

Breeding for Bacterial Wilt Resistance in Tomato in North Carolina

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Bacterial Wilt of Tomato

- *Ralstonia solanacearum* is the soil-borne pathogen
- Infects through wounds and secondary root junctions
- Tomato is the second most important world vegetable crop
- NC grows about 3% of US fresh-market tomato production

Bacterial wilt : Host range, distribution and symptoms

- BW affects over 200 plant species in at least 33 different families
- Greatest losses reported in Solanaceous plants in tropical regions, including SE USA
- Highly destructive wilt pathogen

Symptoms of BW

- Symptoms include
 - Wilting of foliage
 - Bacterial streaming
 - Browning of vascular tissue

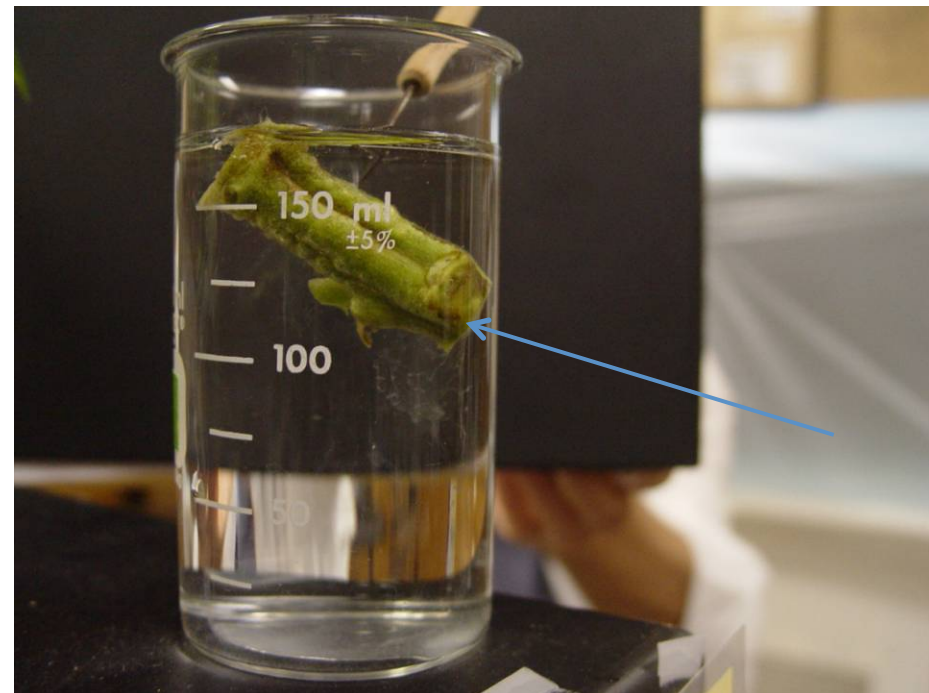


Table: Races and biovars of *Ralstonia solanacearum*

Race	Host Range	Geographic distribution	Biovar
1	Wide	Asia, Australia	3, 4
		Americas	1
2	Banana, other <i>Musa</i> spp.	Caribbean, Brazil, Worldwide	1
3	Potato, some other Solanaceae, Geranium; few other species	Worldwide except US and Canada	2
4	Ginger	Asia	3,4
5	Mulberry	China	5

Source: Daughtrey (2003)

Table: Classification of *Ralstonia solanacearum* into biovars.

	Biovars				
Physiological Tests	1.00	2.00	3.00	4.00	5.00
<u>Utilization of disaccharides</u>					
Cellobiose	-	+	+	-	+
Lactose	-	+	+	-	+
Maltose	-	+	+	-	+
<u>Oxidation of alcohols</u>					
Dulcitol	-	-	+	+	-
Mannitol	-	-	+	+	+
Sorbitol	-	-	+	+	-

Source: French et al, 1995

Genes of Interest

- Resistance QTL have been reported from chromosome 4, 6 and 11
- Universal QTL and/or molecular marker(s) has been a challenge
- Identification of source of resistance and introgression of resistance would be an important achievement

Bacterial wilt (BW) at MHCREC, NC in 2008



Bacterial wilt trial at Jackson Co, 2009

FD502(92)-4 x 132E-3(92)
↓
NC 93188

FD502 goes back to HI 7998 as a source of
Bacterial canker resistance

NC 93188 derived lines = 26
FL lines = 10
GA lines = 4
HI 7997, HI 7998 and Neptune

Total = 43

Six plants plot with two reps
at Jackson



BW severity at Jackson, 2009



BW severity at Jackson, 2009



HI 7997



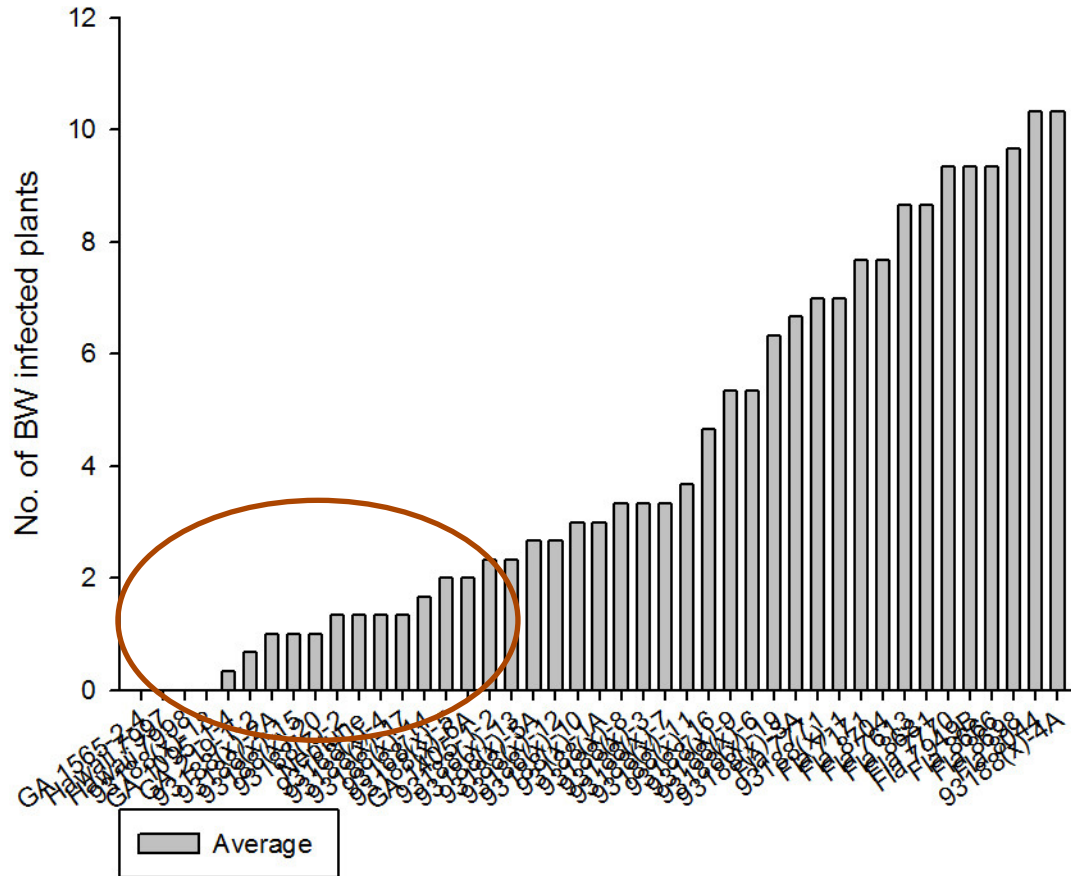
Experiment in 2016

HI 7997

HI 7998

344-14

Average bacterial wilt development in various lines 2009

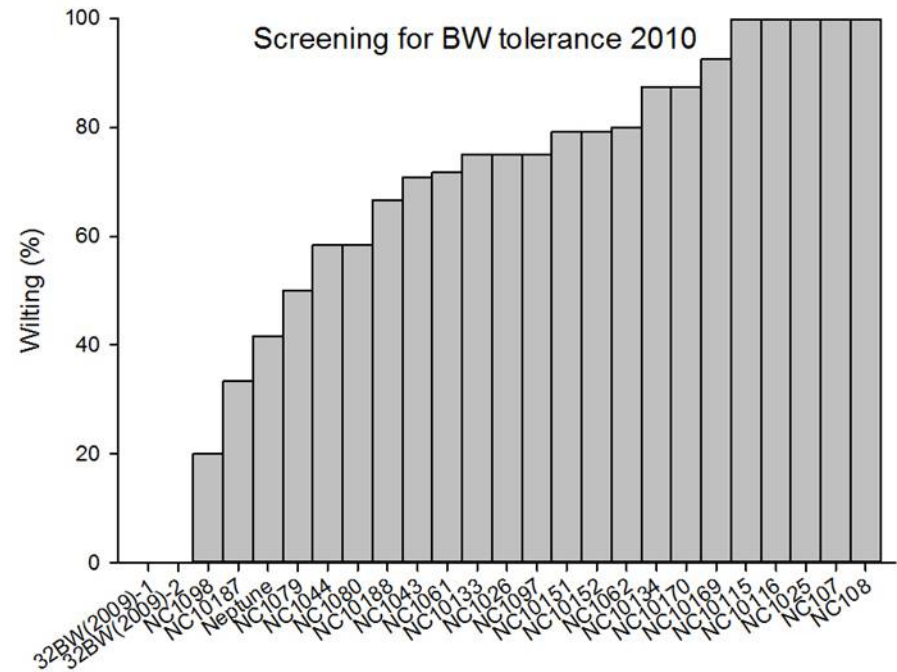
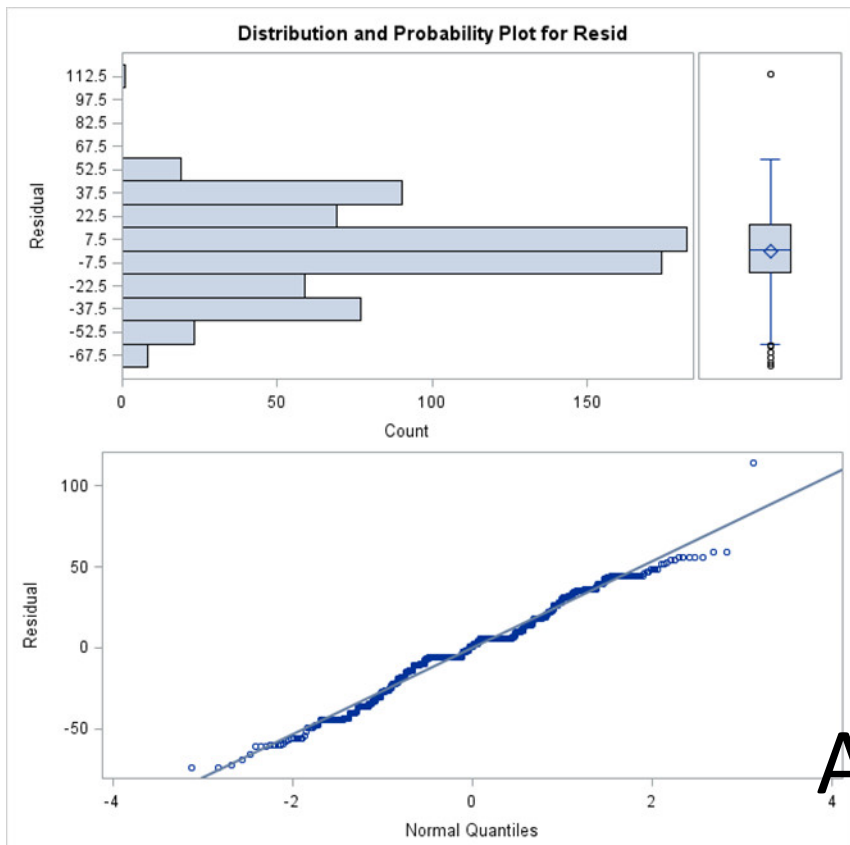




BW trial at Jackson in 2010, NC

BW32(2009)-1

BW32(2009)-2



ANOVA 2010

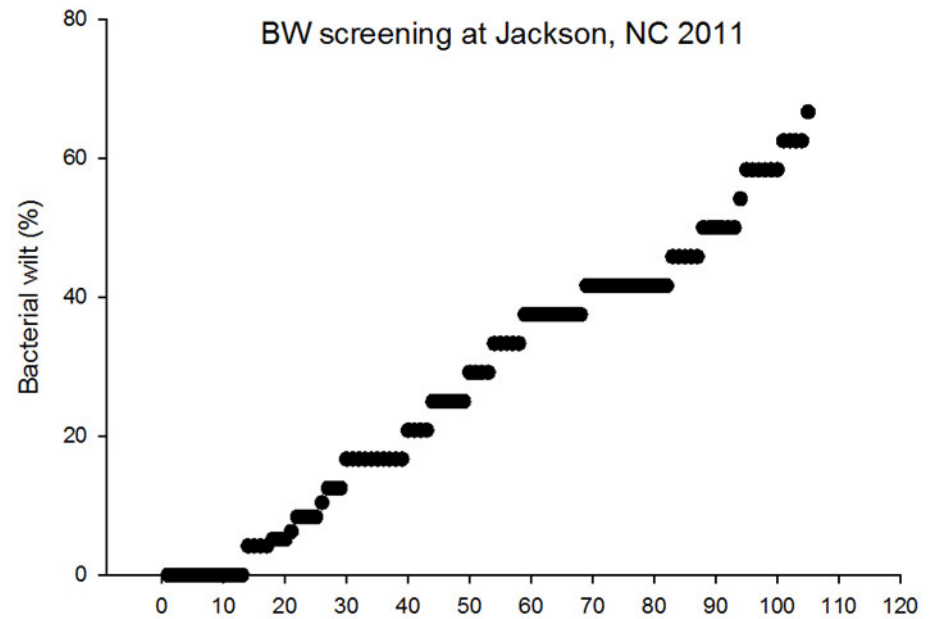
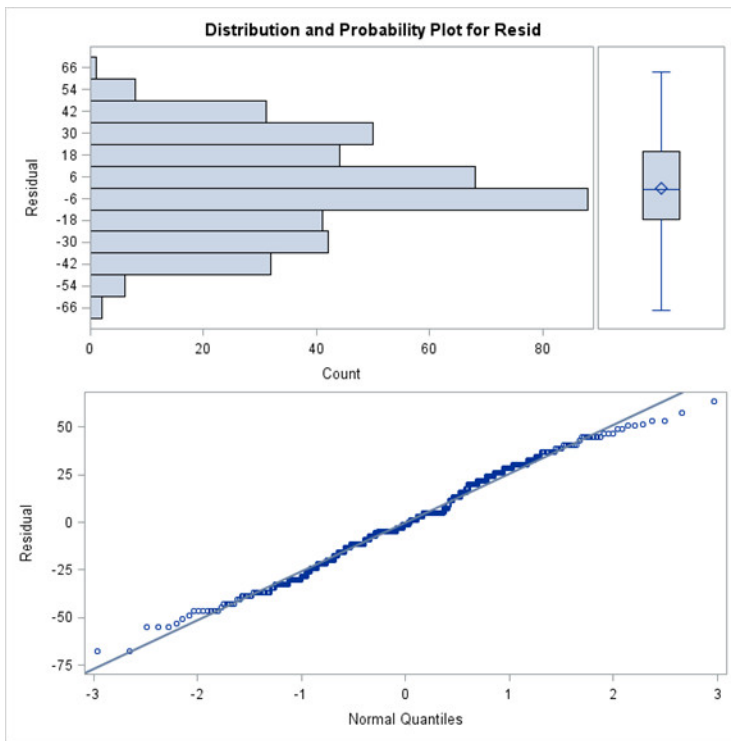
Effect	Num DF	Den DF	Total Wilting	Wilting (%)
Geno	180	352	1.85***	1.77***
Location	1	2	0ns	0.02ns
Geno*Location	178	352	0.15ns	0.15ns

Geno	Pedigree	WiltPer_ 2010
NC1098	530-1B(2007)X32BW(2009)-2	0.0
32BW(2009)-1	32BW(2009)-1	0.0
32BW(2009)-2	32BW(2009)-2	0.0
HI7997	HI7997	0.0
HI7998	HI7998	0.0
NC10186	NC2CELBRIX26BW(2009)-2	20.8
NC10183	NC2CELBRIX21BW(2009)-2	27.5
21BW(2009)-1	21BW(2009)-1	28.3
20BW(2009)-1	20BW(2009)-1	30.8
NC10182	NC2CELBRIX21BW(2009)-1	33.3
NC10187	NC2CELBRIX32BW(2009)-1	33.3
21BW(2009)-2	21BW(2009)-2	41.7
Neptune	Neptune	41.7

A photograph of a tomato field with rows of plants supported by wooden stakes and wire. The plants are covered in green tomatoes, with some showing signs of aging and wilting. The ground is covered with white plastic mulch. Two text boxes are overlaid on the image: one at the top center and one in the middle right.

BW screening at Jackson, 2011

32BW-1(2009) and 32BW-2(2009)



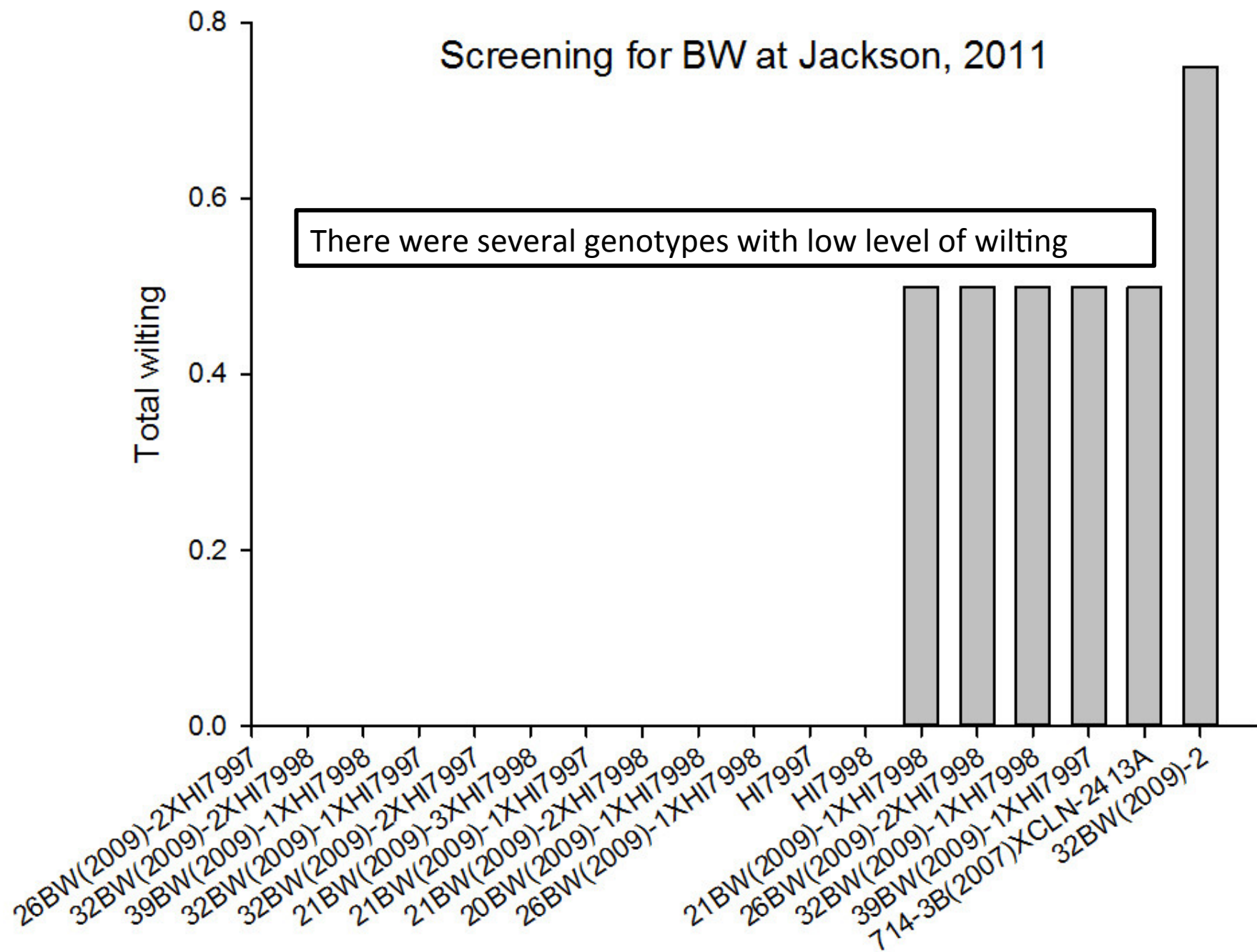
ANOVA 2011

Effect	Num DF	Den DF	Total Wilting
Geno	101	206	3.15***
Location	1	2	5.13ns
Geno*Location	98	206	1.6**

Screening for BW at Jackson, 2011

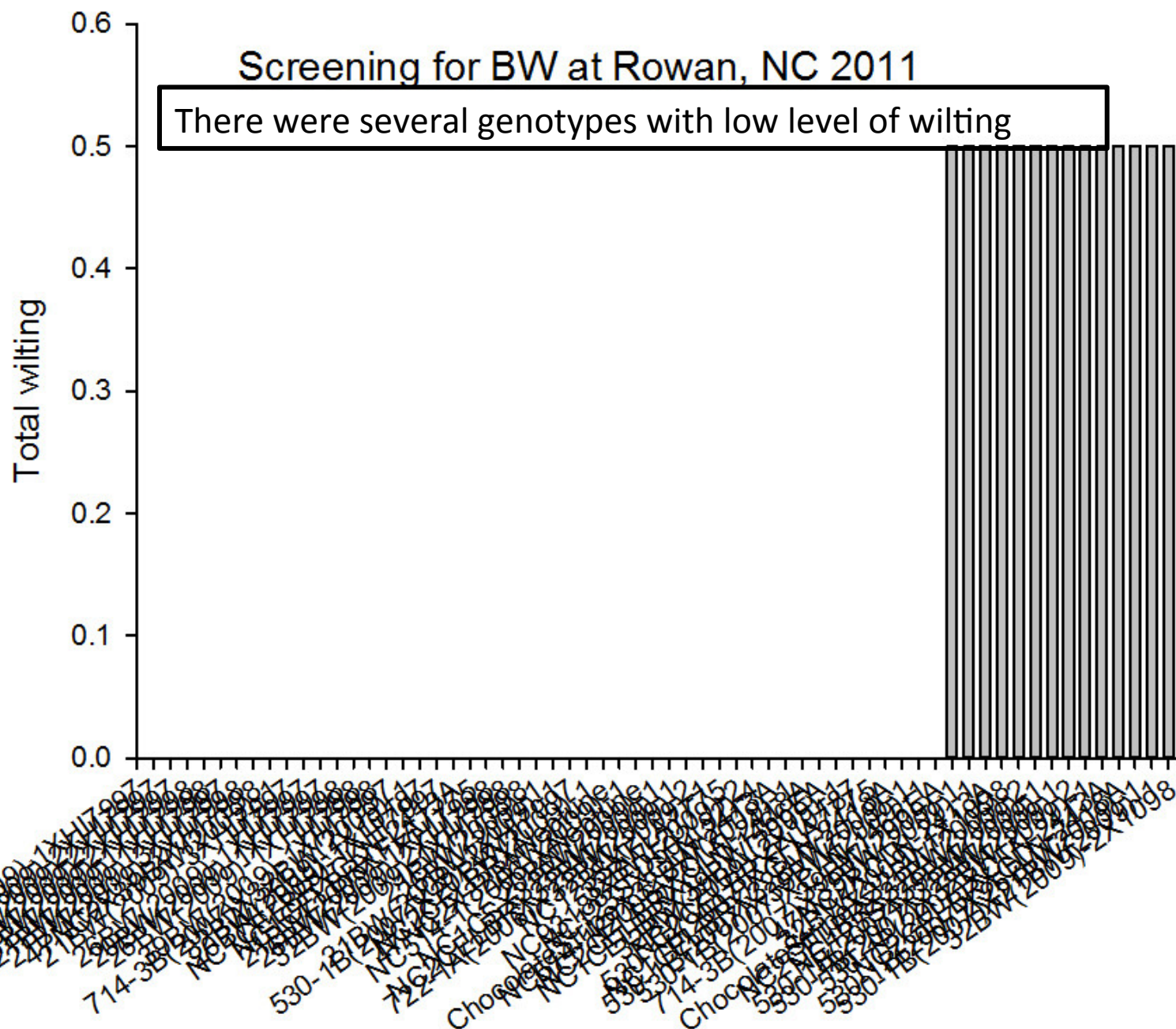
There were several genotypes with low level of wilting

Total wilting



Screening for BW at Rowan, NC 2011

There were several genotypes with low level of wilting



Screening for BW at Jackson and Rowan, NC 2011

There were several genotypes with low level of wilting

Total wilting

0.8
0.6
0.4
0.2
0.0

32BW(2009)-1XHI7997
32BW(2009)-2XHI7997
26BW(2009)-2XHI7997
32BW(2009)-2XHI7997
39BW(2009)-1XHI7998
21BW(2009)-1XHI7998
21BW(2009)-3XHI7997
21BW(2009)-2XHI7998
20BW(2009)-1XHI7998
26BW(2009)-1XHI7998
21BW(2009)-1XHI7997
26BW(2009)-1XHI7998
32BW(2009)-2XHI7998
39BW(2009)-1XHI7998
47NC2X39BW(2009)-2
21BW(2009)-1XHI7997
26BW(2009)-3XHI7997
NC93188XFD502(92)-4
714-3B(2007)XCLN-2413A
NC1235XCLN-2413A
20BW(2009)-1XHI7997

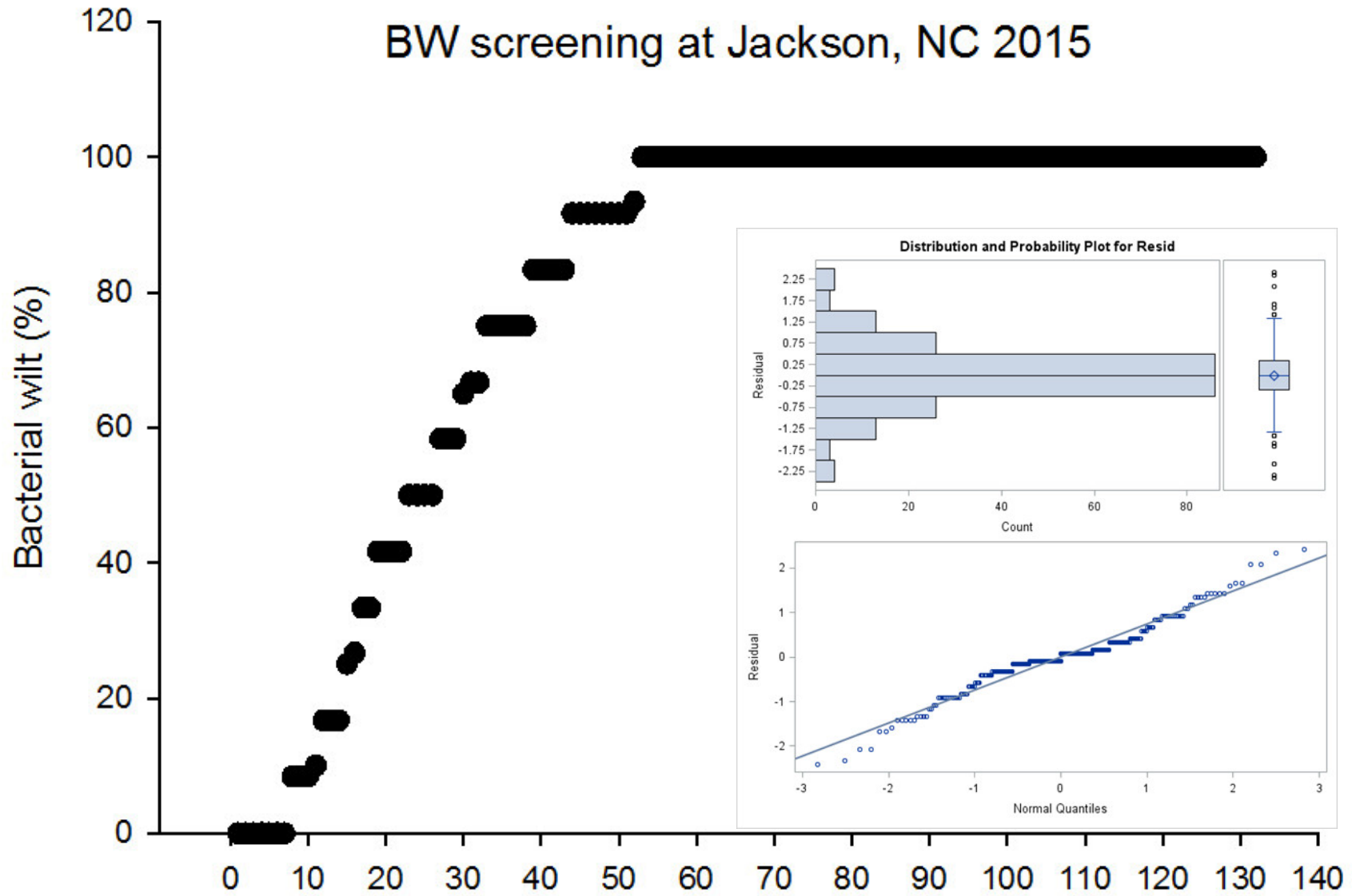
Geno	Pedigree	WiltPer_ 2011
NC11239	32BW(2009)-1X10187	0.0
NC1158	20BW(2009)-1XHI7998	0.0
HI7998	HI7998	0.0
NC1174	32BW(2009)-2XHI7997	0.0
HI7997	HI7997	0.0
32BW(2009)-2	32BW(2009)-2	6.3
NC11238	32BW(2009)-2X1098	8.3
32BW(2009)-1	32BW(2009)-1	10.4
NC10137	NC714XCLN-2413A	12.5
NC1029	NC123SXCLN-2413A	12.5
NC1167	20BW(2009)-1XHI7997	12.5
20BW(2009)-1	20BW(2009)-1	16.7
21BW(2009)-1	21BW(2009)-1	16.7

Geno	Pedigree	WiltPer_2011
NC1159	21BW(2009)-1XHI7998	4.2
NC1163	26BW(2009)-2XHI7998	4.2
NC1164	32BW(2009)-1XHI7998	4.2
NC1175	39BW(2009)-1XHI7997	4.2
32BW(2009)-2	32BW(2009)-2	6.3
NC11238	32BW(2009)-2X1098	8.3
NC1170	21BW(2009)-3XHI7997	8.3
NC1171	26BW(2009)-1XHI7997	8.3
32BW(2009)-1	32BW(2009)-1	10.4
NC10137	NC714XCLN-2413A	12.5
NC1029	NC123SXCLN-2413A	12.5
NC1167	20BW(2009)-1XHI7997	12.5
20BW(2009)-1	20BW(2009)-1	16.7
21BW(2009)-1	21BW(2009)-1	16.7

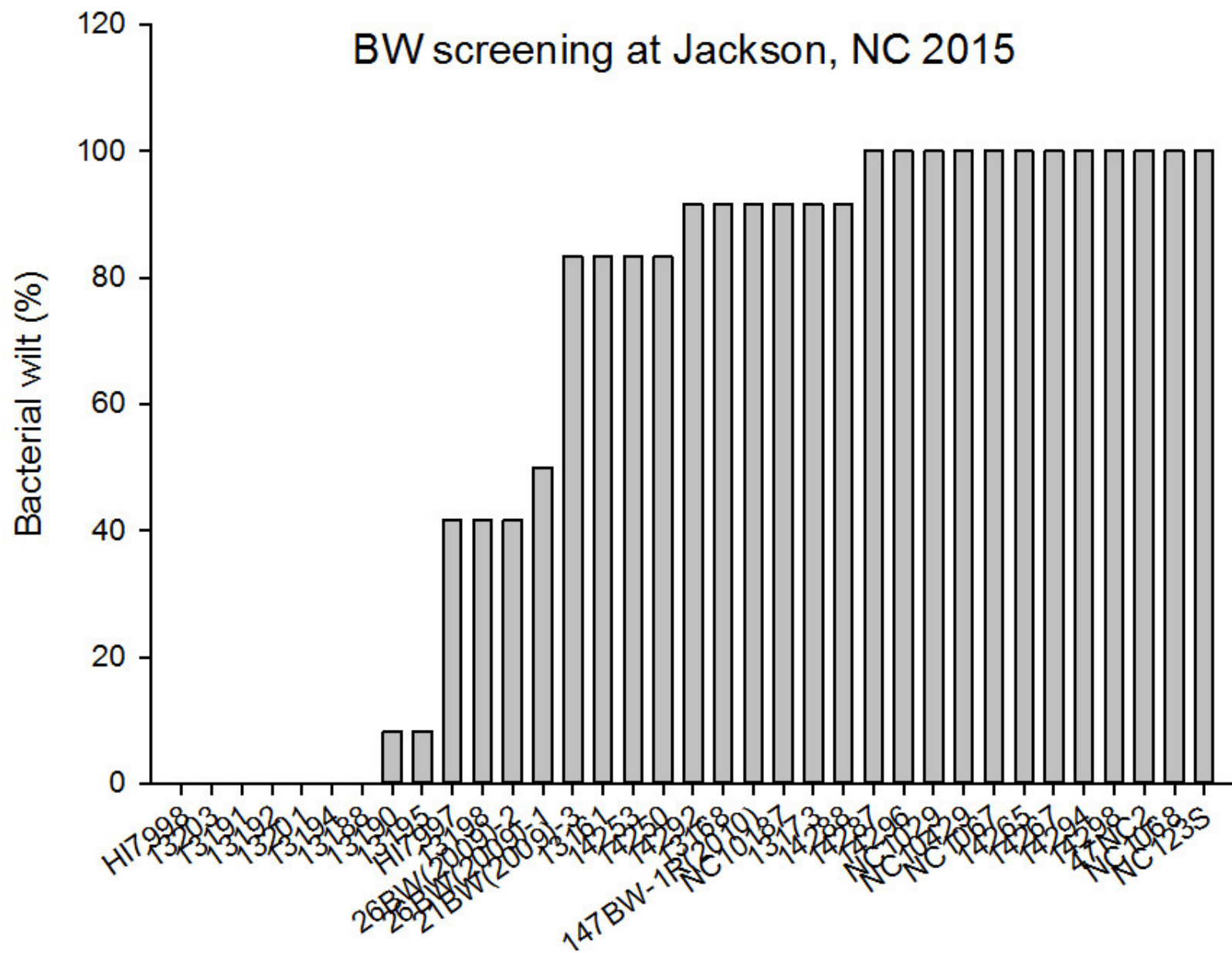
Bacterial Wilt at Jackson, 2015



BW screening at Jackson, NC 2015

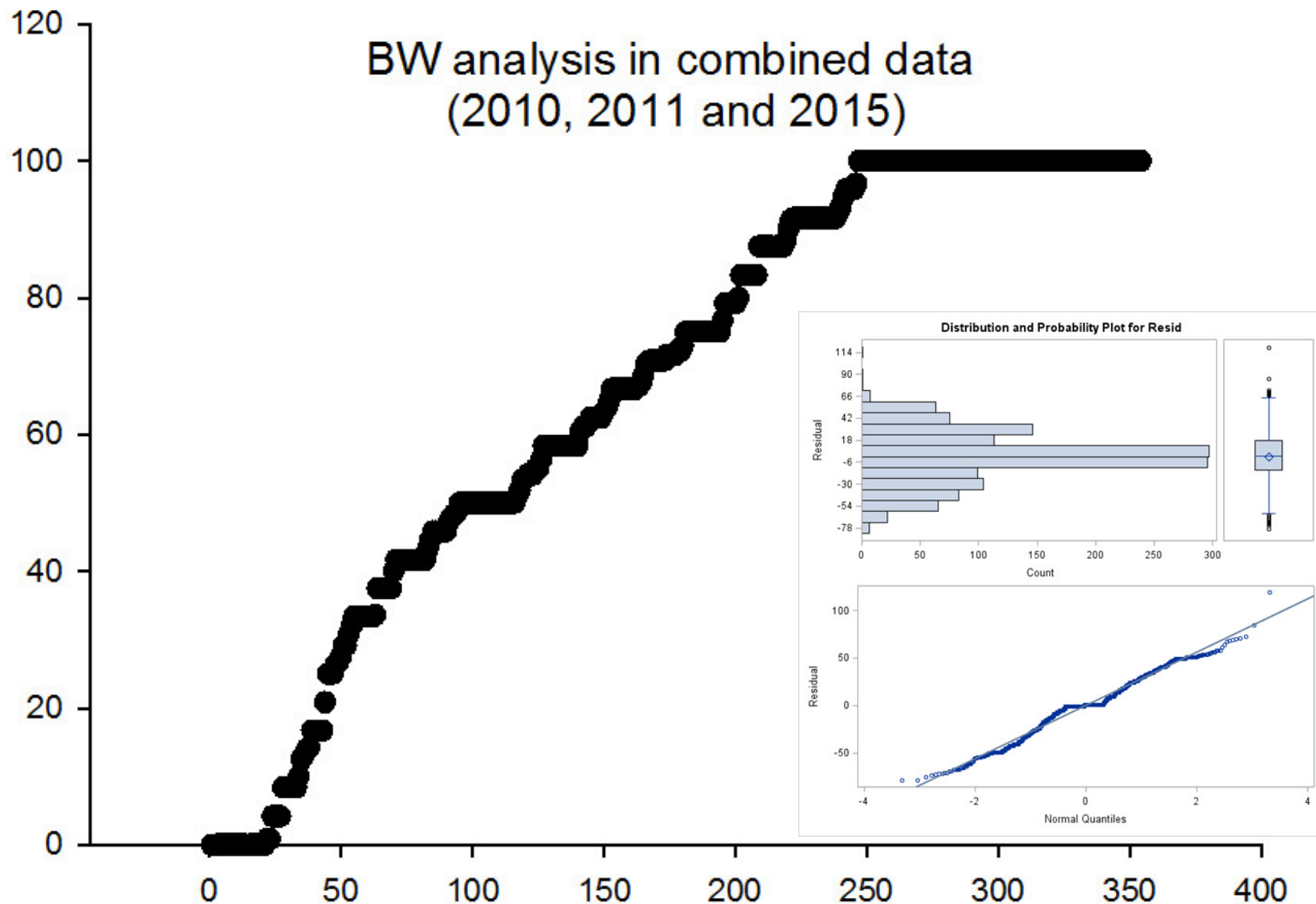


BW screening at Jackson, NC 2015

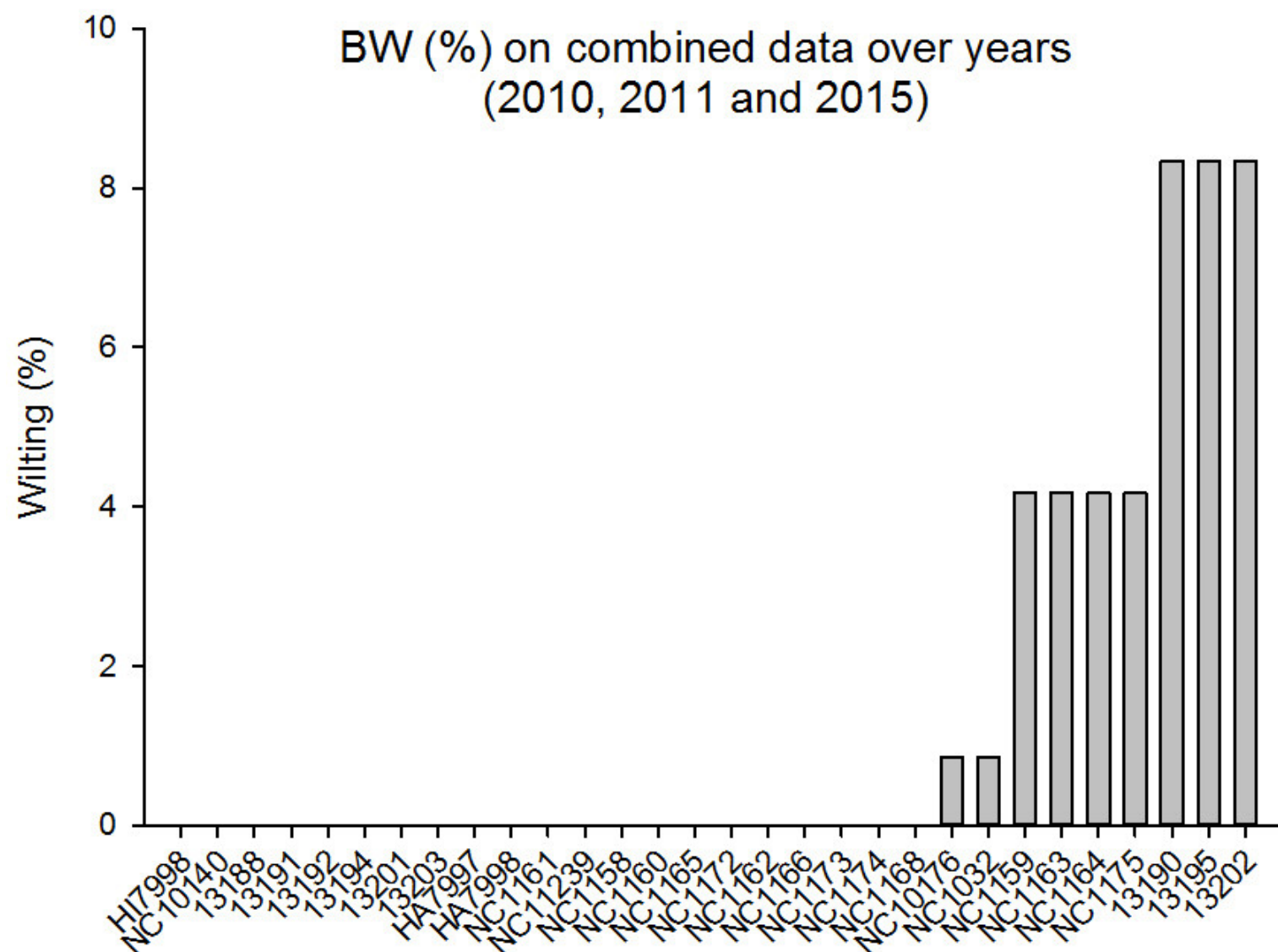


BW analysis in combined data (2010, 2011 and 2015)

Bacterial wilt (%)



BW (%) on combined data over years
(2010, 2011 and 2015)



We continue to select under high inoculum pressure

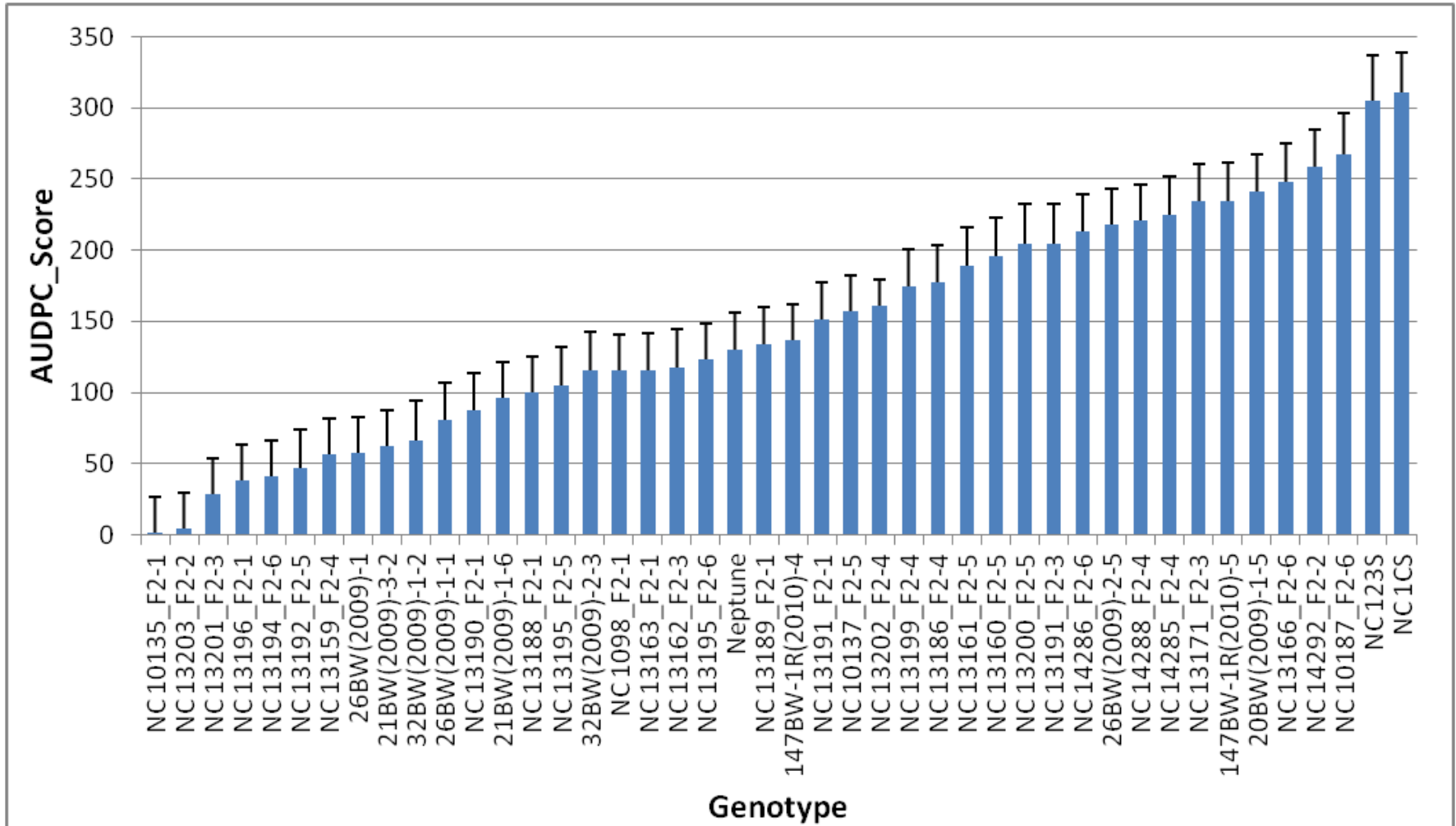


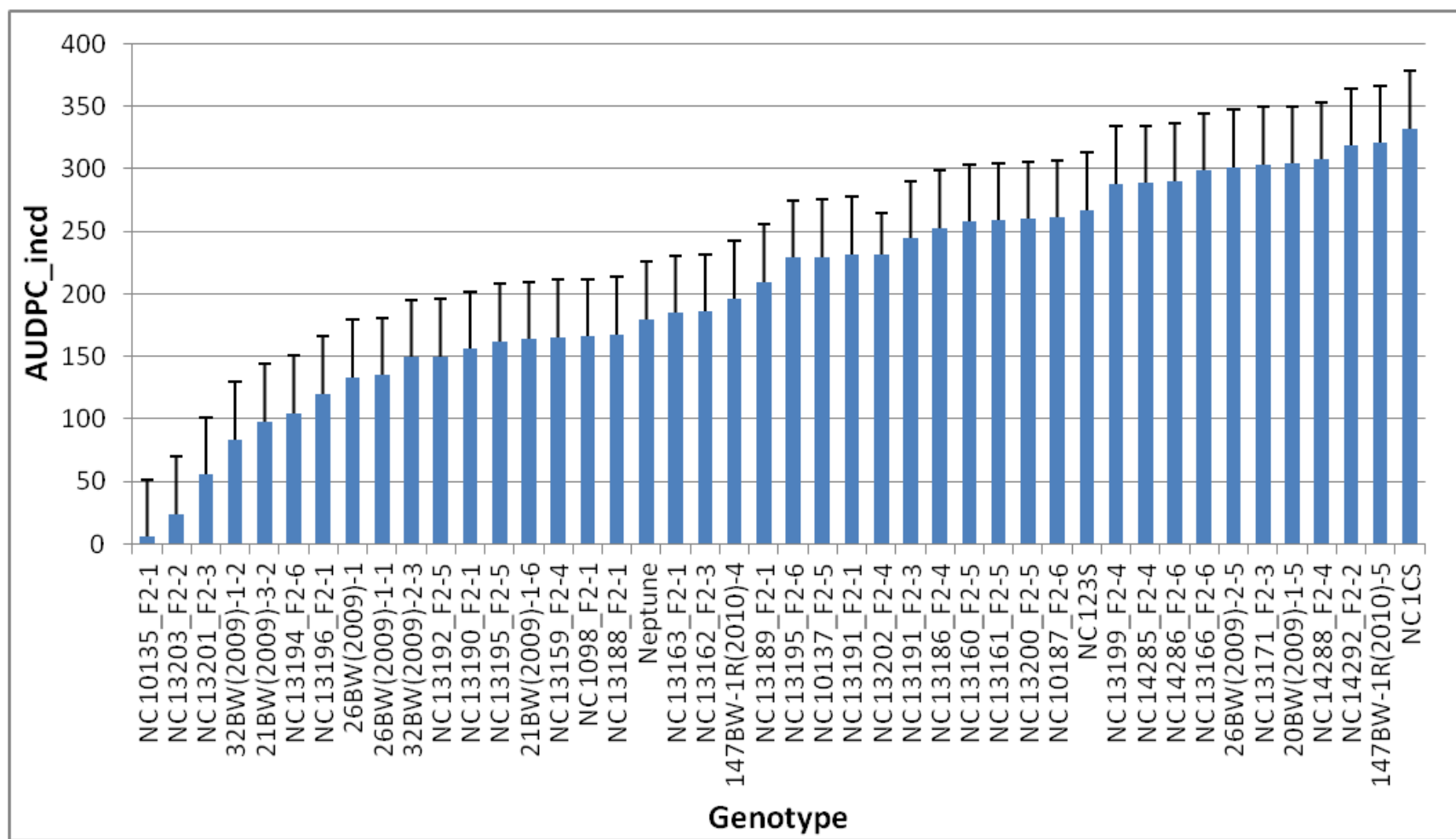
BW severity at Jackson, NC 2016

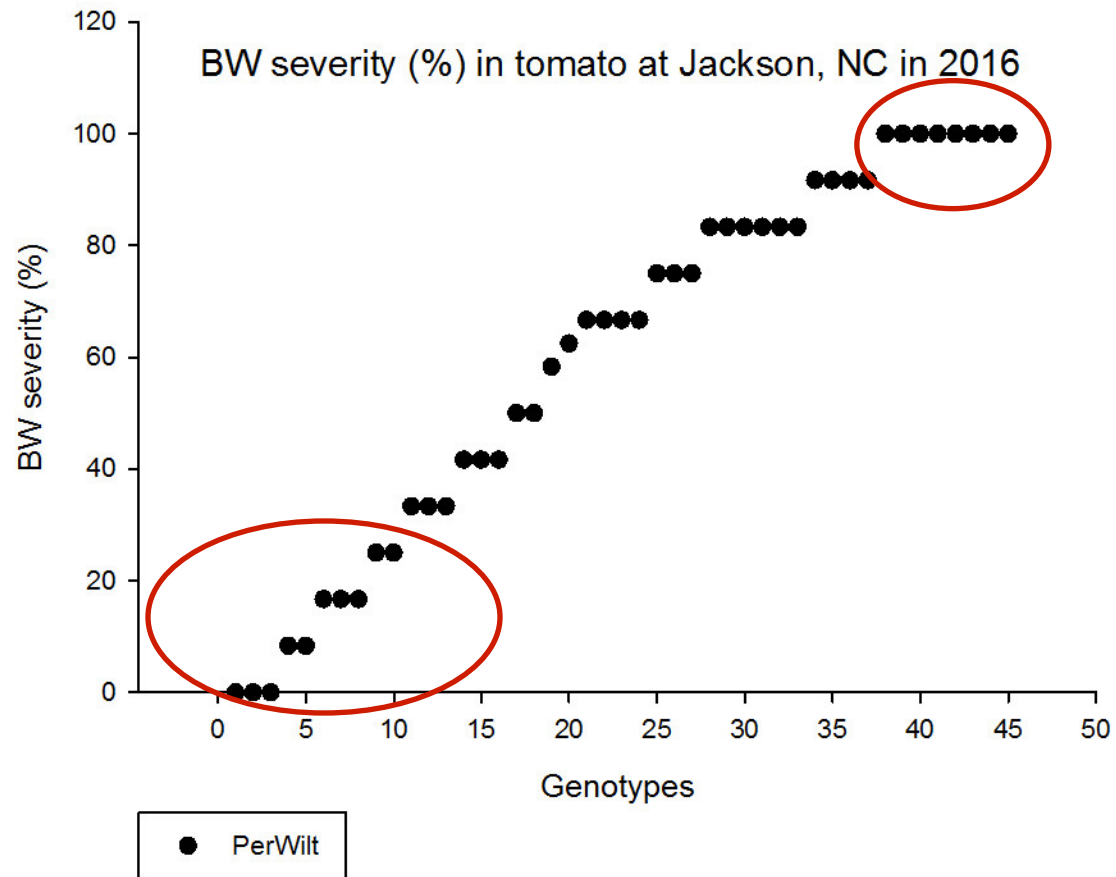


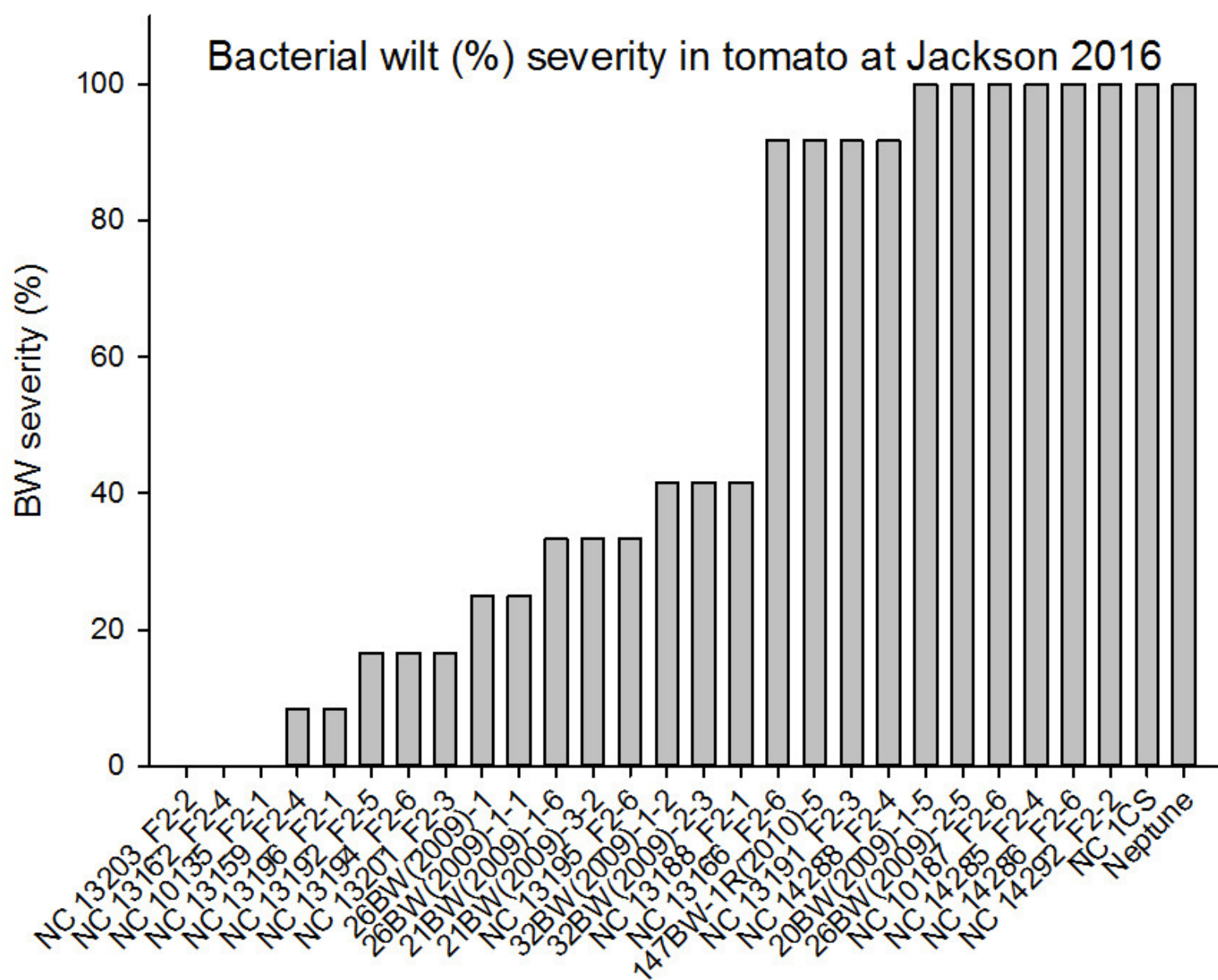


BW Infestation in Jackson 2016









Geno	Pedigree	WiltPer_2015
NC13191	26BW(2009)-2x1163	0.0
NC13188	21BW(2009)-2x1160	0.0
NC13192	32BW(2009)-1x1164	0.0
NC13194	39BW(2009)-1x1166	0.0
NC13203	39BW(2009)-1x1175	0.0
HI7998	HI7998	0.0
NC13201	32BW(2009)-1x1173	0.0
NC13190	26BW(2009)-1x1162	8.3
NC13195	20BW(2009)-1x1167	8.3
NC13202	32BW(2009)-2x1174	8.3
NC13189	21BW(2009)-3x1161	10.0
NC10135	NC714 x 39BW(2009)-1	16.7
NC13196	21BW(2009)-1x1168	16.7
NC13200	26BW(2009)-2x1172	16.7
NC13193	32BW(2009)-2x1165	25.0
NC13199	26BW(2009)-1x1171	26.7

Comparison of resistant genotypes in 2015 and 2016

Geno	WiltPer_2016
NC 13203_F2-2	0.0
NC 13162_F2-4	0.0
NC 10135_F2-1	0.0
NC 13159_F2-4	8.3
NC 13196_F2-1	8.3
NC 13192_F2-5	16.7
NC 13194_F2-6	16.7
NC 13201_F2-3	16.7

BW Resistance: Consistent Reaction in NC

AVRDC lines

Hawaii lines

32BW-1 (2009)

32BW-2 (2009)



32BW(2009)-1



32BW(2009)-1



32BW(2009)-2



32BW(2009)-2



Summary

- Consistent performance of 32BW-1(2009) and 32BW-2(2009) lines, and other lines selected in 2009.
- Backcross has been effective to improve BW tolerance
- AVRDC and Hawaii lines resistant but poor fruit quality
- Fruit quality is being improved gradually

Acknowledgements

