

# Incorporation of Effective Stripe Rust Resistance in Montana Winter Wheat Cultivars



Photos: X. Chen, USDA/WSU

# *Puccinia striiformis* f. sp. *tritici*

- Economically important disease world wide [US, Australia, China], major wheat disease in PNW & Montana
  - [Epidemics in PNW 2001-2012: 2VS, 3S, 6M, 1L]
- Fungal infection of green tissues, 1-leaf to maturity. Symptoms ~1 wk post infection, sporulation ~ 2 wk post-infection
- Rust pustules = uredia, each uredium contains 1000s of urediniospores

# Stripe Rust

- Depending on plant resistance & temperature various amounts of necrosis and chlorosis appear, w/ and /w.out sporulation
- Yield loss associated with loss of photosynthetic tissue [amount and duration]
- Environmental factors [moisture, temperature, wind]
- Management: genetic resistance & fungicides

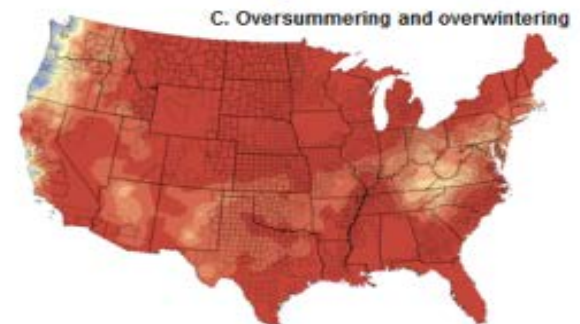
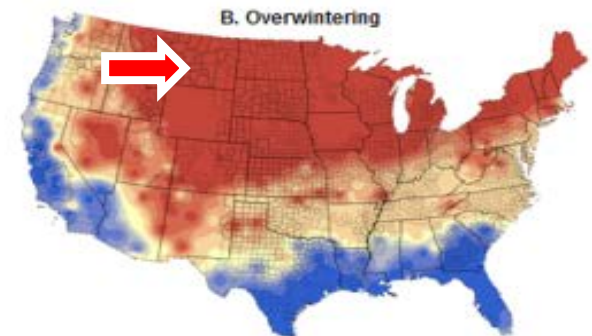
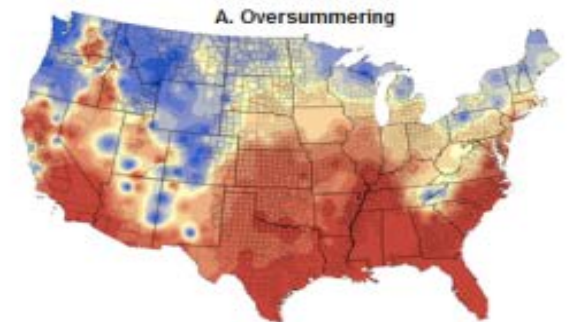
# Stripe Rust

## Environmental Factors

- 3 h continuous moisture (dew) on leaf surface
- Overwinter survival results in early infection
- Race variation for how temps. affect YR devel.

["new' races germinate faster & have shorter latent period at higher temps.]

- Wind [inoculum dispersal]

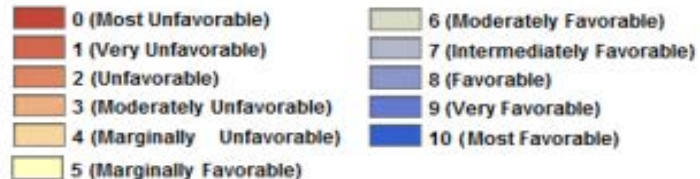


### Legends

Wheat cultivating county (Acres)

0 without border    □ < 15000    □ >15000

Survival index (0-10)



# Stripe Rust Races

- YR separated into races (pathotypes) based on avirulence or virulence reactions on a set of 18 selected single gene lines (differentials)

Information about races and their distribution and frequencies is important for select resistant varieties to grow and for developing new varieties with effective resistance.

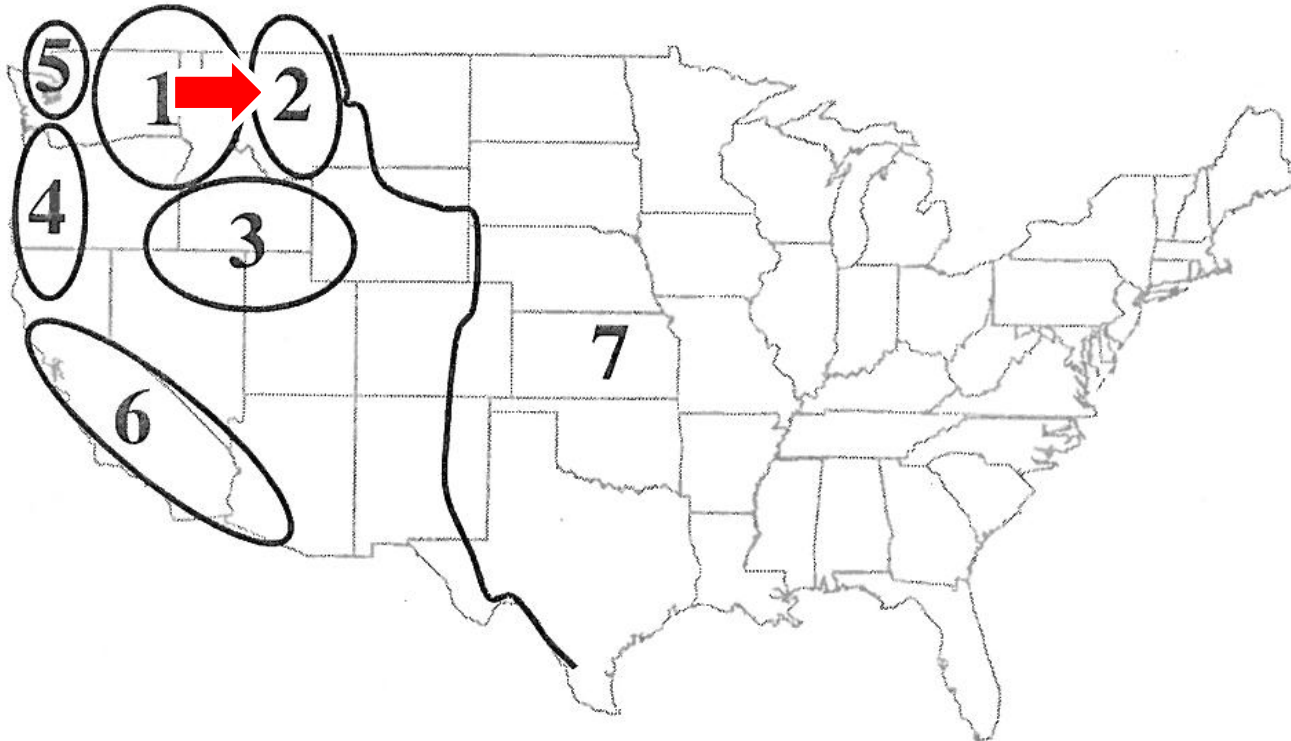
Differential #	Name	Yr gene
1	AvSYr1NIL	Yr1
2	AvSYr5NIL	Yr5
3	AvSYr6NIL	Yr6
4	AvSYr7NIL	Yr7
Etc.		

# US Stripe Rust Races Monitored by Dr. X. Chen, USDA, Pullman

- 2015 – 310 Yr samples collected in US (13 MT)
- 32 unique *Pst* races identified (5 MT)
- Virulence of identified *Pst* races ranged from 0 to 13 of the tested Yr genes
- No races found with virulence to Yr5 & Yr15
- Rapid race changes characteristic of this disease

# Epidemic Regions of YR

**Fig. 2.** Epidemic regions of stripe rust [*Puccinia striiformis* f. sp. *tritici*] in the United States and Canada as determined by Line and Qayoum (1992) and Line (2002). The seven regions (separated by the solid lines or circles) were determined based on virulence distribution of *P. striiformis* f. sp. *tritici* and disease patterns.



Based on geographic barriers, prevailing winds, crop cycles, virulence

All races identified in region 2, 1<sup>st</sup> detected in region 1

# Types of stripe rust resistance

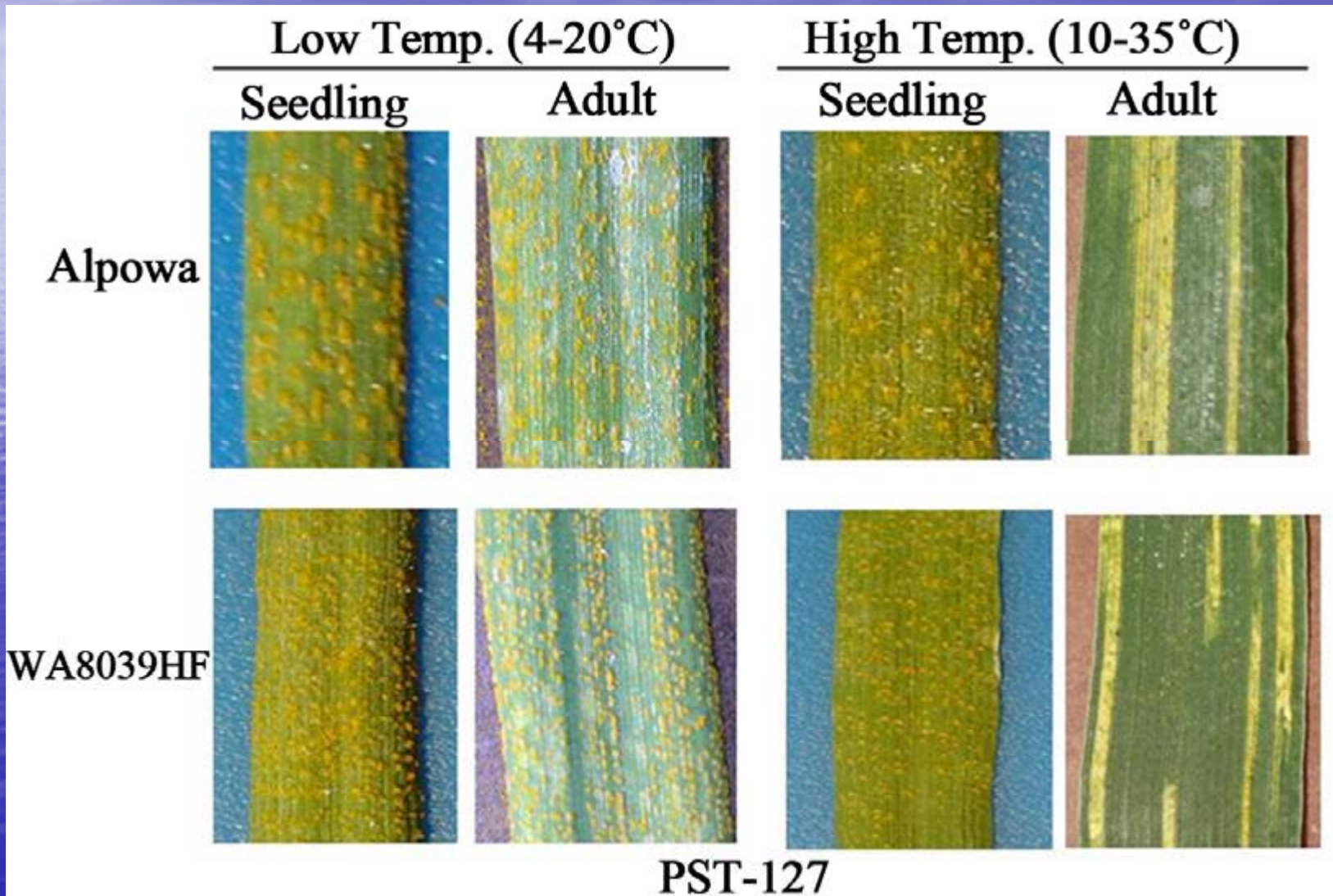
- **All-stage (AS)** – detected in the seedling stage & all stages of plant growth – **race specific immunity [single gene, non-durable]**
- **Adult-plant** – expressed at later stages of plant growth – **usually non-race specific partial resistance (not immunity) [multiple genes, more durable]**



# Types of stripe rust resistance

- High temperature, adult plant (HTAP) –** susceptible at seedling stage followed by increased resistance at higher temperatures (69F)
  - Effectiveness of resistance increases as plant ages & temperature increase**
  - Flag leaf more resistant than lower leaves
  - HTAP rest. Protects crop by lowering the infection type, # of new infections, and the amount and spread of inoculum
  - Screening more difficult if all stage rest. present

4-way tests to detect high-temperature adult-plant (HTAP) resistance to stripe rust. Plants showing a resistant reaction only or mostly in the adult-plant stage at high-temperatures are identified to have HTAP resistance



# Stripe rust resistance

AS – immunity or susc. if *Pst* virulent, single gene, shorter effective life span since *Pst* mutation can render AS rest. ineffective

APR (HTAP) – partial resistance, multiple genes, longer effective life span, ineffective at lower temps., may not be enough under severe epidemic conditions

**Strategy – Combine AS and HTAP**

# MT Winter Wheat Breeding

- Combine multiple sources of Yr resistance, e.g. add Yr5 and Yr15 to elite cultivars (already resistant)
- Use molecular markers and phenotypic screening to identify resistant selections
- Select Yr resistant headrows at Boz, Kal
- Test Yr resistance over multiple sites & years
- Combine with other positive traits & quality

# Phenotypic screening (natural infection, no fungicide) at Bozeman & Kalispell, MT & Pullman & Mt. Vernon, WA



2005 NWARC



# Selection for Winter Wheat Yr resistance at NWARC Kalispell

- 2013 F5 hill plots from 7 populations (560)
- 2014 F6 Observation Nursery (60)
- 2015 Prel. Yield Trial (10 seln. + 4 checks)
- 2016 Prel. Yield Trial (20 seln. + 5 checks)
- 2017 Marker selected Yr5Yr15 hill plots (460)

# 2016 MT Intrastate – Stripe Rust

Cultivar/Line	Stripe Rust													
	Montana (%)							Pullman, WA		MT. Vernon, WA				
	Kalispell			Bozeman			2 loc	Milk		Stem elong.		Heading/flowering		
	5-Jun	10-Jun	30-Jun	2-Jun	8-Jun	16-Jun	'late'	IT <sup>1/</sup>	%	IT <sup>1/</sup>	%	IT <sup>1/</sup>	%	
										13-Jun		18-Apr		18-May
MT1488	8	17	<u>22</u>	5	12	10	<u>16</u>	2	15	3	30	5	80	
MT1471	<u>3</u>	9	35	0	<u>1</u>	4	20	3	10	2	10	3	20	
Judee	17	21	27	8	9	15	21	5	30	3	20	3	30	
Warhorse	12	16	37	0	4	5	21	5	10	2	20	2	20	
MT1465	10	27	37	tr	3	7	22	3	5	2	20	3	20	
Loma	22	30	35	12	14	10	23	5	15	3	30	2	20	
Colter	15	23	38	tr	5	12	25	2	20	2	20	2	20	
MTW1491	17	51	51	tr	7	10	31	5	10	2	20	4	30	
MT1348	7	12	56	tr	5	8	32	5	15	2	15	2	20	
Northern	20	28	52	3	15	14	33	5	30	3	30	2	20	
CDC Falcon	87	96	96	5	32	42	69	8	100	8	60	5	80	
Decade	85	94	93	12	36	57	75	8	100	8	40	4	50	
Brawl CL Plus	70	87	84	12	65	76	80	8	100	5	30	8	80	
Jerry	89	98	97	18	41	66	82	8	100	8	60	8	80	
Byrd	85	94	95	15	49	70	83	8	100	8	80	8	80	
Bearpaw	92	98	96	22	61	72	84	8	100	8	40	5	60	
Broadview	90	95	88	40	57	83	86	8	100	8	80	8	80	
Avery	73	97	95	7	51	77	86	8	100	2	20	8	80	
Cowboy	85	94	94	32	49	80	87	8	100	5	30	8	80	
Average	33.4	49.9	69.5	12.7	17.7	25.2	47.4							
LSD (0.05)	7.9	12.9	15.6	8.2	11.8	8.3	31.1							

# 4 year Mean Stripe Rust Infection

Cultivar/Line	Stripe Rust (%) Bozeman and Kalispell			
	2016	2015-16	2014-16	2013-16
location-years	2	4	5	6
<b>Warhorse</b>	<b>21</b>	<b><u>13</u></b>	<b><u>10</u></b>	<b><u>14</u></b>
<b>Judee</b>	<b>21</b>	<b>14</b>	<b>11</b>	<b>14</b>
<b>Northern</b>	<b>33</b>	<b>19</b>	<b>15</b>	<b>17</b>
<b>Colter</b>	<b>25</b>	<b>18</b>	<b>15</b>	<b>19</b>
<b>SY Wolf</b>	<b>33</b>	<b>23</b>	<b>18</b>	<b>21</b>
<b>WB-Quake</b>	<b>42</b>	<b>27</b>	<b>22</b>	<b>28</b>
<b>WB3768</b>	<b>44</b>	<b>27</b>	<b>21</b>	<b>29</b>
<b>SY Clearstone 2CL</b>	<b>47</b>	<b>30</b>	<b>24</b>	<b>34</b>
<b>Yellowstone</b>	<b>51</b>	<b>33</b>	<b>26</b>	<b>35</b>
<b>Rampart</b>	<b>56</b>	<b>45</b>	<b>37</b>	<b>47</b>
<b>CDC Falcon</b>	<b>69</b>	<b>52</b>	<b>42</b>	<b>52</b>
<b>Broadview</b>	<b>86</b>	<b>71</b>	<b>58</b>	<b>65</b>
<b>Bearpaw</b>	<b>84</b>	<b>73</b>	<b>62</b>	<b>68</b>
<b>Decade</b>	<b>75</b>	<b>70</b>	<b>63</b>	<b>69</b>
<b>Cowboy</b>	<b>87</b>	<b>81</b>	<b>66</b>	<b>72</b>
<b>Jerry</b>	<b>82</b>	<b>78</b>	<b>73</b>	<b>77</b>
<b>Average</b>	<b>47.4</b>	<b>36.9</b>	<b>32.3</b>	<b>39.7</b>
<b>LSD (0.05)</b>	<b>31.1</b>	<b>18.0</b>	<b>16.5</b>	<b>16.2</b>
<b>C.V.</b>	<b>33</b>	<b>35</b>	<b>41</b>	<b>35</b>





Hill plots, 2013



Yield trials



NWARC winter wheat stripe rust research, 2013-2016



Hill plots, 2013

# Breeder seed Colter



**Montana producers & MWBC: Thanks for your continued support of our program!**