UNIVERSITY OF SASKATCHEWAN

Characterization of crested wheatgrass germplasms for plant maturity and associated physiological and morphological traits

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INTRODUCTION

Introduction

- Long-lived cool season with extensive root system
- Tolerant to drought and extreme winter temperatures
- First perennial grass to green-up in the spring
- High quality at early growth stages

Alfalfa

Crested wheatgrass

Why need for research?

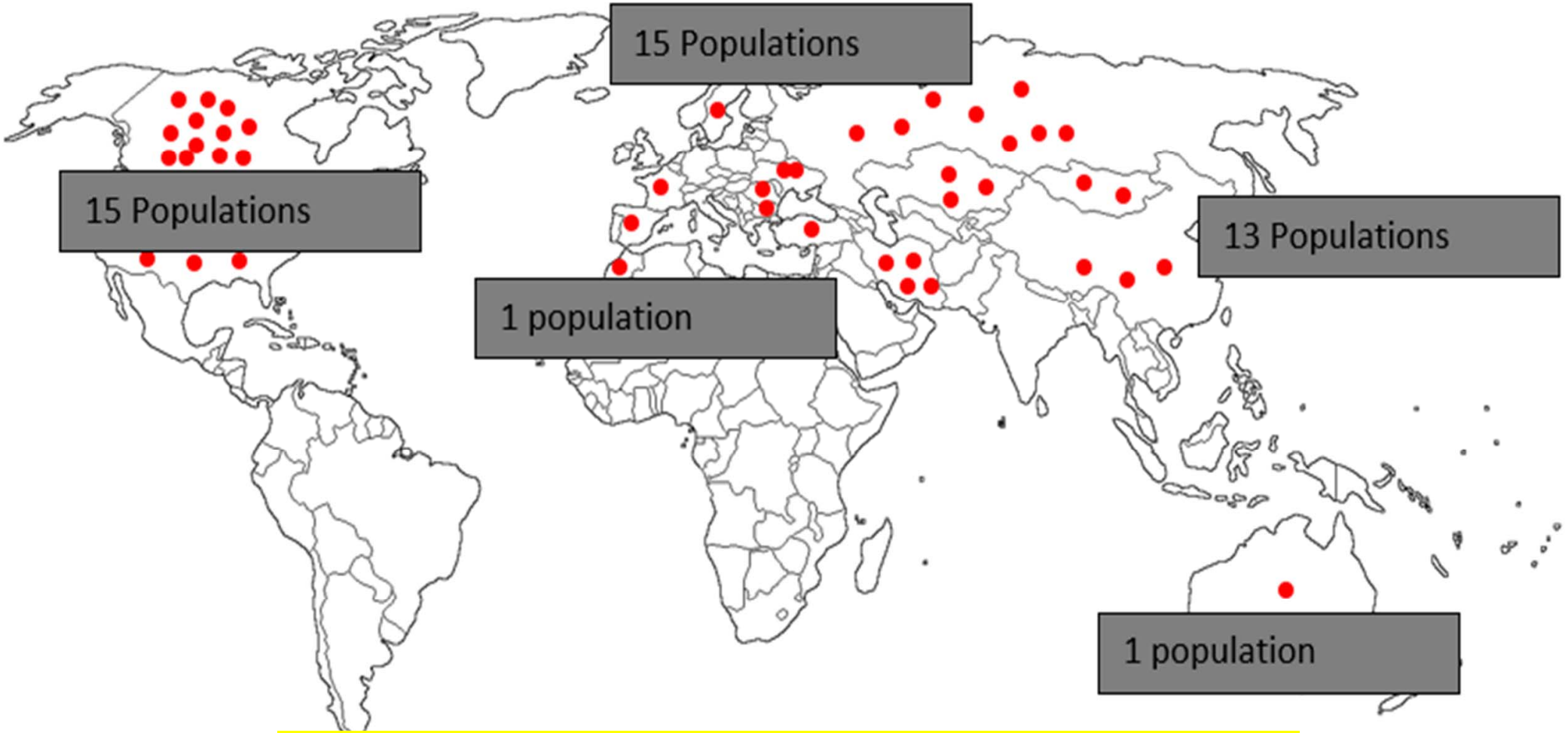
- Rapidly decline of forage quality and palatability with plant maturity

- Genetic variation of plant maturity in crested wheatgrass is not well documented

Crested wheatgrass wolf plants in Swift current and Carrot river

MATERIALS AND METHODS

Germplasm collection



Total: 45 populations

Continent and ploidy level of CWG populations

Continent	No of populations	Ploidy level		
		Diploid (2x)	Tetraploid (4x)	Hexaploid (6x)
North America	15	3	11	1
Europe	15	4	9	2
Asia	13	1	9	3
Australia	1	-	1	-
Africa	1	-	1	-
Total	45	8	31	6

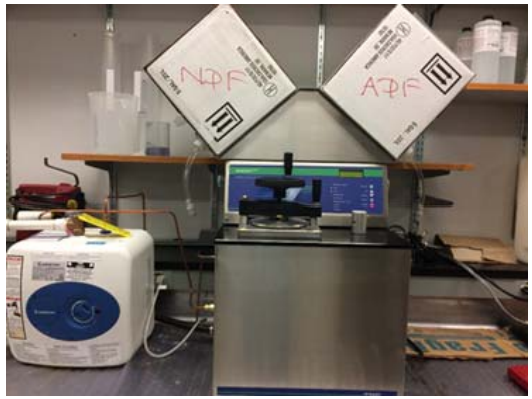
Experimental design

- Randomized Complete Block Design (RCBD)
- Four Replications
- Eight individual plant population^{-1}

Data collection

- **Agronomic traits**
  - Spring vigor
  - Leafiness
  - Hay stage vigor
  - Regrowth
  - Plant height
  - Days to heading
  - Leaf-to-stem ratio
  - Forage (DM) yield

- **Nutritive value traits**
  - Crude protein concentration (CP)
  - Acid detergent fiber (ADF)
  - Neutral detergent fiber (NDF)



- **Ploidy determination**

Climatic Conditions

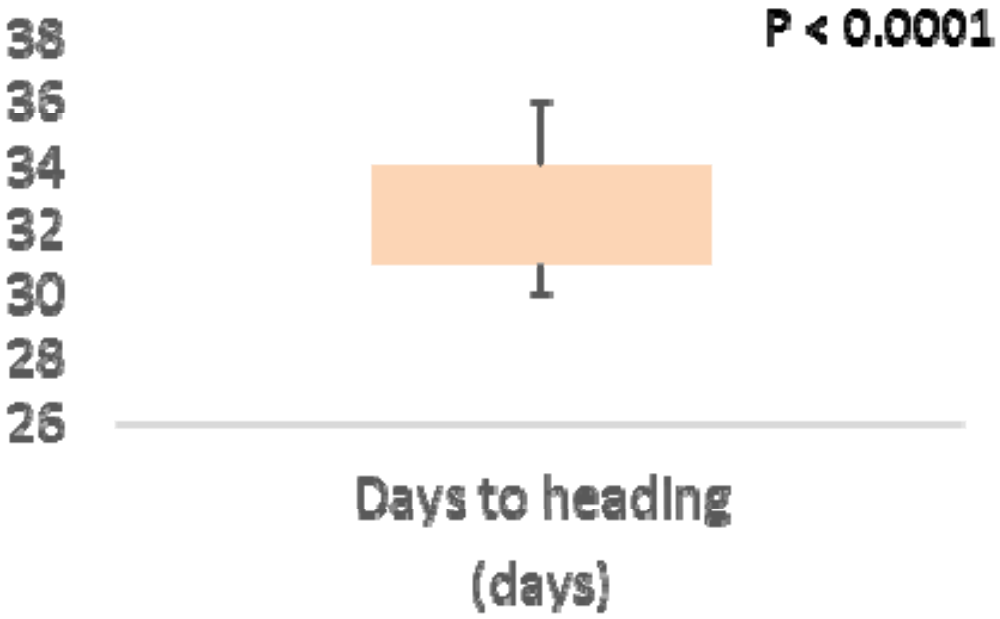
Table 1. Monthly mean temperature and precipitation during 2014, 2015, 2016, 2017 and long-term average monthly temperature and precipitation in Saskatoon.

	Monthly mean temperature					Monthly precipitation				
	2014	2015	2016	2017	Avg[a]	2014	2015	2016	2017	Avg[a]
Monthly	°C					mm				
January	-15.0	-11.8	4.5	-13.1	-13.9	6.1	5.8	17.3	7.4	14.6
February	-19.2	-17.4	-7.9	-9.3	-11.4	2.1	16.5	7.0	9.1	9.1
March	-10.1	-2.4	-1.5	-5.2	-4.9	5.8	5.1	13.9	11.3	14.5
April	1.7	5.6	5.5	4.3	5.2	74.2	21.1	3.0	18.4	21.8
May	10.1	10.1	13.7	12.1	11.8	61.1	0.4	41.6	46.3	36.5
June	14.1	17.2	17.4	16.1	16.1	94.8	13.6	49.7	30.9	63.6
July	18.3	19.4	18.7	19.6	19.0	44.5	84.3	58.6	25.5	53.8
August	17.9	17.4	16.9	17.8	18.2	18.5	45.2	70.2	25.2	44.4
September	12.4	11.9	11.8	12.8	12.0	10.7	50.0	24.1	29.1	38.1
October	6.7	6.7	2.1	5.0	4.4	14.1	33.9	40.8	17.8	18.8
November	-9.7	-3.0	1.9	-9.8	-5.2	30.5	14.0	9.2	15.4	12.4
December	-9.4	-9.3	-13.7	-12.3	-12.4	2.5	4.0	9.7	6.9	12.8
Total	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	364.9	292.4	345.1	243.3	340.4

Avg[a], Average of 30 yr. in Saskatoon (1981-2010), obtained from Environment Canada (2017).
NA[b], denotes not applicable.

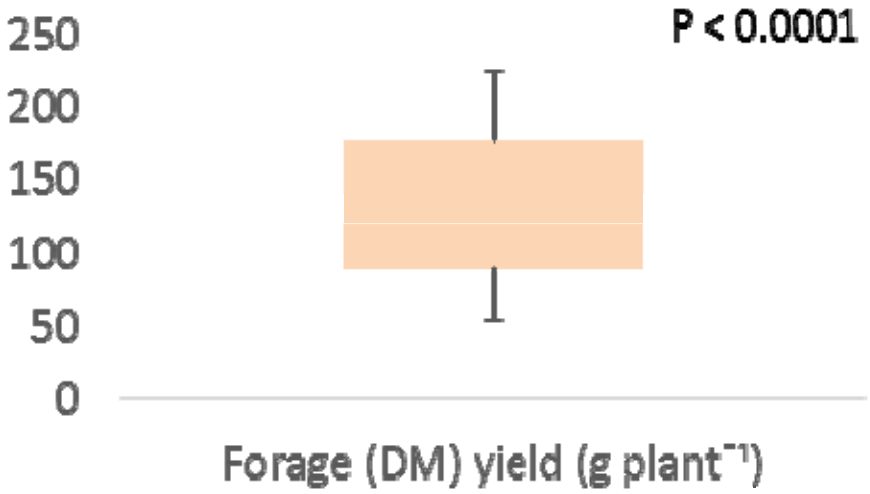
RESULTS

Results



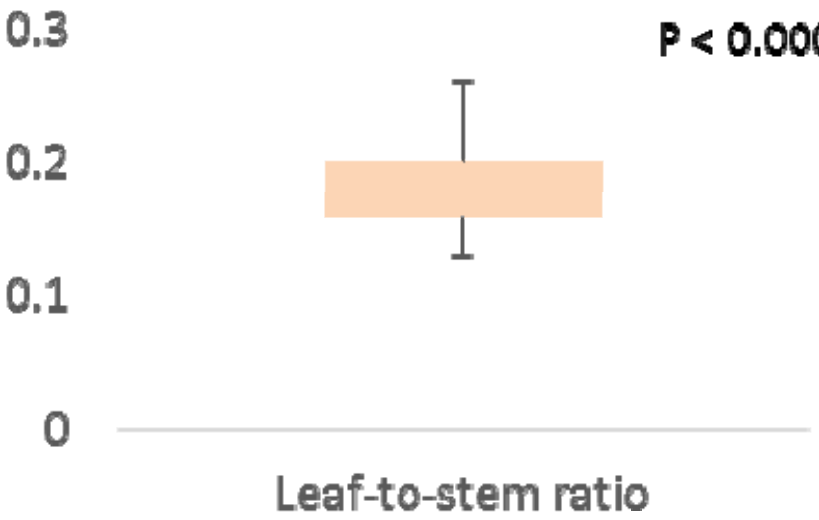
Ranged from 30 – 36 days

Results



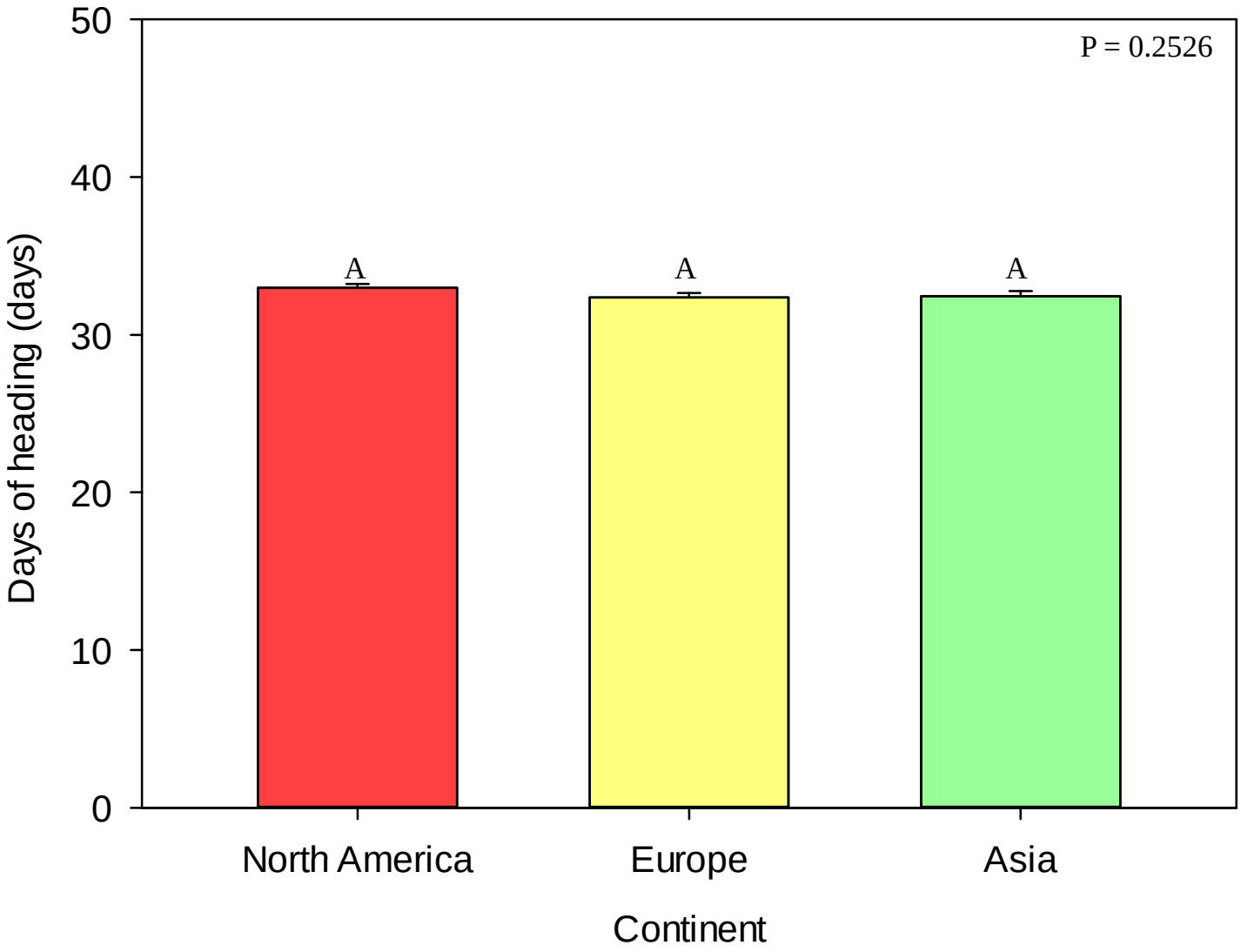
Ranged from 54 g plant^{-1} to 225 g plant^{-1}

Results

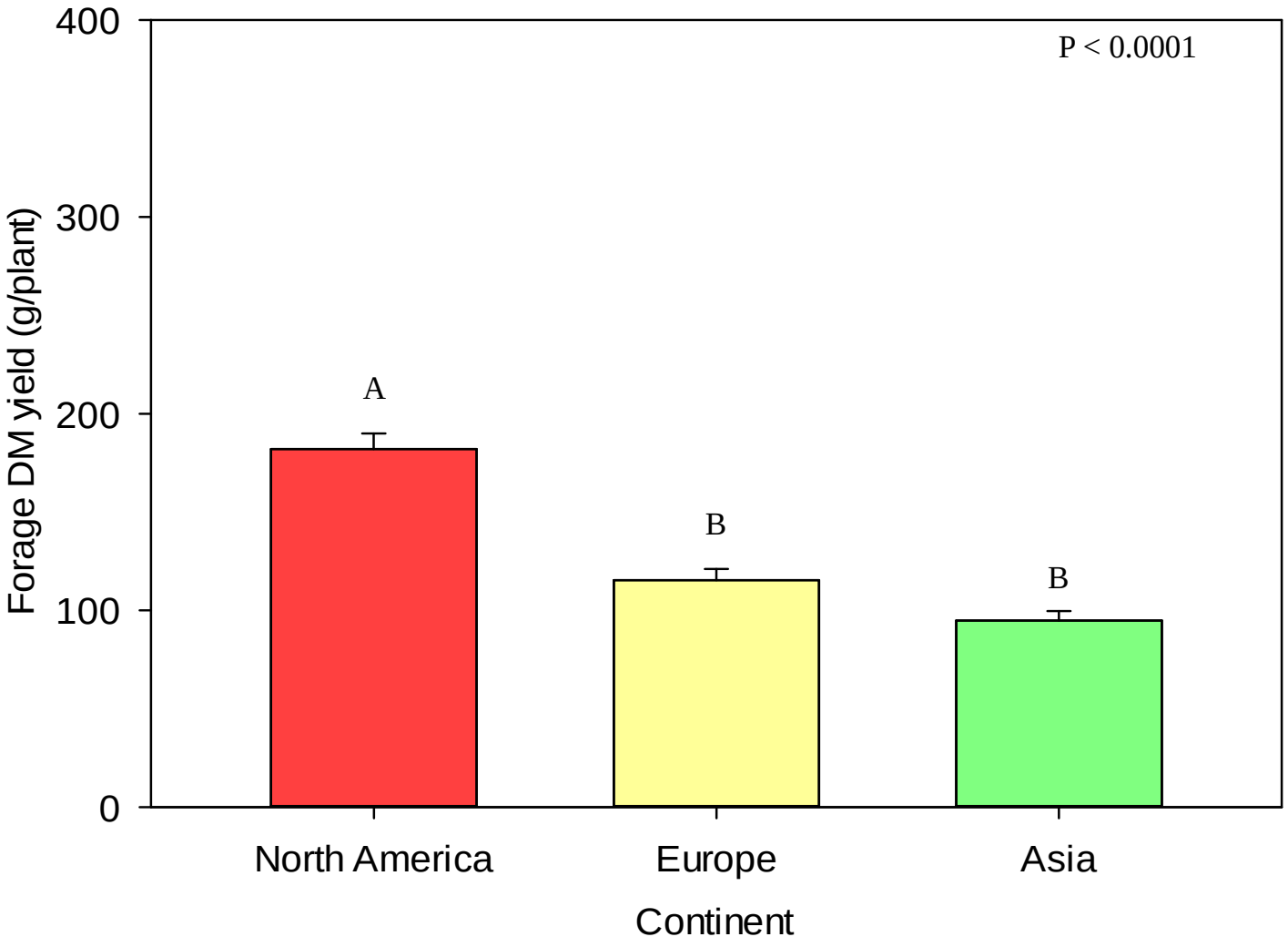


Ranged from 0.13 to 0.26

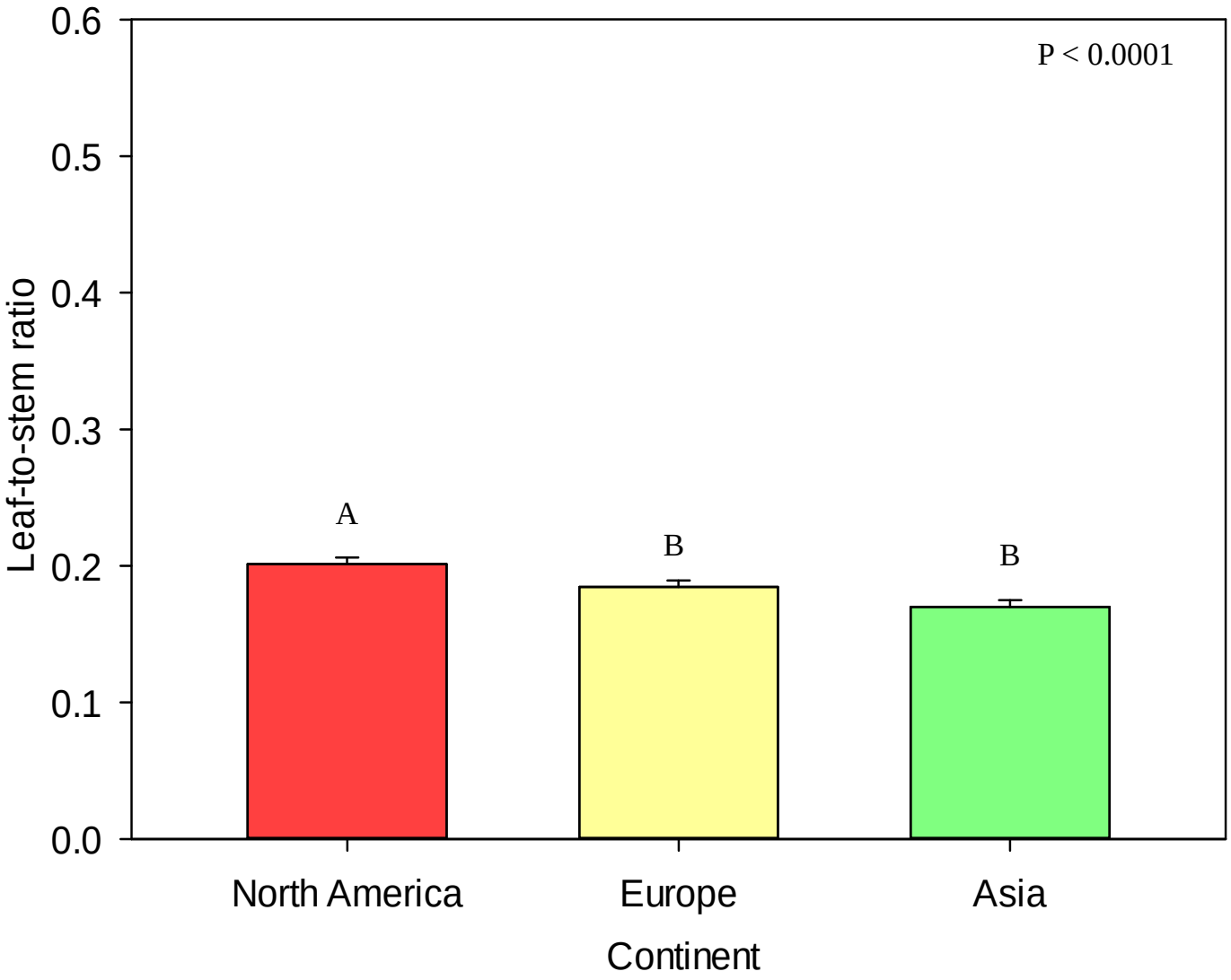
Phenotypic variation among continents



Phenotypic variation among continents



Phenotypic variation among continents



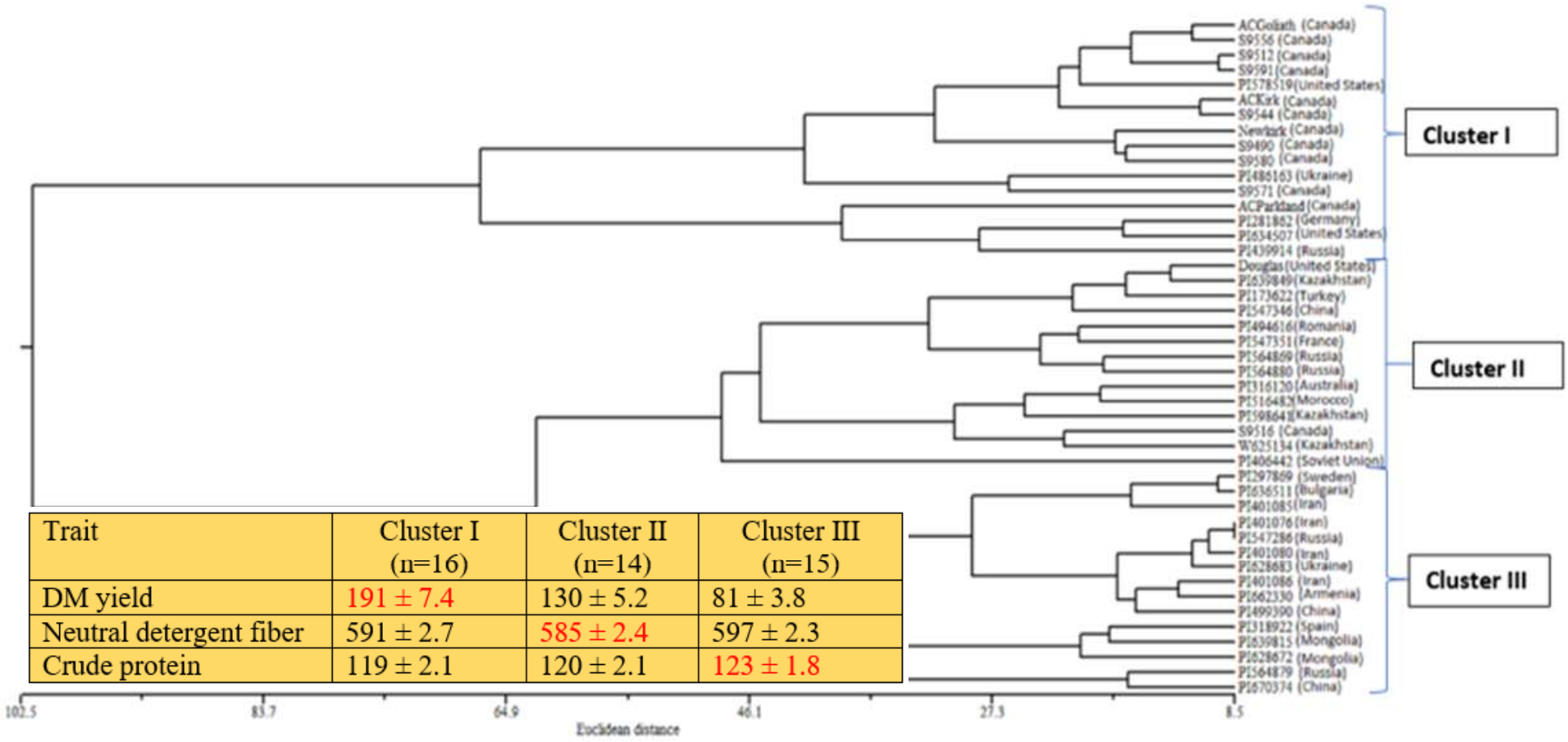
Coefficient of correlation among measured traits

Table 3. Coefficient of correlation (r) among 11 traits measured from 45 crested wheatgrass populations evaluated Saskatoon, SK, Canada

	PH	SV	DH	HSV	LFS	LSR	CP	NDF	ADF	DMY	RG
PH	1[a]	***	*	***	***	***	NS	NS	***	***	***
SV	0.72	1	***	***	***	***	*	NS	NS	***	***
DH	-0.12	-0.43	1	***	NS	***	***	*	**	***	***
HSV	0.44	0.66	-0.36	1	***	***	***	NS	NS	***	***
LFS	0.66	0.59	0.10	0.46	1	***	***	NS	NS	***	***
LSR	0.27	0.37	-0.11	0.36	0.39	1	NS	NS	NS	***	***
CP	-0.10	-0.11	-0.43	-0.37	-0.15	-0.08	1	NS	*	***	*
NDF	0.05	-0.03	0.16	-0.09	-0.05	-0.04	-0.03	1	***	NS	NS
ADF	0.19	-0.02	0.18	-0.05	0.02	0.03	-0.13	0.64	1	*	NS
DMY	0.57	0.77	-0.28	0.58	0.79	0.50	-0.23	0.04	0.11	1	***
RG	0.64	0.81	-0.40	0.58	0.59	0.35	-0.11	-0.03	-0.02	0.71	1

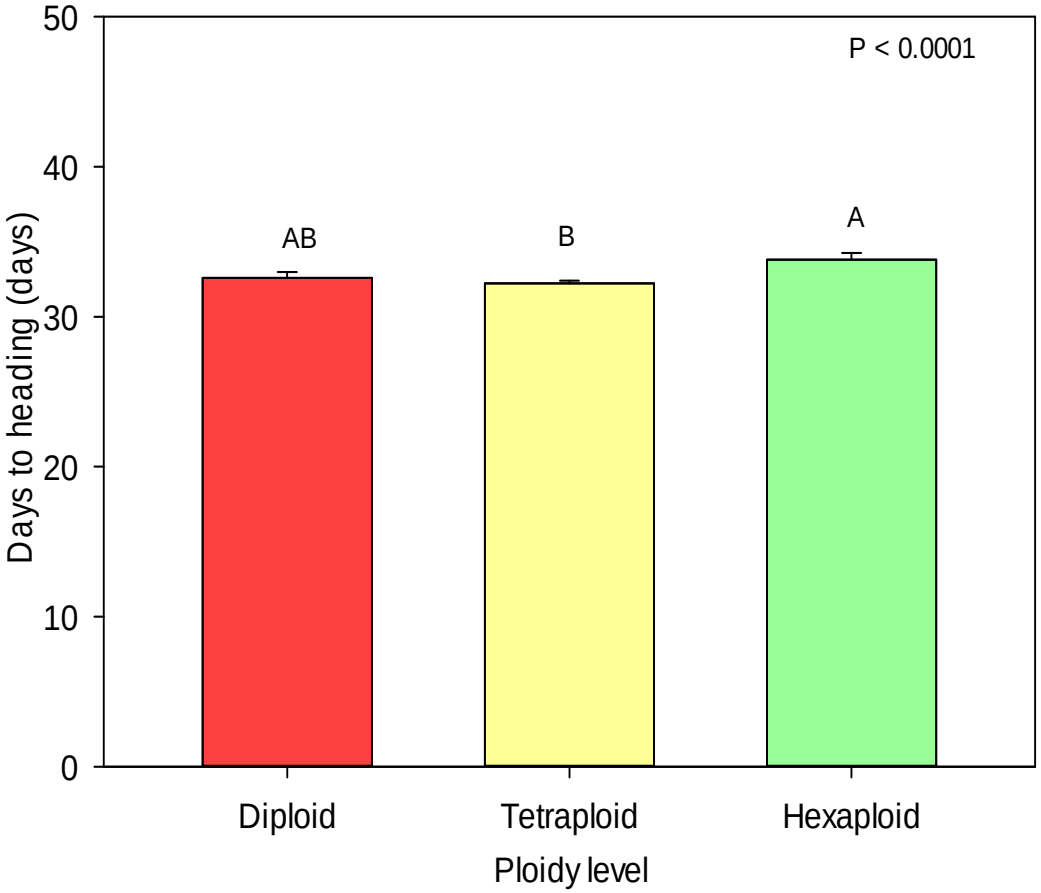
PH=plant height; SV=spring vigor; DH=days to heading; HSV=Hay stage vigor; LFS=leafiness; LSR=Leaf-to-stem ratio; CP=Crude protein concentration; NDF=neutral detergent fiber concentration; ADF=acid detergent fiber; DMY=dry matter yield; RG=regrowth concentration; [a] Coefficient of correlation (r); ***, significant at P<0.0001; **, significant at P <0.001; **, significant at P <0.05; *, NS, non-significant

Phenotypic traits based on dendogram revealed by UPGMA cluster analysis

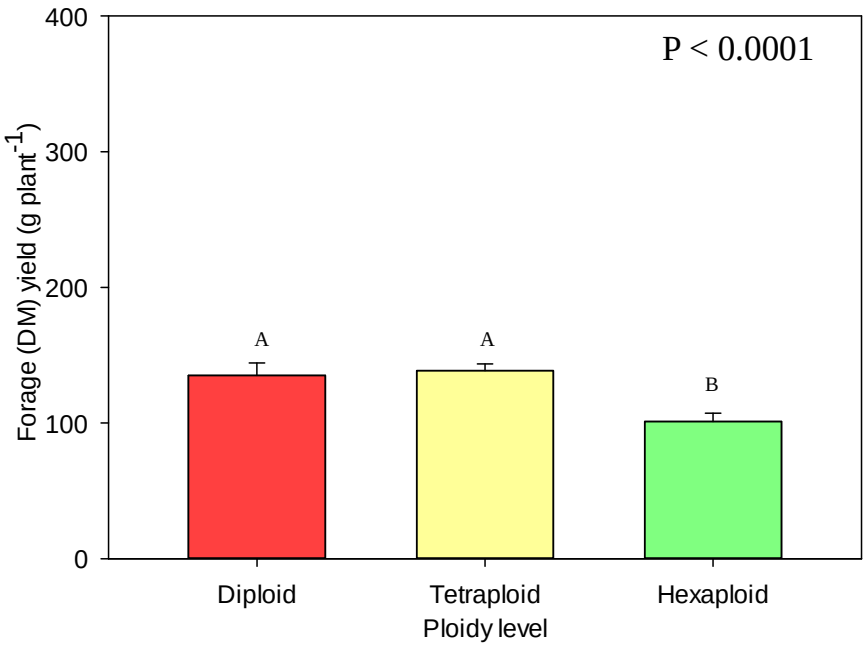


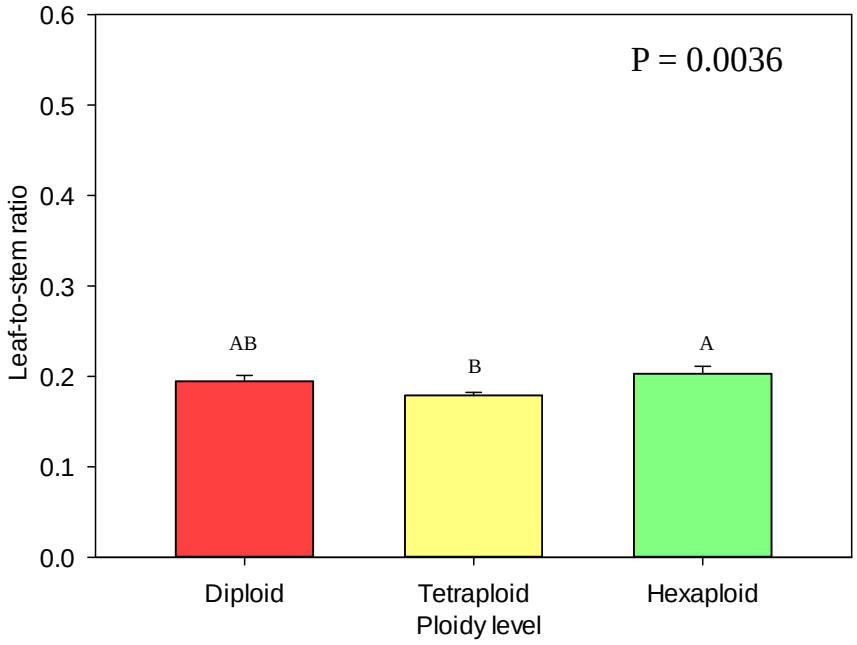
Trait	Cluster I (n=16)	Cluster II (n=14)	Cluster III (n=15)
DM yield	191 ± 7.4	130 ± 5.2	81 ± 3.8
Neutral detergent fiber	591 ± 2.7	585 ± 2.4	597 ± 2.3
Crude protein	119 ± 2.1	120 ± 2.1	123 ± 1.8

Phenotypic variation among ploidy levels



Phenotypic variation among ploidy levels





CONCLUSION

Conclusion

- Selecting for plant maturity in general leads to reduction in forage dry matter yield and leaf-to-stem ratio in crested wheatgrass populations

- Three clusters classified by: DM yield, neutral detergent fiber and crude protein traits

- Hexaploid populations under western Canadian climate did not perform well.

Acknowledgement

Dr. B. Biligetu

Dr. R. Chibbar

Dr. B. Coulman

Dr. Y. Bai

Acknowledgement

Forage Breeding Research Team

Fellow Graduate Students

Acknowledgement

Saskatchewan Forage Network


Thank you