Table 1. Plot yields of camelina varieties and the herbicide tolerant (HT) line planted in Pullman after wheat plots sprayed with different rates of Beyond herbicide.

Camelina line	Rate*	Yield/plot
Calena	0X	305
Cheyenne	0X	300
HT line	0X	302
Calena	1X	233
Cheyenne	1X	254
HT line	1X	308
Calena	2X	113
Cheyenne	2X	134
HT line	2X	308
Calena	4X	7
Cheyenne	4X	8
HT line	4X	319

* 0X = no beyond application. 1X, 2X, 4X are one, two and four times the recommended rate of Beyond herbicide sprayed on the previous seasons winter wheat crop.

No public or private camelina breeding programs are present in the region so we have begun a breeding program to make high yielding, high oil varieties that are adapted to PNW growing conditions and herbicide tolerant. Our original mutant line has been crossed to several camelina lines that have performed well in regional variety tests. This summer (2013) will be the second year of testing several hundred advanced lines made from these crosses. We hope to release a herbicide tolerant variety to potential growers in 2015.

In addition to yield and oil content we are collecting germplasm and evaluating lines for several important agronomic traits. Stand establishment is one of the biggest problems with camelina production because the seed is very small and only emerges from very shallow plantings. There is considerable variation for seed size in camelina germplasm so we hope to make larger seeded varieties in the future. We are beginning a study to determine if this will have an adverse effect on oil content. Another important trait is rapid early season growth which should make stands more competitive with weeds, another problem with camelina production. Some camelina lines with larger seeds also have more vigorous seedlings. There are currently no broadleaf herbicides registered for camelina production. The herbicide sethoxydim (Poast®) has recently been registered for postemergence application to control grass weeds but provides little control of broadleaf weeds. Since we had good success in finding mutants tolerant to group 2 herbicides, we are beginning to select for mutations that provide resistance to other broadleaf herbicides. This may allow us to add to our weed control tools for this emerging crop.

Variation for seed size in camelina germplasm

For additional information on camelina production, see http://cru.cahe.wsu.edu/CEPublications/FS073E/FS073E.pdf

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

MICHAEL M. NEFF, DAVID FAVERO, PUSHPA KOIRALA, JIWEN QIU AND JIANFEI ZHAO
DEPT. OF CROP AND SOIL SCIENCES, WSU; AND MOLECULAR PLANT SCIENCES GRADUATE PROGRAM, WSU

In low rainfall, dryland-cropping areas of eastern Washington stand establishment can have a major impact on yields of camelina and canola. During dry years these seeds need to be planted in deep furrows so that the developing seedling has access to water in the soil. 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 particular ways, 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 dominant-negative 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 recently identified two more types of dominant-negative mutations that lead to the same *sob3-6-like* seedlings, which are larger than the wild type (Fig. 1). One of these dominant-negative mutations is caused by the complete removal of the DNA binding domain. The second dominant-negative mutation is caused by the removal of six amino acids that are necessary for AHL interactions with DNA-binding transcription factors. We have also shown that expressing *sob3-6* in the Brassica *Camelina sativa* leads to larger seeds and taller seedlings with no negative impact on adult size. 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 (Fig. 2). We are currently identifying AHL-interacting factors to further understand how these DNA-binding proteins regulate seeding development and emergence in dry soils.

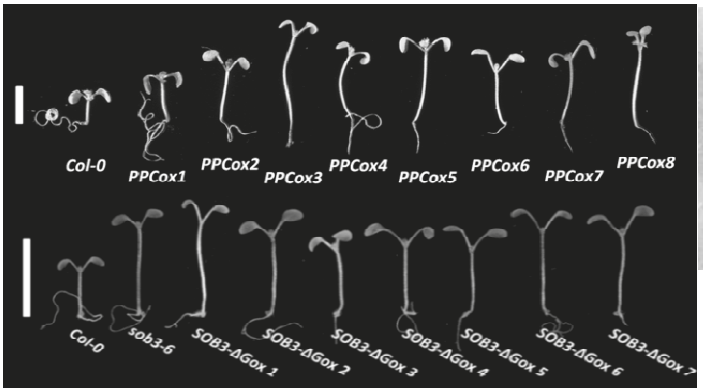

Fig. 1. Over-expressing an AHL protein in Arabidopsis lacking the AT-hook domain leads to taller seedlings (top). The same phenotype can be obtained with an AHL protein that lacks six amino acids (bottom). Scale Bars = 1 cm. Adapted from Zhao et al. (in review PNAS).

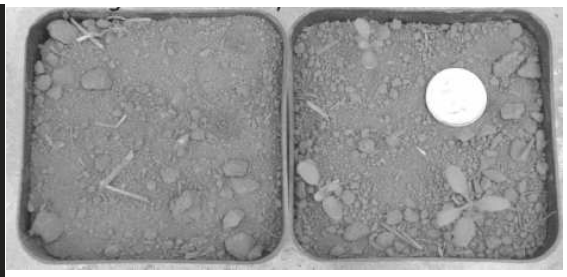

Fig. 2. *Camelina* expressing the *sob3-6* mutation emerge from deep planting in dry soil. Non-transgenic (left) and transgenic (right) seeds were planted on 1 cm of moist Palouse silt/loam and covered with 8 cm of dry silt/loam. All seeds germinated. 5 of 10 transgenic seeds emerged, 3 survived. Experiment repeated twice.

International Commitment

WILLIAM L. PAN, DEPT. OF CROP AND SOIL SCIENCES, WSU

Prior to his service as Chair of CSS, Pan accompanied then Chair Dr. Tom Lumpkin on trips to China, Egypt and central Asia. Upon leaving WSU, Tom became a global agricultural leader, and as he turned over the departmental reigns, Bill promised to continue the department's active engagement with international projects and programs. This commitment extended a CSS commitment to wheat breeding collaborations in central Asia, and a new project on Iraq Agricultural Extension Revitalization (IAER). Pan co-designed and coordinated training sessions with WSU International Programs for Iraqi Extension personnel. A highlight experience for Pan was a trip to Baghdad shortly after the fall of Saddam Hussein. Transportation was complements of the US military via C130 cargo plane, a gunner-manned transport helo, and an armored ground vehicle through one the most contested 6 miles in the world at the time between the Baghdad airport and the US Green Zone surrounding Saddam Husseins' captured lavish palace. The US was preparing to evacuate the palace and return it to the people of Iraq. Training sessions focused initially on dryland agronomy and soil fertility, then expanded to womens' role in agriculture, food safety, organic agriculture, grazing and forage production, and soil/water conservation. Sessions were conducted in Washington State, Egypt, Syria and Jordan. More than 60 CSS and affiliated WSU faculty, staff and students participated in the training sessions, motivating many to continue their involvement in subsequent international projects.

Iraqi Extension Specialist expresses his gratitude for the IAER training opportunity and tour of irrigation systems at WSU IAREC