Ecotype Response of Jointed Goatgrass (*Aegilops cylindrica*) Caryopses to Vernalization Duration

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Introduction

Studies conducted at Oregon State University have shown that length of vernalization and floret position within the spikelet can reduce seed production and germination response in jointed goatgrass populations. However, examination of fitness of seedlings produced by spring emerged plants in comparison to those from fall emerged mother plants has not been studied. Jointed goatgrass of different ecotypes may respond uniquely to reduced vernalization. Studies comparing these responses with jointed goatgrass populations from different environments will provide a better understanding of this adaptive mechanism.

Objective

To determine if previously observed impacts from reduced vernalization on jointed goatgrass seed production would result in reduced seedling vigor in jointed goatgrass populations from different growing environments.

Materials and Methods

Jointed goatgrass spikelets were collected from three geographically separate populations: a roadside (BicR), a winter wheat rotation (DavWW), and a spring wheat rotation (BreS). Caryopses from these collections were harvested from maternal plants seeded in a common garden at Pendleton, OR in either October or the following February. These two plantings constitute either a long (October), or a short (February) vernalization period. The spikelets were dissected, caryopses excised and sorted by floret position. All studies were arranged as randomized complete blocks with four replications and were repeated.

Greenhouse

Jointed goatgrass secondary floret caryopses from each population produced under both vernalization regimes were sown 2.5 cm deep in 28 X 43 cm flats filled with commercial potting medium. Plant height was measured for each individual seedling for 15 days after emergence. At the end of the 15 day period the seedlings were clipped at the soil surface, oven dried, and weighed.

Growth chamber

Caryopses from each floret position (primary 1º, secondary 2º, and tertiary 3º) from all three populations were placed into separate germination boxes on moistened germination paper. A 25/15º C day/night temperature regime with a 12 h photoperiod was maintained in both experiments. Observation of germination was made daily for seven days after planting. Germination was defined as 3 mm of radicle emergence. At the end of the seven day period, the caryopses were removed from the germination boxes, root and shoot length were measured, for 48 h, and weighed.

A significant run effect was observed for both experiments, so each was analyzed separately.

Results

Greenhouse

In both experiments, greater total emergence was observed in all three populations from caryopses produced under the longer vernalization period than from those from the shorter vernalization period (Figure 1a). However no clear differences in emergence were observed between populations.

Figure 2. Mean seedling heights from both greenhouse experiments of all three populations with fitted linear regressions.

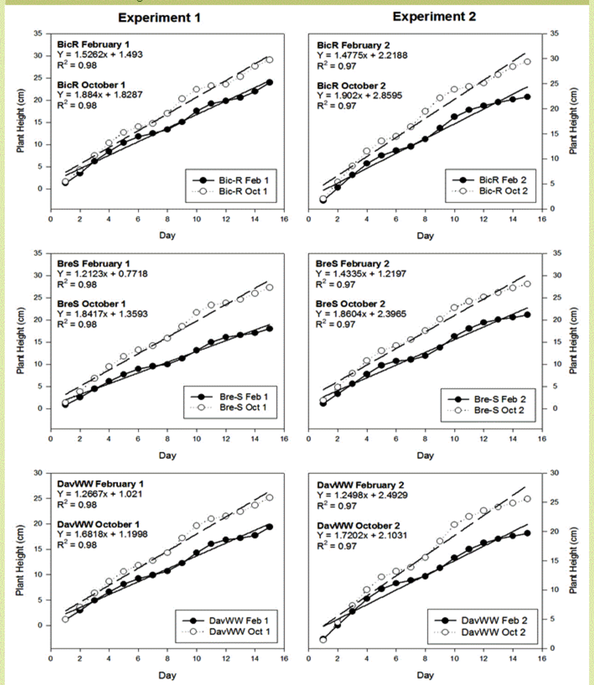
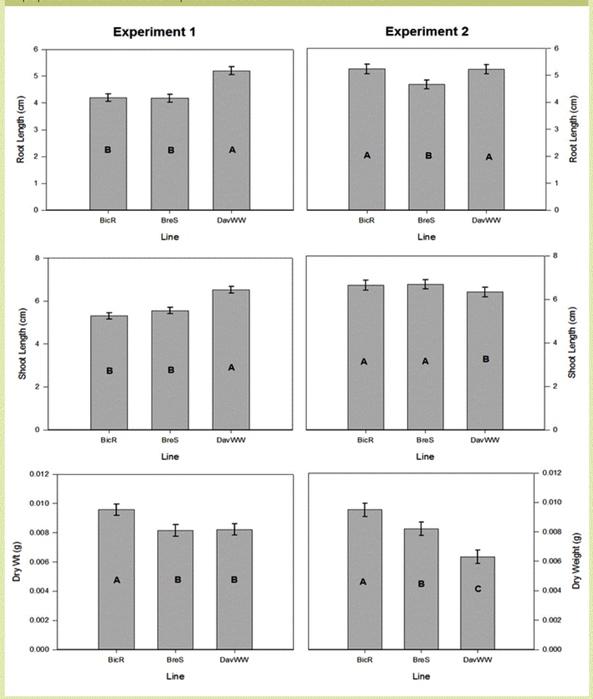


Figure 3. Mean seedling root length, shoot length, and dry weight averaged over floret position and month from both growth chamber experiments of all three jointed goatgrass populations. Error bars represent 95% confidence intervals.



Results (continued)

Increasing the length of vernalization of the mother plants had a positive impact on dry weight produced 15 days after emergence. The mean seedling heights measured in the both greenhouse experiments for 15 days after emergence from all three populations and both vernalization periods were fit to linear regression models (Figure 2). Comparisons of the slope coefficients generated by the linear models indicated significant differences in the seedling height responses to vernalization period in both experiments for all three populations (Table 1). But no clear differences were detected between populations.

Figure 1. Jointed goatgrass seedlings from the BicR population, at both vernalization periods 6 days after planting in the greenhouse (a), and 4 days in the growth chamber (b).

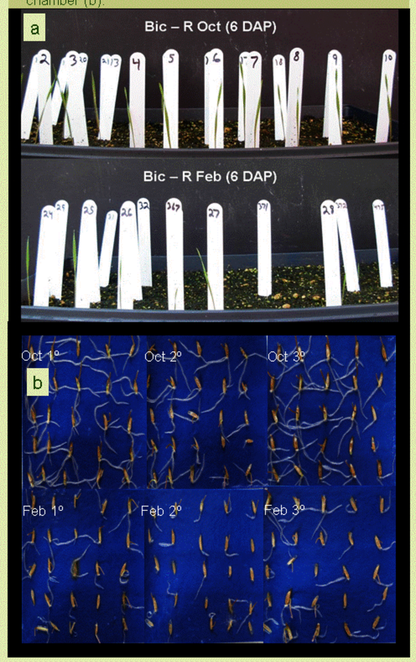


Table 1. Comparison of slope coefficients for linear regression models of average daily plant height generated for each population between the two vernalization periods.

Slope coefficient	Type III SS	F value	P>F
Exp 1			
Feb vs Oct - BicR	17.92	15.47	0.0006
Feb vs Oct - BreS	55.47	54.98	<0.0001
Feb vs Oct - DavWW	24.11	30.08	<0.0001
Exp 2			
Feb vs Oct - BicR	25.24	14.41	0.0008
Feb vs Oct - BreS	25.51	18.46	0.0002
Feb vs Oct - DavWW	30.97	20.25	0.0001

Growth Chamber

In the growth chamber, caryopses from the shorter vernalization period displayed significantly lower total germination, final dry weight, and root and shoot growth from those of the longer vernalization period in all three populations (Figure 1b,Table 2). Floret position did not influence caryopses total percent germination. However, it was influential on dry weight, and shoot and root length, but the responses were not consistent, and were therefore averaged over populations. Combined (month + floret) average response in root length, shoot length, and dry weight to vernalization time varied between populations and experiments (Figure 3).

Conclusions

In all three populations, plants grown from caryopses produced under a longer vernalization period had greater emergence and greater biomass than those produced under a shorter vernalization period. In growth chamber experiments, there was greater germination, increased dry weight, and more shoot and root development of seedlings from caryopses with a longer vernalization period. These results indicate that length of vernalization has a significant impact on the fitness of jointed goatgrass seedlings regardless of the environmental adaptation of the maternal parent.

Table 2. Mean shoot, and root lengths and dry weights for jointed goatgrass seedlings produced by caryopses from plants from both long and short vernalization periods in the growth chamber.

	BicR						BreS						DavWW					
	Root Length		Shoot Length		Dry Wt.		Root Length		Shoot Length		Dry Wt.		Root Length		Shoot Length		Dry Wt.	
Planting Date	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2
	cm		cm		g		cm		cm		g		cm		cm		g	
February	3.49	3.73	4.75	5.09	0.005	0.005	2.737	2.938	4.86	5.29	0.005	0.005	3.79	3.86	5.39	5.23	0.005	0.004
October	4.84	5.5	5.8	6.66	0.013	0.014	5.471	5.78	6.2	6.89	0.011	0.011	6.47	6.38	7.54	7.47	0.012	0.01
LSD (0.05)	0.1981	0.178	0.2535	0.222	0.0006	0.0005	0.205	0.15	0.272	0.289	0.0011	0.0005	0.244	0.19	0.286	0.218	0.001	0.0004