crops due to increased productivity of winter wheat and reduced N fertilizer input costs. This information boosts growers' decision-making ability to grow biofuel or any spring crop prior to winter wheat.

2010 Rotation Study Spring Crops planted to winter wheat for 2011 at Spillman Farm, Pullman, WA

Table 1. Spring Crop Seed Yields, 2008 Moscow, 2009, 2010, and 2011 Pullman

Spring Crop	2008	2009	2010	2011	2008-11 avg.	Avg. % Variation
	---------------------- lbs/acre --------------------					
Spring Wheat	3750	3915	1700	2770	3035	26.4
Spring Barley	4625	5485	3520	4145	4445	13.8
Dry Pea	1830	245	840	2565	1370	61.4
Lentil	1075	740	480	1850	1035	56.8
Camelina	1895	2585	1715	1530	1930	17.0
Yellow Mustard	1390	1635	695	1415	1285	23.1
Oriental Mustard	915	2290	700	1750	1415	42.9
Canola	700	1610	670	1395	1095	37.3
Average	2025	2315	1290	2175	1950	34.8
LSD (0.05)	515	765	750	455		

Increasing Seed Size and Seedling Emergence in the Brassicas Arabidopsis and Camelina

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In low rainfall, dryland-cropping areas of Eastern Washington stand establishment can have a major impact on yields of camelina and canola. One approach to facilitate stand establishment is to develop varieties with larger seeds and longer hypocotyls as seedlings while maintaining normal stature as adults. Unfortunately, few mechanisms have been identified that uncouple adult stature from seedling height. The Neff lab has identified a group of plant-specific genes that, when mutated in a particular way, increase seed size and seedling height without adversely affecting adult stature. These genes encode AHL (AT-Hook Containing, Nuclear Localized) proteins. In the Brassica *Arabidopsis thaliana,* we have identified a unique mutation (*sob3-6*) in one of these genes, *SOB3/AHL29*, that expresses a protein with a disrupted DNA-binding domain and a normal protein/protein interaction domain. In *Arabidopsis*, this mutation confers normal adult plants that produce larger seeds and seedlings with hypocotyl stems that are up to twice as long as the wild type. We have shown that a similar DNA-binding mutation (*esc-11*) in another *AHL* family member in *Arabidopsis*, *ESC/AHL27*, confers similar phenotypes as *sob3-6*. We have also shown that expressing this *Arabidopsis* mutation in the Brassica *Camelina sativa* leads to taller seedlings with no negative impact on adult size. By analyzing seed weight, we have shown that these taller seedlings are, in part, caused by an increase in seed size (Figure 1). However, the increase in height using the *Arabidopsis* mutant allele in camelina is only 30% and not the 100% realized by using the *Arabidopsis* mutant allele in *Arabidopsis*. Even with this 30% increase in hypocotyl length in camelina, we have shown that these larger seeds and taller seedlings can dramatically enhance emergence from deep planting (8 cm) in dry soil (Figure 2).

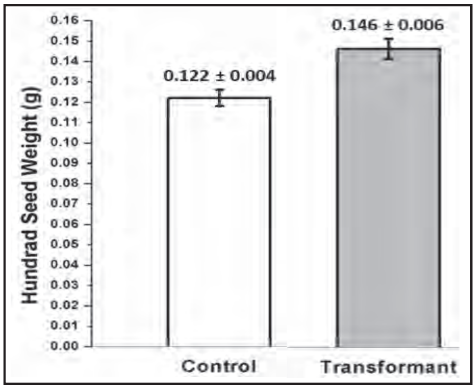

Fig. 1. Seed size is increased in *Camelina* The average weight of 100 wild-type (control) seeds is compared to the transgenic line used in Figure 2.

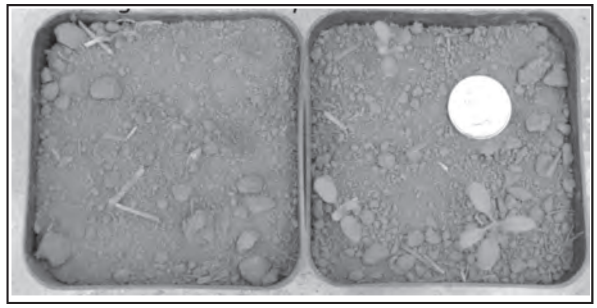

Fig. 2. *Camelina* plants expressing the *Arabidopsis sob3-6* mutation can emerge from deep planting in dry soil. Ten seeds (left: non-transgenic, right: transgenic) were planted on 1 cm of moist Palouse silt/loam and then covered with 8 cm of dry silt/loam. All seeds germinated however, no wild type seeds could emerge from this deep planting. Five transgenic seeds emerged and three survived. This experiment has been repeated twice.

Development of Camelina Lines Resistant to Group 2 Herbicides

Scot Hulbert, Ian Burke, and Ron Sloot, WSU

In the high rainfall, annual cropping zone, Group 2 residual herbicides (imidazolinones and sulfonylureas) continue to pose a major constraint to producing oilseed crops, particularly canola and camelina. After extensive field, greenhouse and laboratory testing, we have identified one mutant population in camelina that shows resistance to all Group 2 herbicides tested. This mutant occurred in the Cheyenne background and we have crossed it to Calena. Several large F2 families were planted in the field in June 2011 and sprayed with Pursuit. Seed from vigorous plants were harvested and planted in duplicate plots at Lind in late winter 2011. Seeds from single plants were again selected and were planted in yield plots this spring.

We hope to release a WSU cultivar in 2013 and we have already sent seed of the original mutant in the Cheyenne background to two different commercial breeding programs. We expect the SM4 mutation to be incorporated into several widely grown cultivars in the future, and expect this to reduce risks associated with camelina production in most regions.

Biennial Canola – A Three-for One Forage + Oil + Meal Crop

Robert Kincaid[1], Kris Johnson[1], Bill Pan[2], and Scot Hulbert[2]; [1]Dept. Of Animal Sciences; [2]Dept. Of Crop and Soil Sciences, WSU

Growing winter canola in eastern Washington is difficult without a fallow period or irrigation. Stand establishment after crop harvest in late summer can be problematic due to low soil moisture, and if seeding dates are later than recommended for the region, the canola plants may be too small to survive low winter temperatures. Good stands are not always easy to establish in late summer even when planting into fallow. A biennial canola study on 17 acres near Pullman examined early-planted, interseeded winter canola and spring peas as a potential source of forage, and a means of seeding into available soil moisture. Peas were planted on July 1, 2010, followed by canola seeding the next day. The field was swathed and windrows harvested on September 8,