Understanding and Improving Winter Wheat Seedling Emergence from Deep Planting Depths

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Farmers in the winter wheat-summer fallow region of the Inland Pacific Northwest plant seed as deep as seven inches below the soil surface to reach adequate soil moisture for germination and emergence. Successful emergence through a thick, dry, soil mulch is critical for stand establishment and grain yield potential. Winter wheat varieties that can emerge quickly and successfully from these depths under limited moisture conditions are needed. The present-day semi-dwarf cultivars in PNW contain Rht1 and Rht2 dwarfing genes that do not emerge as well as the the taller varieties that were grown in the 1960s. The Rht mutations seem to reduce coleoptile length and thus impede seedling emergence. Funded by the Washington Grain Commission, our objectives are to improve seedling emergence of the present-day varieties and to study the genetics and variation of this trait among cultivated wheats of the world. First, with the objective to transfer the emergence trait from the available resources, both Buchanan (hard red) and Moro (soft white club) were used as donor parents. Focusing on the Xerpha × Buchanan cross, about 14,000 BC_1 seeds were developed. Evaluation of the BC_1F_1 seedlings showed a complex inheritance for the coleoptile length trait as only about 25% of the seedlings showed coleoptile length similar to that of the donor parent. We have developed a few lines with coleoptile lengths more than 100 mm and they appear to have grain quality better than Xerpha. These lines will be field-tested at Lind this year for emergence from deep planting, as well as for agronomic traits. To meet the second objective, 670 lines of our world collection of varieties were evaluated for coleoptile length, field emergence, 1000 kernel weight and plant height. Coleoptile lengths ranged from 40 to 120 mm with most of the cultivars showing a range of 40 to 80 mm. Average coleoptile length of spring entries was similar to that of winter lines. To test the emergence capabilities, these lines were evaluated in a replicated field emergence experiment at the Lind station (Fig. 1). The lines were planted deep with 4.7 inches of soil covering seeds. On the 7th day after planting, only 1% of the entries had emerged, and 25% showed emergence on the 8th day. Although there was a general correlation between coleoptile length and emergence, we observed that there were factors other than coleoptile length that were also important for emergence. Some of the best emerging lines had coleoptile lengths of only 50 to 60 mm. Similarly, some entries with coleoptile lengths longer than 90 mm showed very poor emergence. We also observed that coleoptile lengths longer than 90 mm either did not increase emergence or had a negative effect. Our results suggest that emergence for deep planting depths is a complex trait and we need a better understanding of the underlying genetic and molecular mechanisms in order to improve it in a targeted manner.

Fig. 1. Counting the number of emerged wheat seedlings from the world collection at Lind in early September. Fifty seeds of each of the 670 lines were planted with four replications, thus we determined the emergence status of 134,000 individual seeds at 24-hour intervals for several days.

Facultative Growth-Dormant Seeding in The Pacific Northwest

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On November 19, 2010, we planted 18 HRS and 18 SWS cultivars in Walla Walla, Washington to test for performance in a dormant seeded (~facultative growth) production system. The same 18 HRS cultivars were planted in April 2011 adjacent to the fall planted trial. Nine winter wheat cultivars were planted alongside the trials for check comparisons. Plots were planted, evaluated, maintained, harvested, and processed by both the Spring Wheat and Winter Wheat Breeding Programs. This experiment is being replicated in 2011-2012 and lines which perform well over both years will be communicated to producers interested in dormant-seeding wheat. In addition, 18 near-isogenic winter wheat lines, with four vernalization alleles were also tested and spring growth habit observed. The purpose of these experiments is to intentionally select lines which have facultative growth habit.

Based on the results of 2011 experiments, we see trends that suggest the importance of selecting spring wheat lines with stronger