# Heterosis of Agronomic Traits in Novel Orchardgrass Germplasm

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# Germplasm evaluation

Incorporate new germplasm

Phenotypic evaluation of germplasm
- Diploid and tetraploid accessions
- Breeding populations
- Cultivars

Phenotypes
- Heading date / morphology
- Forage yield
- Winter survival / freezing tolerance

# Germplasm sources

1) IADG102: U.S. cultivars – biomass & visual vigor
2) IADG103: Japanese accessions – biomass & visual vigor
3) IADG104: Various sources – broad crowns & decumbent growth
4) IADG105: Russian accessions – biomass & visual vigor
5) UTDG101: Chinese collection – very late & high digestibility
6) UGDG102: Russian collection – early
7) Latar
8) Paiute
9) Potomac

# Family/population hybrid devlopment

- Open-pollinated block

  → 162 half-sib families

  Randomly selected from crossing block

- Full diallel

  → 36 population hybrids

  Seed production was limiting factor

# Field designs & evaluation

- Half-sib evaluation for heritability
  - Logan, UT and Rexburg, ID under irrigation
  - Nine commercial checks & parental populations
  - Pseudo-sward conditions
  - Morphology, 2008 & 2009
  - Agronomics, 2008 & 2009
  - Seed production, 2010

- Population hybrid evaluation for heterosis
  - Logan, UT under irrigation
  - Nine commercial checks & parental populations
  - Pseudo-sward conditions
  - Dry matter yield combining ability
  - Forage quality

# HSF heritability

**Morphology**

No G x E Interaction

| | |
|---|---|
| Culm length | 0.48 (0.10) |
| Culm width | 0.18 (0.15) |
| Flag leaf height | 0.51 (0.07) |
| Flag leaf length | 0.64 (0.07) |
| Flag leaf width | 0.26 (0.13) |
| Panicle height | 0.31 (0.12) |
| Spikelet length | 0.56 (0.08) |
| Nodes · spikelet$^{-1}$ | 0.20 (0.15) |
| Maturity | 0.74 (0.04) |

**Agronomy**

| | Logan | Rexburg |
|---|---|---|
| Dry matter yield | 0.70 (0.04) | 0.58 (0.07) |
| Crude protein | 0.56 (0.07) | 0.39 (0.10) |
| *In vitro* true digestibility | 0.69 (0.05) | 0.10 (0.15) |
| Neutral detergent fiber | 0.65 (0.06) | 0.36 (0.10) |
| Water soluble carbohydrates | 0.42 (0.09) | 0.56 (0.07) |
| Seed yield | 0.47 (0.07) | 0.77 (0.03) |
| Seed weight | 0.60 (0.06) | 0.50 (0.07) |

# HSFs vs. parents morphology

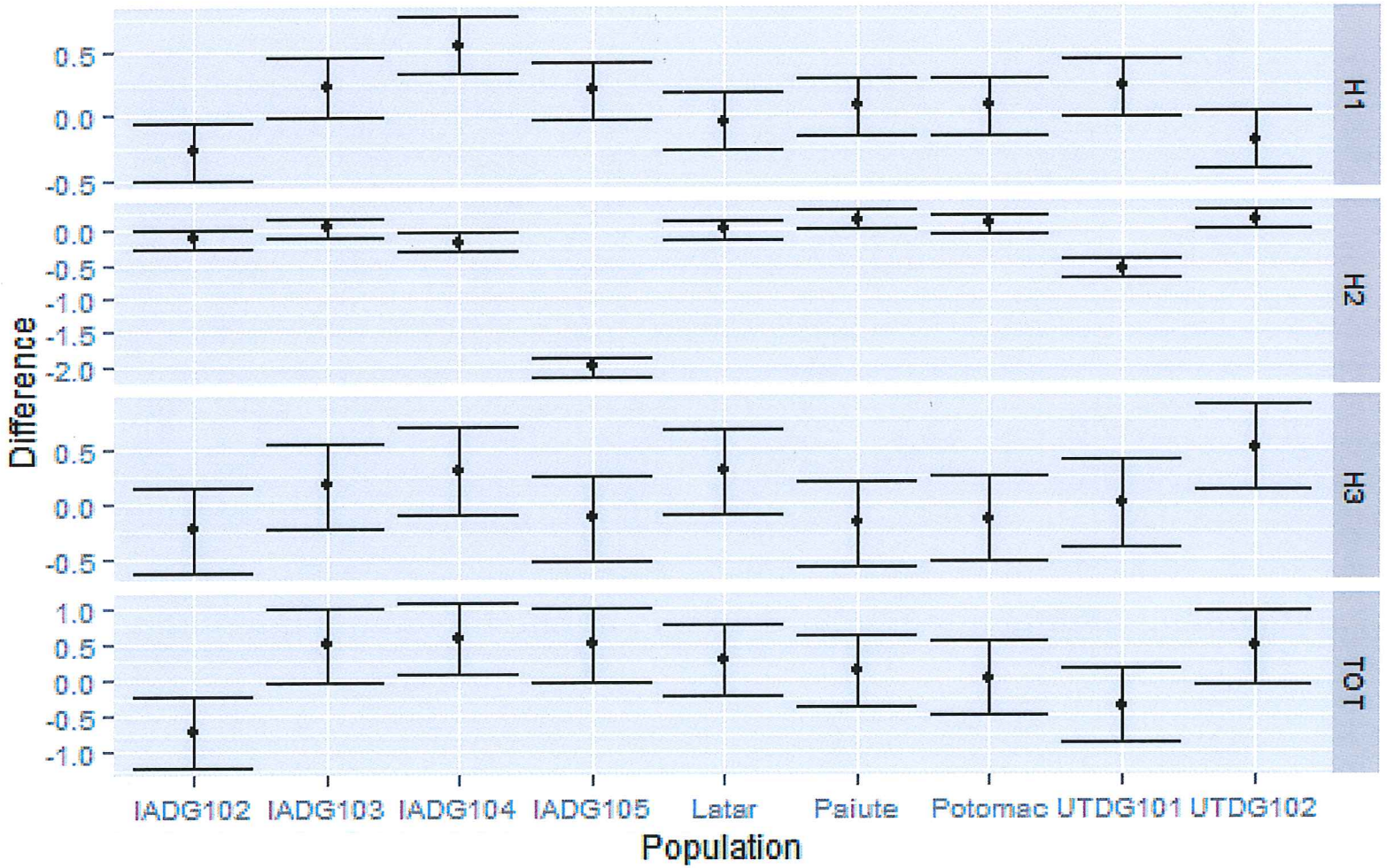
- Few differences between parental populations and means of corresponding half-sib families
  - IADG102 and Latar HSFs: shorter spikelets
  - UTDG101 HSFs: longer culms and higher, but shorter flag leaves
  - Paiute HSFs: later maturity

# HSFs vs. parents agronomics

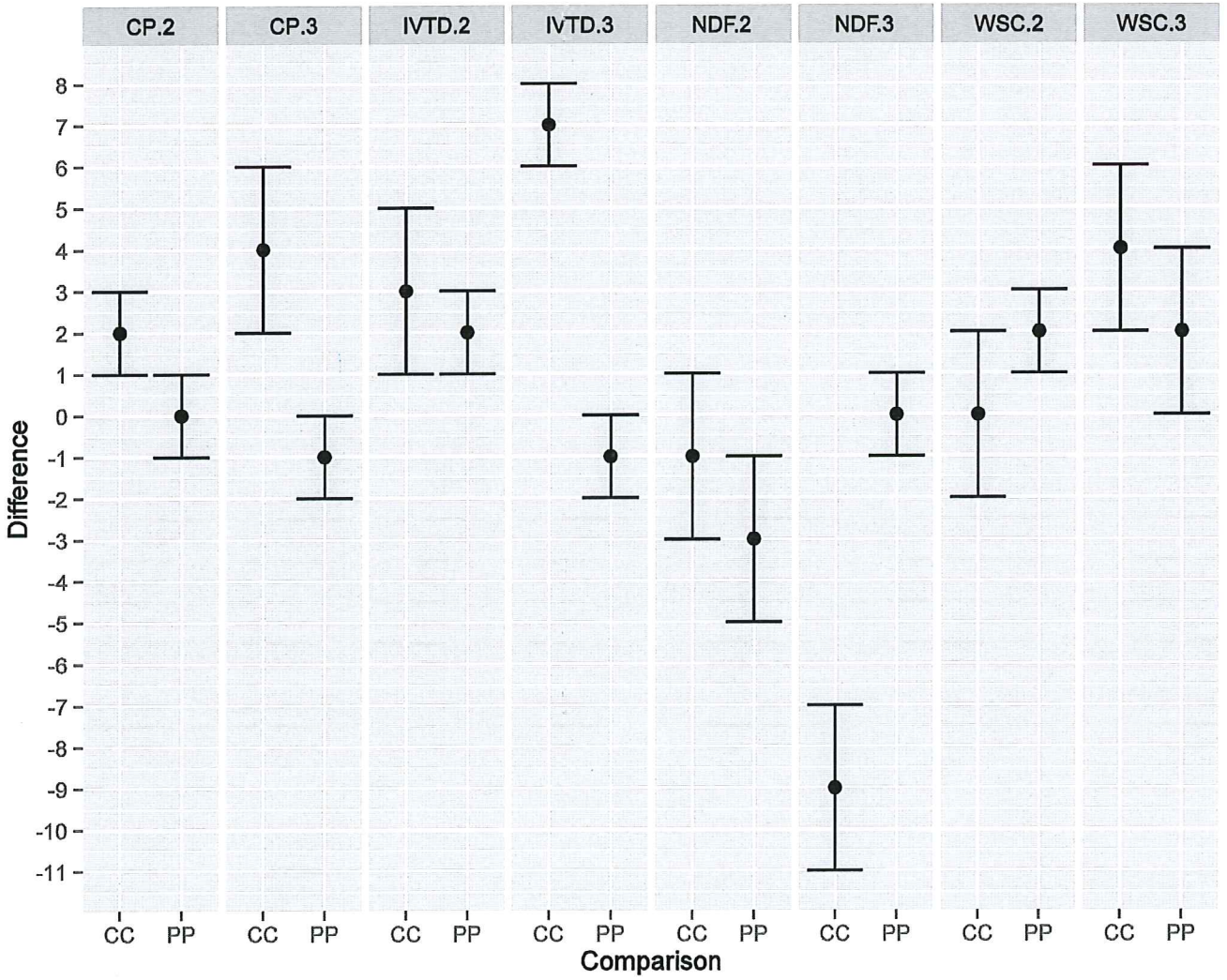
| Population | Logan | Rexburg |
|---|---|---|
| IADG102 | - | - |
| IADG103 | - | ↑ DMY |
| IADG104 | - | - |
| IADG105 | ↑ DMY | ↓ SY |
| UTDG101 | ↑ DMY, NDF; ↓ IVTD | - |
| UTDG102 | - | ↑ SY |
| Latar | - | ↓ SW |
| Paiute | - | - |
| Potomac | ↓ SW | - |

# PHs vs. individual parents - dry matter yield

Mean phenotype of PHs higher than checks only at H1



# PHs vs. parents & checks - quality



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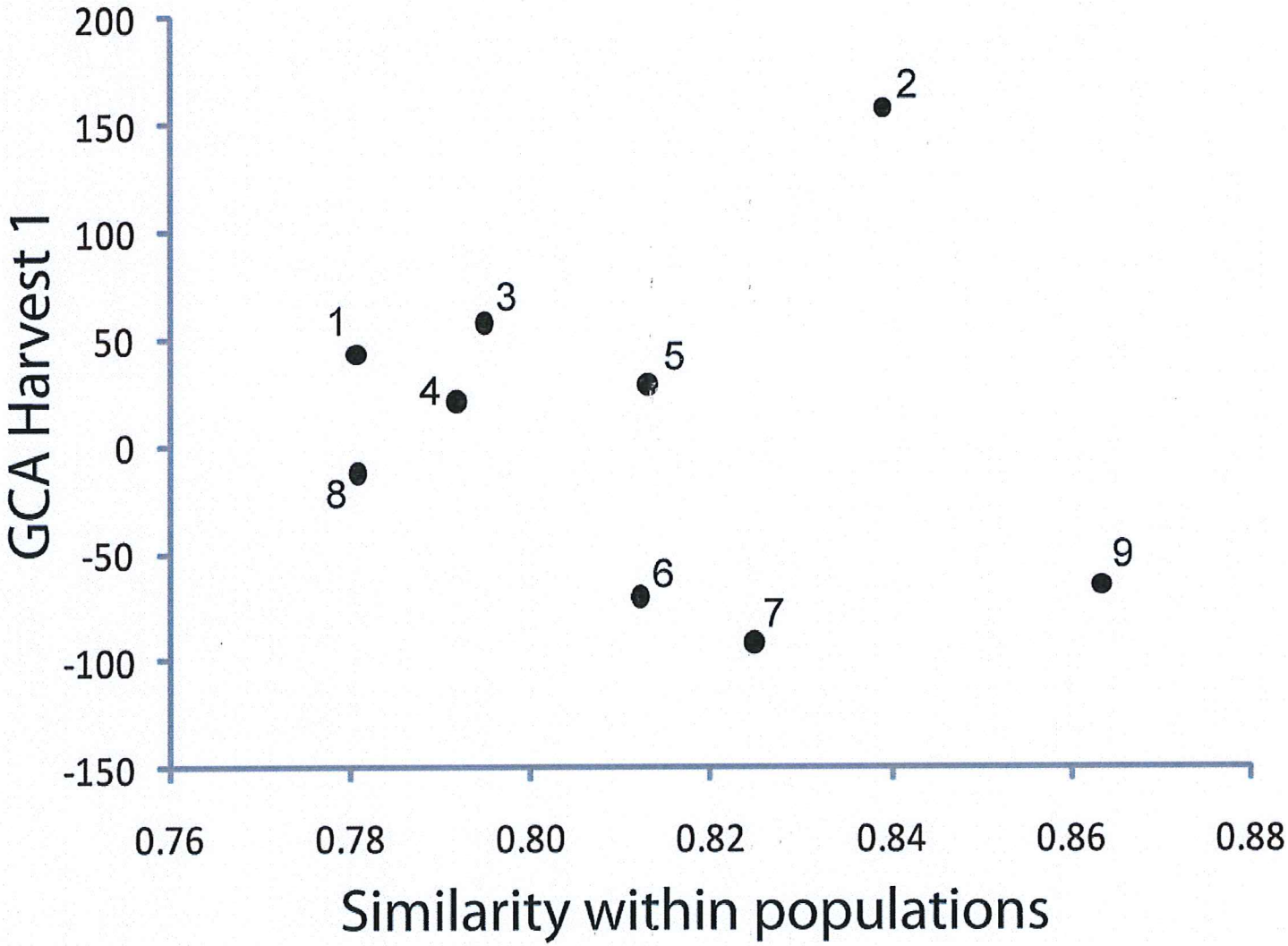
# PHs vs. individual parents - quality

| Population | DMY.1 | DMY.2 | DMY.3 | CP.2 | CP.3 | IVTD.2 | IVTD.3 | NDF.2 | NDF.3 | WSC.2 | WSC.3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IADG102 | - | - | - | - | 5 | - | 8 | - | -15 | - | 10 |
| IADG103 | - | - | 106 | - | -5 | 7 | 5 | - | -7 | - | 10 |
| IADG104 | - | -69 | -129 | - | -15 | 6 | -10 | - | 11 | - | - |
| IADG105 | - | - | - | - | - | - | -9 | -10 | - | 12 | - |
| UTDG101 | -65 | - | - | - | -5 | 8 | -8 | -10 | - | 10 | 7 |
| UTDG102 | 157 | 51 | 251 | - | - | -6 | -8 | - | - | - | - |
| Latar | - | - | - | 5 | 7 | -6 | - | 7 | - | -14 | -19 |
| Paiute | -71 | - | - | - | 8 | - | 4 | - | - | 5 | - |
| Potomac | -92 | - | -102 | - | - | 5 | 4 | - | - | - | 6 |

# Heterosis

- Many instances of MPH and HPH
  - Little consistency
  - Many of the individual HSFs and PHs performed better than the checks
- Recommended PHs
  - DMY: IADG103 x UTDG102, Potomac x UTDG102, IADG103 x UTDG101, Latar x UTDG102, IADG105 x Paiute
  - CP.3: IADG102 x Paiute, IADG104 x IADG105
  - IVTD.2: IADG102 x IADG103, IADG103 x IADG104, IADG103 x Paiute, IADG104 x Potomac
  - IVTD.3: IADG103 x Latar
  - NDF.3: IADG105 x Paiute
  - WSC.2: IADG104 x IADG105
  - WSC.3: IADG102 x IADG103, IADG102 x UTDG101, IADG103 x IADG104, IADG103 x IADG105, IADG103 x Potomac

# Genetic relationships



# Conclusions

- Commercial population hybrids difficult
  - Expense of seed production
  - Inconsistent heterosis
- Identified promising sources of germplasm
  - Almost every population exhibited potential heterosis for at least one trait
  - Continued germplasm improvement efforts
  - Promising population hybrids can be advanced as elite synthetics
  - Developed early and late populations
- Useful germplasm for ongoing genetic studies
  - Flowering time
  - Freezing tolerance
  - Carbohydrate pathways
  - Release of UTDG101 (Jensen et al. 2014; J. Plant Registrations)

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# Thank you