Assessment of two QTL *QDB.ui-6DL and QDB.ui-7DS* for dwarf bunt resistance in winter wheat grown in the Pacific Northwest of the USA

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Outline

- Importance of host resistance to dwarf bunt
- Fine mapping of *QDB.ui-7D*
- KASP genotyping for *QDB.ui-7DS and QDB.ui-6DL*
- Resistant lines and source of resistance
- Summary and future plan

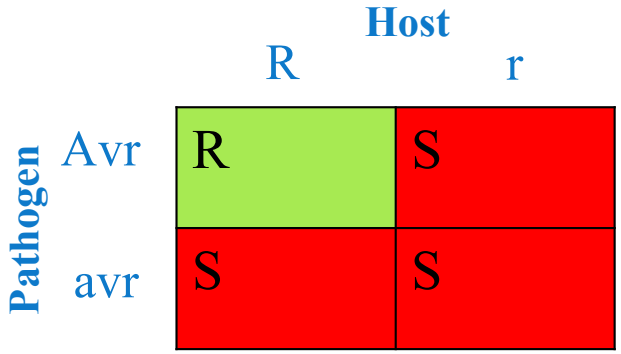
Dwarf bunt (DB)

- One of the destructive diseases of winter wheat.
- Caused by *Tilletia controversa.*
- Reducing grain yield up to 75% in severe epidemic years (Goats, 1996), more occurrences reported in recent years.
- Reducing quality because of fishing smell and darker color.
- Teliospores can stay in the field for many years.

Disease management

- Chemicals: systemic fungicide difenoconazole
- International trade – Quarantine
- Little attention in the past five decades
- Key traits for organic wheat production
- Bio-control
- Host resistance

Host resistance is an effective control method



- Fits gene-for-gene model
- DB and CB share the same resistance genes?
- Sixteen *R* genes designated: *Bt1-Bt15*, *Btp* (Goates, 2012)

QTL associated with both dwarf and common bunt resistance – 6DL and 7DS

QTL on 6DL:

- For CB in Singh et al., 2016
- Bt9 for CB in Steffan et al., 2017
- For DB in Wang et al., 2019 and Gordon et al., 2020

QTL on 7DS:

- For DB in Chen et al., 2016
- For CB and DB in Muellner et al., 2020

Objective of the present study

- To assess the 6DL and 7DS QTL for dwarf bunt resistance in bunt differential lines and a set of winter wheat cultivars and lines grown in PNW wheat growing region

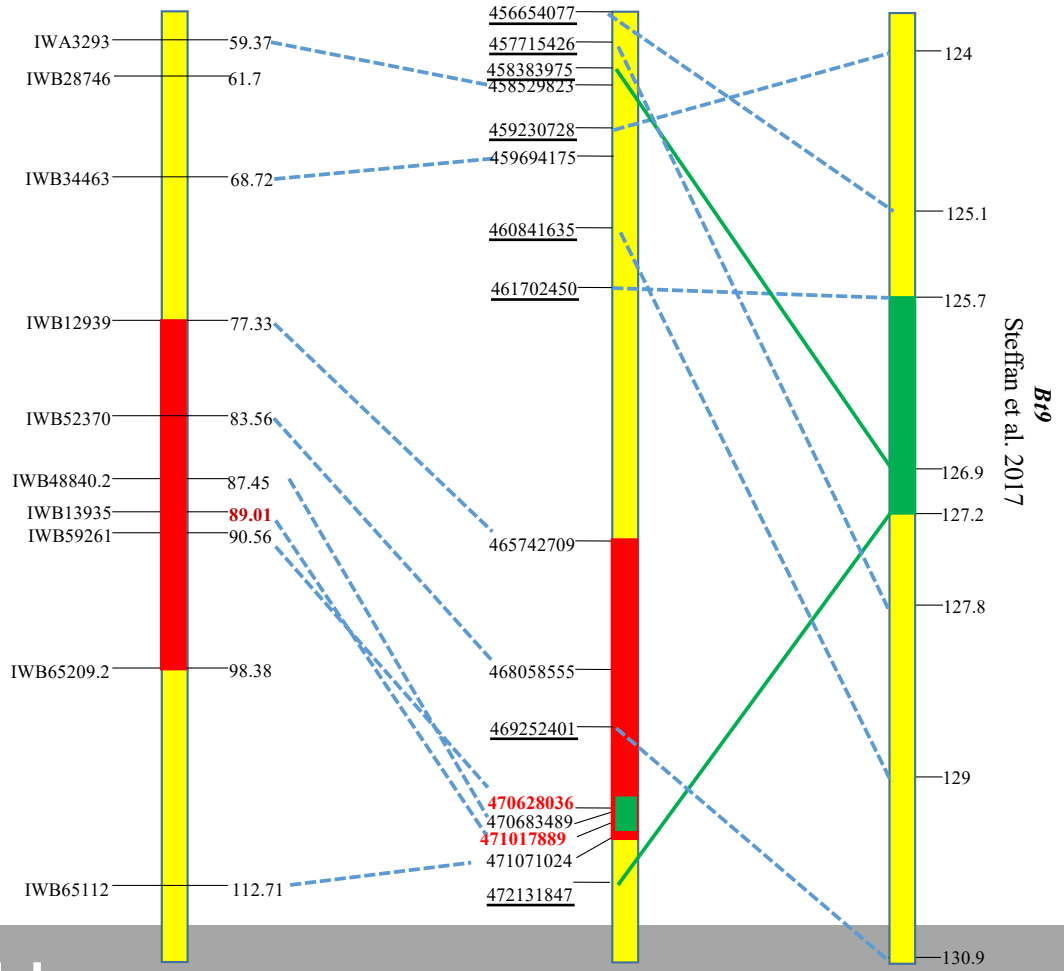
Winter wheat lines used in the current study

- Elite lines from UI program (2020)
- Elite lines from UI winter wheat variety trial (2018)
- Differential lines (Chen et al., 2016; Wang et al., 2019)
- Known resistance sources (Chen et al., 2016)

Dwarf bunt nursery in Logan, UT

- 1 m long rows
- Spores collected from the previous year
- Inoculate after seedling emergence, prior to snow cover
- Assess incidence (%) before harvest

QDB.ui-6DL
PV = 47.3%



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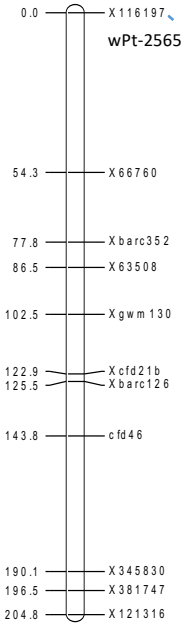
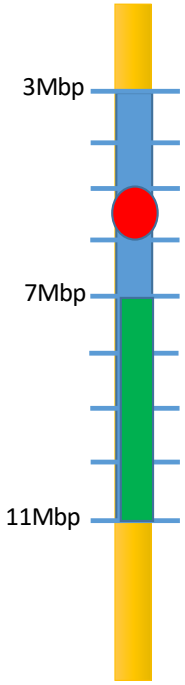
Fine-mapping and candidate genes analysis for *QDB.ui-7DS* – *Heterozygous inbred family, exome capture, and target capture*



Genetic map (cM)
IDO444 x RioBlanco
Chen et al., 2016



Physical map
Chinese Spring v1.0

QDB.ui-7DS: Chen et al., 2016 and 2021 (personal communication)
K1.26, K1.94, K1.97, K2.24, K2.50, K2.56, K3.82,
K5.33, K5.38, K5.45, K5.58, K5.65, K7.56, K10.72, K10.84

QBt.ifa-7DS: Muellner et al., 2020
K7.073, K8.054, K8.186, K8.253, K9.310, K10.715, K10.835

Haplotypes of the 7DS and 6DL QTL in thirteen differential lines

Bt gene	DB BLUE*	Line	7DSK5.33	7DSK5.45	6DL-2	6DL-5	Hap
Bt1	104.4	Sel 2092(M82-2012)	RB	RB	ID835	ID835	4
Bt2	119.2	Sel1102(M82-2012)	RB	RB	ML	ID835	3
Bt3	51.2	Ridit(M81-2008)	ID444	ID444	ML	ML	2
Bt4	120.4	CI 1558	RB	RB	ML	ML	6
Bt5	32.1	Hohenheimer(M82-2052)	ID444	ID444	ML	ID835	5
Bt6	67.4	Rio	ID444	ID444	ID835	ID835	1
Bt7	112.7	Sel. 50077	RB	RB	ML	ML	6
Bt8	7.5	PI 173438/Eg(M82-2161)	ID444	ID444	ID835	ID835	1
Bt9	55.3	Eg/PI 178383(M90-387)	ID444	ID444	ID835	ID835	1
Bt10	37.0	Eg/PI 178383(M82-2102)	ID444	ID444	ID835	ID835	1
Bt11	4.5	Eg/PI 166910(M82-2123)	RB	RB	ML	ID835	3
Bt12	3.4	PI 119333	ID444	ID444	ML	ML	2
Bt13	11.0	Thule III	ID444	ID444	ML	ML	2

* Gordon et al., 2020. TAG

Haplotypes of the 7DS and 6DL QTL in known resistance sources

Line	Gene	7DSK5.33	7DSK5.45	6DL-2	6DL-5
Blizzard	Unknown	ID444	ID444	ML	ML
Bonneville	Unknown	ID444	ID444	ML	ID835
Golden Spike	Unknown	ID444	ID444	ID835	ID835
CI 14106	Bt-12	ID444	ID444	ML	ML
CI 14107	Bt-12	ID444	ID444	ML	ML
Gary	Unknown	RB	RB	ML	ID835
Promontory	Bt-3, Bt-9, Bt-10	ID444	ID444	ID835	ID835
Manning	Bt-3, Bt-9, Bt-10	RB	ID444	ID835	ID835
Deloris	Bt-3, Bt-9, Bt-10	RB	ID444	ML	ID835
Utah 100	Bt-3, Bt-9, Bt-10	RB	ID444	ML	ID835
Lewjain	Bt-8, Bt-9, Bt-10	ID444	ID444	ML	ML
Winridge	Bt-8, Bt-9, Bt-10	ID444	ID444	ML	ML
PI 178383	Bt-8, Bt-9, Bt-10+	ID444	ID444	ID835	ID835
Stava	Bt-8, Bt-9, Bt-10	ID444	ID444	ML	ID835

Haplotypes of the 7DS and 6DL QTL in fourteen PNW resistant lines

Line	Resistance Source	2018DB (%)	7DS-K5.33	6D-J2	6D-J5
UI Sparrow	PI178383/PI476262/CI14106	0	ID444	ID835	ID835
IDO1607	PI178383/PI476262	0	ID444	ID835	ML
Utah 100	Manning (PI178383/Ridit)	0	RB	ML	ID835
IDO1101	PI476262	1	ID444	ML	ID835
MTF1435	Promontory (Manning)	2	ID444	ID835	ID835
IDO1506(W)	Bonneville (PI476262)	2.5	RB	ID835	ID835
Greenville	Utah 100 (Manning)	2.5	RB	ML	ID835
Yellowstone	Promontory (Manning)	3.5	ID444	ID835	ID835
SY Assure	unknown	4	RB	ID835	ID835
Rosalyn	Madsen?	6	ID444	ML	ID835
Sequoia	Eltan	9	ID444	ML	ID835
Devote (WA8271)	Eltan	9	ID444	ID835	ML
Norwest Duet	Eltan	10	ID444	ML	ML
IDN07-28017B	Lewjain	11	ID444	ML	ID835

3+1 resistance sources

Haplotypes of the 7DS and 6DL QTL in twenty-one resistant lines

Source	20 DB (%)	7DSK5.33	6DL-2	6DL-5	Source	20 DB (%)	7DSK5.33	6DL-2	6DL-5
UI Silver	0	ID444	ID835	ID835	Manning	2	ID444	ID835	ID835
IDO1906	0	ID444	ID835	ID835	Manning	2	ID444	ID835	ID835
IDO1101	0	ID444	ID835	ID835	Manning	2	RB	ID835	ID835
IDO835+	0	ID444	ML	ID835	Manning	2	RB	ID835	ID835
Manning	0	RB	ID835	ID835	Manning	2	ID444	ID835	ID835
Manning	0	RB	ID835	ID835	BNVL+	5	ID444	ID835	ID835
Manning	0	RB	ID835	ID835	Manning+	5	RB	ID835	ID835
Manning	0	RB	ML	ML	Manning	5	RB	ID835	ID835
Manning	0	RB	ML	ML	IDO587?	10	ID444	ID835	ML
UI Sparrow	0	ID444	ID835	ID835	Manning	10	RB	ID835	ID835
IDO587?	0	ID444	ID835	ID835					

9 lines have 7DS + 6DL; 8 lines have two markers of the 6DL

Summary and Future Plans

- US PNW has highly resistant cultivars and lines to DB.
- 6DL has higher frequency than the 7DS QTL in resistant lines.
- *QDB.ui-7DS* and *QBt.ifa-7DS* are possibly related to two Bt genes based on physical position and candidate gene locations and reactions to DB and CB.
- Bunt differential lines should be recharacterized.
- Better marker for the 6DL and 7DS should be developed.
- Candidate gene validation study is needed.

Acknowledgements

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