME	18.5	32.4	47.1	6.44	8.59	-0.09
QFvr.nc-7D	ME	101.0	118.0	118.0	5.90	7.81	0.09
QFvr.nc-2B	KIN19	38.4	67.9	104.4	3.58	6.45	-0.11
QFvr.nc-3B	KIN19	28.0	46.1	88.6	4.07	7.37	-0.11
QFvr.nc-5A	KIN19	43.0	57.9	57.9	3.30	5.92	-0.10
QFvr.nc-6A	KIN19	18.5	24.0	47.1	4.76	8.72	-0.12
QFvr.nc-7D	KIN19	101.0	117.2	118.0	3.58	6.45	0.10
QFvr.nc-2A	RAL19	0.0	7.0	23.3	4.07	7.13	-0.08
QFvr.nc-2B	RAL19	47.7	66.0	102.8	5.22	9.31	-0.10
QFvr.nc-4A	RAL19	105.8	114.4	134.7	2.84	4.89	-0.07
QFvr.nc-5A	RAL19	43.0	57.9	57.9	4.04	7.07	-0.08
QFvr.nc-6A	RAL19	9.0	32.4	47.1	3.34	5.78	-0.08
QFvr.nc-2B	RAL20	34.3	42.0	87.6	3.76	7.17	-0.11
QFvr.nc-3B	RAL20	43.7	74.9	79.6	2.87	5.39	-0.09
QFvr.nc-5A	RAL20	43.0	57.9	66.9	5.84	11.46	-0.13
QFvr.nc-5B	RAL20	137.4	145.0	150.2	3.17	5.99	-0.09
QFvr.nc-3B	WAR20	49.8	70.0	77.0	4.23	9.68	-0.44
QFvr.nc-4A	WAR20	115.5	134.0	145.3	5.35	12.44	-0.50