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Population and Environmental Effects on Seed Production, Germination, and Seedling Vigor in Western Wheatgrass *(Pascopyrum smithii* [Rydb.] A. Love)

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ABSTRACT

Western wheatgrass (*Pascopyrum smithii* Rydb. A. Love) has low seed production and poor germination and seedling vigor, limiting its use when quick establishment is needed to stabilize degraded range. lands. This study examined differences among germplasm sources and seed production environments on western wheatgrass seed traits. Seed was harvested from 10 western wheatgrass populations grown in three environments. Seed yield, seed weight, seedling germination, and seedling vigor were then determined. Seedling vigor was measured by greenhoose evaloation of seedling emergence percentage and rate from a planting depth of 635 cm. There were significant population x environment interactions for seed yield and seed weight. However, high Spearman's rank correlations between environments within each trait (r = 0.64 to 0.85, *P* = 0.048 to 0.002) suggested that environment had only a moderate effect on ranking of populations. Mean seed yield and 100-seed weight varied significantly among populations. ranging from 2,6 to 25.4 g plant $^{-l}$ and 0.43 to 0.54 g, respectively. Seed germination was high, ranging from 78.4 to 94.4%; however, population performance was not consistent across environments. Environ ment had no effect on seedling emergence ride, whereas emergence among populations ranged from 2.4 to 4.2 seedlings d-1 germination rate and seed weight were both correlated with seedling emergence rate *(r* = 0.57, P = 0.001 and *r* = 0.49, *P* = 0.01, respectively). These results indicated that seed production environment had little effect on western wheatgrass seed yield or seedling vigor and that it may lie possible to breed for improvement in these traits by selecting among and within western wheatgrass populations.

WESTERN wheatgrass is a perennial, cross-pollinating native grass that is an important component of rangelands in the mixed grass prairies throughout the central and northern Great Plains and in some areas of the Intermountain West (Asay and Jensen, 1996; Hart et al., 1996). Because of its sod-forming characteristics, it is widely recommended for use in rangeland improvement and revegetation after disturbances such as mining, construction, and fire (Asay and Jensen, 1996). Western wheatgrass is found naturally throughout central and southern Colorado, including the Fort Carson United States Army base headquartered in Colorado Springs, CO, where it is used to reseed 200 to 1215 ha per year following military training and rangeland fires (J.D. Kulbeth, Rangeland Management Specialist, Natural Resources Division, Fort Carson, personal communication, 2002). Western wheatgrass has low seed yields and is difficult and slow to establish because of seed dormancy and poor seedling vigor; however, thick stands may result over time from extensive rhizome development (Asay and Jensen, 1996). The inherent slow establishment of western wheatgrass limits its effectiveness in reducing erosion and controlling invasive weeds in areas with frequent, severe disturbances, The development of new western wheatgrass cultivars with improved seed production and seedling vigor would greatly enhance the value of this species for revegetation of frequently disturbed rangelands, military training lands, and areas with repeated wildfires.

Seed weight and ability to emerge from a deep planting depth have been used as selection criteria for improving seedling vigor in grasses (Andrews et al., 1997; Asay and Johnson, 1983a; Johnson and Asay, 1993; Kalton et al., 1959; Lawrence, 1963). Lawrence (1963) suggested that high seed test-weight and faster emergence rate from deep depths were effective selection criteria for improving seedling vigor in Russian wildrye *[Psathyrostachys juncea* (Fisch.) Nevski]. This strategy was successfully used to evaluate Russian wildrye and crested wheatgrass [A. gropyron desertorum (Fisch. ex Link) Schultes] breeding populations (Asay and Johnson, 1980, 1983a; Johnson and Asay, 1993) resulting in the release of `Bozoisky-Select' Russian wildrye (Asay et al.. 1985a), Tetra-1 Russian wildrye germplasm (Jensen et al., 1998), 'Hycrest' crested wheatgrass (Asay et al., 1985b), and 'Vavilov' Siberian wheatgrass (Asay et al., 1995). These cultivars and germplasms are known for their improved seedling vigor and establishment ease in comparison to older cultivars. A recent Russian wildrye cultivar, Mankota, was also selected, in part, for its ability to emerge from a depth of 5 cm (Berdahl et al., 1992). Lafond and Baker (1986) also found that seed size and speed of emergence were associated with seedling vigor in wheat *(Triticum aestivum* L.)

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