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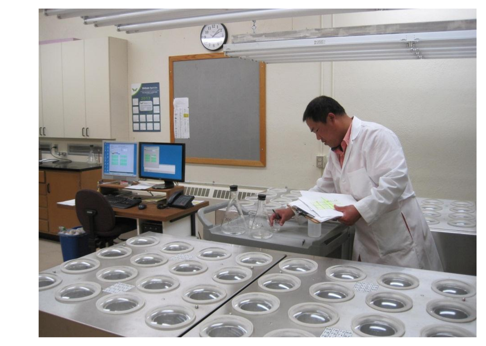
Comparative germination of Cicer Milkvetch and Purple Prairie Clover under varying temperature and osmotic pressure



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Introduction

- The scientific evidence is clear that surface temperatures on earth are warming at a pace that signals a shift in the global climate. Global warming may change the total precipitation resulting in more frequent occurrences of drought. This will result in serious impacts on terrestrial ecosystem processes. Environmental factors regulating germination include temperature, water and oxygen. The semiarid region of Canada is known for drought. A shift in precipitation has been noted, resulting in less available moisture over the entire growing season.
- The question is whether this will lead to a loss or increase in seed germination, if it leads to a decrease in seed germination the risk of some plant extinction does exist, if it leads to an increase in seed germination the result may be a positive feed-back effect for climate change. To examine the possibilities we selected 2 legumes for comparison.

Materials & methods

The seed populations were created using an equal quantity of seed from each collection, and the seed populations were stored at 5℃ in a seed storage room prior to this study.

Cicer milkvetch (*Astragalus cicer* L.) is a long-lived rhizomatous perennial legume, native to and widely dispersed in central and eastern Europe. It is slowly finding its place as a pasture, hay, and conservation species under irrigated and dryland conditions primarily in the areas of western Canada.

Purple prairie clover (*Dalea purpurea* L.) is a long lived native legume of the Northern Great Plains region. It is heat loving and quite tolerant of dry conditions due to their deep tap roots.

Experimental Design

The germination experiment considered two-factors: germination water and germination temperature. Germination water potentials had osmotic potentials of 0,-0.5,-1.0 MPa, respectively. They were achieved using polyethyleneglycol dissolved in distilled water to make the desired solution, distilled water was used as the control; Germination temperatures were eight values ranging from 15℃ to 35℃ in 5℃ increments. Germination counts were made daily for 21 days, seeds with a radicle greater than 3 mm were considered germinated and removed from the petri dishes. The experiment was repeated twice.

Statistical Analysis

All data analyses were conducted with SAS 9.0 statistical software (SAS 9.0, USA). A three-way analysis of variance (ANOVA) was conducted for final germination using the PROC MIXED procedure of SAS (Little et al. 1996) with germination water, germination temperature and their interaction as fixed effects.

Results & discussion

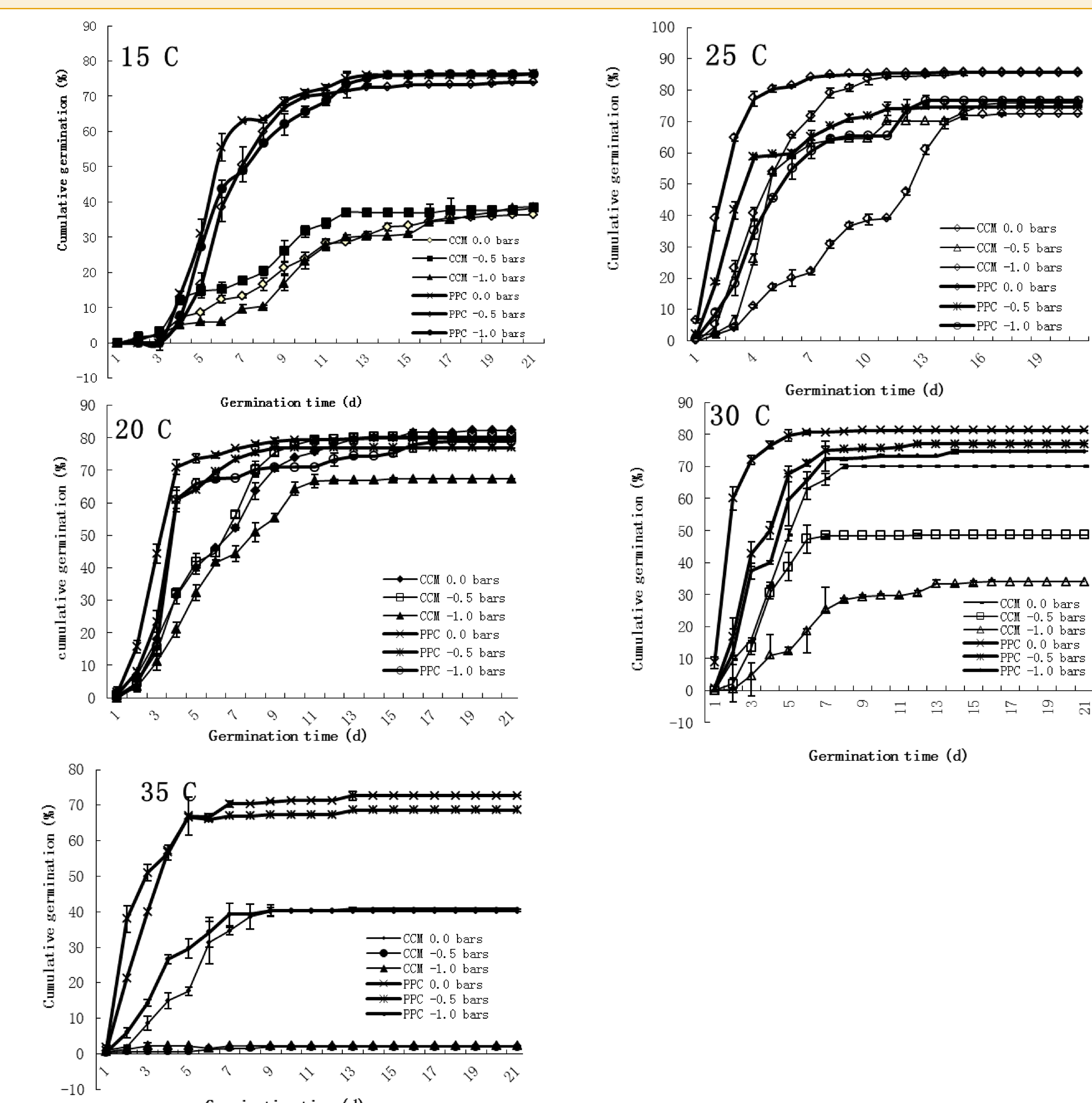

Fig 1. Germination percentage of Cicer Milkvetch and Purple Prairie clover over varying temperatures and water potentials. Values are mean ± SE

Higher temperature and lower available water inhibited seed germination, such as cicer milkvetch seed germination under 35 ℃ and -0.5 MPa, -1.0 MPa treatment applied for up to 21 days just has 2% germination, purple prairie clover had under 40%. Under osmotic pressure seeds take up available water and undergo a chemical change. High temperature a inhibits seed germination (Darryl G. Stout 1998).

Table 1 Comparative final germination, GI and germination potential of cicer milkvetch and purple prairie clover for temperature, water potential and interactions.

	Germination			GI			Germination potential		
	F value	pr>F	Semy	F value	pr>F	Semy	F value	pr>F	Sem[y]
Spe[z]	229.27	<0.0001	1.05	431.69	<0.0001	0.38	11.01	0.001	2.7
Water	58.28	<0.0001	1.29	102.38	<0.0001	0.46	4.69	0.0106	3.4
Temp	126.98	<0.0001	1.67	96.84	<0.0001	0.67	2.95	0.0222	4.41
spe*water	4.77	<0.0098	1.83	2.47	0.09	0.66	0.38	0.6823	4.84
spe*Temp	25.89	<0.0001	2.36	11.58	<0.0001	0.85	0.48	0.7504	6.24
water*Temp	6.31	<0.0001	2.89	6.88	<0.0001	1.04	0.31	0.9596	7.65
spe*water*Temp	4.05	<0.0001	4.1	1.98	0.05	1.48	1.49	0.1665	10.82

[z]Spe, species; Temp, temperature; water, water potential.
Sem [y] standard error of the means.

Purple prairie clover had significantly greater germination under varying temperature and water potential than cicer milkvetch (Fig.1 and Table 2,3). In the present study, purple prairie clover seeds can be germinated in the short term. Increasing available soil moisture increases the chance of greater germination and seedling emergence under the low and erratic precipitation for the purple prairie clover. But cicer milkvetch is difficult to germinate in extremely limited water availability. This work indicates that purple prairie clover can germinate under low water availability in the Canadian prairies, and it should be relatively easy to establish.

Table 2 Final germination rate(%) of Cicer and Purple clover under varying temperature and water potential

Temperature(C)	Cicer milkvetch			Purple prairie clover		
	Water potential(bars)			Water potential(bars)		
	0	-0.5	-1.0	0	-0.5	-1.0
15	36.33b±1.03	38.33b±0.30	38.67b±0.30	76.50ab±0.60	74.00a±0.30	76.33a±1.49
20	82.33a±1.49	80.33a±0.30	67.33a±0.0	80.00a±0.30	77.00a±0.00	79.00a±0.50
25	85.33a±0.30	76.00a±0.00	72.33a±1.49	85.67a±0.00	74.66a±0.60	76.67a±1.55
30	70.00a±0.00	48.67b±0.00	34.00b±1.15	81.33ab±0.00	77.00a±0.00	74.67a±0.00
35	40.00b±0.19	2.00c±0.00	2.33c±0.00	72.67b±1.19	68.67b±1.24	40.67b±0.52
P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

a-c Means with the same letter across column were significantly different at p<0.05 level.

Conclusions

Warmer temperature and decreased soil moisture tended to reduce the total germination rate.

The seed germination of purple prairie clover is better than cicer milkvetch for more stressful temperatures and water potentials examined in this work. Purple prairie clover is quite tolerant of reduced water potential and high temperatures.

For both legumes, the best temperature range is from 20℃ to 30℃ and the best water potential was the control for seed germination.

References

Littell, R.C., Milliken,G.A., Stroup, W.W. and Wolfinger, R.D,1996. SAS System for Mixed Models.SAS Institute Inc.,Cary,NC,USA.

Darryl G. Stout, 1998. Rapid and Synchronous Germination of Cicer Milkvetch Seed Following Diurnal Temperature Priming.Agronomy and Crop Science 181,263-266.

Acknowledgements

I would like to thank Dr. Schellenberg and AAFC-Semiarid Prairie Agricultural Research Centre for their support and help, and also thank M. Kehler for technical assistance.

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