



Triticeae CAP
Coordinated Agricultural Project

Tcap Transmission

September 2012

<http://www.triticeaecap.org>

Funded by the USDA National Institute of Food and Agriculture



United States Department of Agriculture
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INSIDE RESEARCH:

Directors Notes	1
ITMI meeting	2
Breeder Success Story	2
Barley NSGC core SNP re-	3
Phenotyping NSGC	4
The Triticeae Toolbox.	5

Directors Notes: Gary Muehlbauer and Jorge Dubcovsky

As we wrote the end of Year 2 report, it became clear that the TCAP has already had a measurable impact in research and education. This newsletter provides an update of some of the TCAP activities. The TCAP is having a major impact on the international wheat and barley breeding and genetics community, as many of the TCAP participants attended the International Triticeae Mapping Initiative and six gave presentations focused on TCAP-related activities (see page 2). The education component of the project has served as an positive force within the TCAP to coordinate research and education activities and to integrate students, breeders and researchers in wheat and barley improvement. The online communication tools have greatly reduced the isolation of breeding students in smaller institutions, formed an integrated cohort of graduate students, and provided a broader perspective on breeding. In addition, students from minority serving institutions (MSIs) are being attracted to plant sciences research (see page 10-11). To date, over 400 people have attended TCAP workshops and training sessions. The research component of the project has made tremendous strides resulting in unprecedented **genotyping** and **phenotyping** capacity for wheat and barley breeders. **SNP** maps have been developed along with **genotyping-by-sequencing** technologies, providing a huge number of new and high-throughput markers for the **genotyping** centers. Implementation of **canopy spectral reflectance** technologies has provided an expanded vision of the variation for **water** and **nitrogen use efficiency** in wheat and barley **germplasm**. For example, the **National Small Grain Core Collection (NSGCC)** for barley and wheat has been phenotyped for nitrogen and water use efficiency (see page 4). Combined with the **genotype** data for the **NSGCC** (see description of **genotyping** of barley **NSGCC** on page 3), the phenotypic data is being used to identify favorable chromosome segments for **WUE** and **NUE** (page 4). A breeding success is the deployment of the solid stem trait in new wheat varieties for sawfly resistance (see page 2). The T3 database is serving as a central collaboration tool for the breeding programs (see page 5). To facilitate the use of T3, new tools have been developed and additional **genotype** and **phenotype** data were uploaded. Taken together, these activities have laid the foundation for nationwide education and research activities for the next three years of the project. These education and research activities will help ameliorate the negative impacts of climate change in cereal production in the US, as well as train a large cohort of plant breeders in traditional and modern breeding strategies that will provide the continuity required for sustainable cereal breeding activities.



ITMI meeting - Gary Muehlbauer

TCAP participants attended the International Triticeae Mapping Initiative and Wheat **Genomics** Committee Joint Workshop.

The 22nd International Triticeae Mapping Initiative (ITMI) and 4th National Wheat **Genomics** Committee (NWGC) Joint Workshop was held in Fargo, North Dakota from June 24-29. Over 170 Triticeae geneticists from around the world attended. TCAP PIs that attended the meeting included: Eduard Akhunov, Jim Anderson, Stephen Baenziger, Gina Brown-Guedira, Robert Brueggeman, Arron Carter, Timothy Close, Bikram Gill, Peter Morrell, Gary Muehlbauer, Mark Sorrells, and Brian Steffenson. A small group of TCAP students also attended including: Liana Nice, Ana Gonzales, Kathryn Turner, Celeste Falcon, Keith Merrill, Andres Salcedo, and Prabin Bajgain. The meeting provided an ideal forum for the Triticeae community to “get up to speed” with the various genetics and breeding activities around the world.

Several talks were presented by TCAP PIs and students. Timothy Close (UC, Riverside) updated the attendees on his effort to advance the barley **genome**. He presented his USDA-AFRI NIFA-funded project to **sequence** and **genetically anchor** 14,600 gene-containing barley **Bacterial Artificial Chromosomes (BACs)**. Eduard

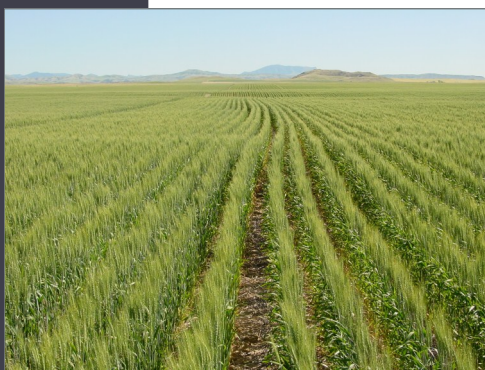
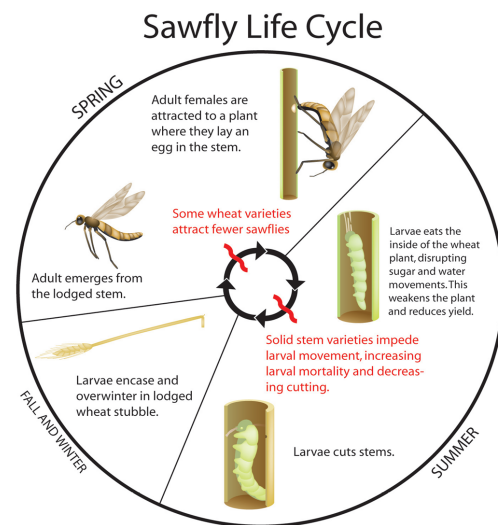
Akhunov (Kansas State University) discussed the results from **genotyping** a worldwide sample of wheat cultivars and landraces with 9K **SNPs**. His analysis revealed numerous signatures of selection, providing useful information for future wheat breeding efforts. Gary Muehlbauer (University of Minnesota) described the large-scale structural variation observed in the barley **genome**. In a comparison of wild and cultivated barley, he showed that up to 15% of the **genome** exhibited **copy number variation**. Arron Carter (Washington State University) discussed how his breeding program is beginning to utilize **genomic selection** to more effectively and efficiently develop new wheat varieties. Gina Brown-Guedira (USDA-ARS, Raleigh, NC) discussed an international collaboration to develop **KASP markers** for **marker-assisted selection** in wheat. Ana Gonzales (University of Minnesota), a Ph.D. student in Peter Morrell’s laboratory, discussed the results of the **genotyping** of the barley **National Small Grains Core Collection** with 9K **SNPs**. She showed results that begin to provide insight into the regions and **genes** associated with domestication and environmental conditions.

Breeder success story

Luther Talbert

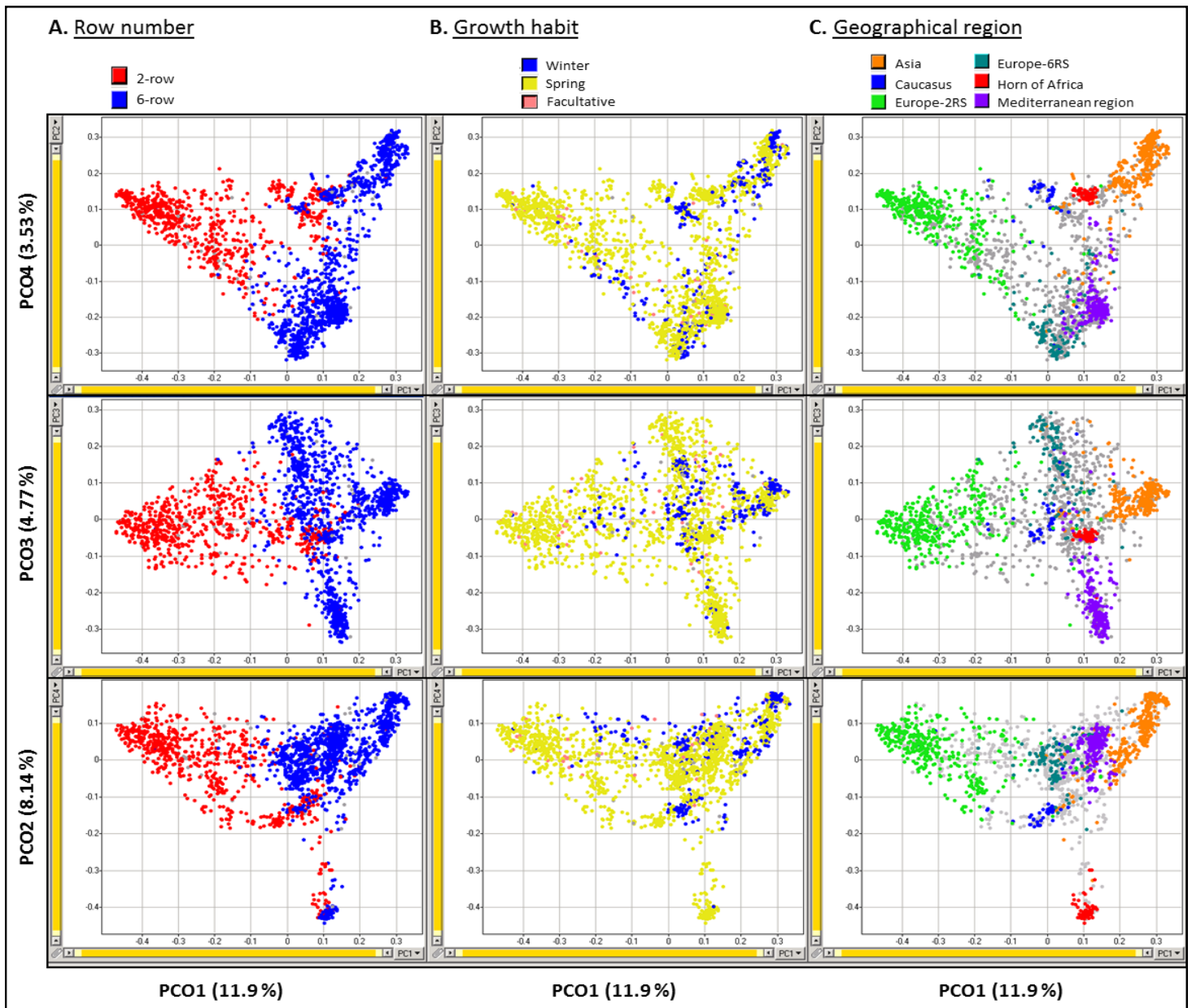
Molecular markers can be used as a tool for introgression of specific genes into otherwise superior genetic backgrounds. This need arises when a variety possesses the **genes** necessary for high yield potential, yet lacks resistance to diseases or pests. The stem-boring wheat stem sawfly prevents many excellent varieties from being successfully grown in Montana. A potentially useful form of resistance is the simple genetic trait of solid stems. The solid stem character impedes movement of the larvae inside the stem and causes a high level of larval mortality.

The conversion of popular hollow-stemmed (sawfly susceptible) varieties to solid-stemmed (sawfly resistant) versions can provide new varieties for growers in sawfly-infested areas. Montana State University Wheat Genetics group identified markers for solid stems and then used those markers to complete a **backcrossing** program to introgress the major **gene** for stem solidness into several popular varieties. One target was the variety Norpro, a high-yielding, but sawfly-susceptible variety, developed by the private company Syngenta (Agripro). A solid-stemmed version of this variety was developed through this grant, and transferred to Agripro wheat breeder Joe Smith for further development and commercialization. A new variety, named SY Tyra, was marketed for the first time in 2012 for sawfly-infested areas of Montana. SY Tyra provides a much-needed option for Montana growers faced with infestation by the wheat stem sawfly.



Barley NSGC core SNP results - Maria Munoz-Amatriain and Gary Muehlbauer

A subset of 2417 barley accessions from the **National Small Grain Collection (NSGC)** was **genotyped** with the **9K-SNP iSelect Illumina** platform. The subset that represents barley diversity comprises cultivars and breeding lines, landraces, and genetic stocks collected worldwide. The figures below, which were created through **principle coordinate analysis (PCoA)**, plot 2298 accessions where more similar **genotypes** occur closer together in the plots. Colors in column A differentiate accessions by row number, in column B by growth habit and in column C by geographic region. The three rows of plots view the data from different aspects, providing a multi-dimensional perspective of genetic relatedness. **Genotyping** clearly separated most 2 row from 6 row accessions and many accessions by region. The practical outcomes of this work will be the increased understanding of the genetic diversity of the barley **NSGC** core for future breeding activities.



University of Idaho Wheat Breeding and Genetics Program Completes Second Year Phenotyping of Spring Wheat and Barley NSGC Core Subsets—Jianli Chen



The **phenotyping** program at Aberdeen had a productive year in 2012. They completed phenotypic evaluation of 540 six-row spring barley accessions, from the National Small Grains Core Collection,

(**NSGC**) with 40 checks under three water/nitrogen treatments. In addition, they repeated the 2011 experiment, evaluating 600 **NSGC** spring wheat accessions and 60 check plots under irrigation versus limited water conditions.

Dr. Chen utilized **NSGC** materials in the breeding program. Of 540 spring wheat core accessions evaluated in 2011, about 30 were selected with good yield performance and/or high water and nitrogen use efficiency. These accessions have been shared with breeders in the TCAP program. In addition, a subset of 120 hard white spring lines were evaluated for bread baking quality, resistance to Fusarium head blight (FHB), and resistance to pre-harvesting sprouting (PHS). Based on the first year of screening, 16 showed a high level of resistance to FHB and 30 showed a high level of resistance to PHS. These novel lines have been used as parents in crosses this summer. Dr. Huirong Mu (a visiting scientist from China) has led these activities.

The major phenotyping effort requires a large number of people led by Dr. Jianli Chen. Dr. Yueguang Wang (new post-doctorate supported by TCAP), Mr. Justin Wheeler (support scientist in the program), Mr. Brian Bowman (Ph.D student supported by TCAP), Mr. Junli Zhang (Ph.D Student support-

ed by Idaho Wheat Commission), Mr. Santosh Nayak (MS student supported by the National Need Fellowship,

NNF), Mr. Jack Clayton (field technician), Mr. Weidong Zhao (lab technician), Ms. Sage Goff (college student from BYU-Provo), Mr. Cutis Brown (college student from Idaho State University), and Mr. Jose Carrillo (technical aide) established a 5-acre drip irrigation nursery for both barley and wheat, and completed the agronomic, **CSR** evaluation, and harvesting. The USDA-ARS research leader, Dr. Mike Bonman, **NSGC** curator Dr. Harold Bockelman, and Dr. Cathy Wilson from Idaho Wheat Commission were actively involved in all T-CAP activities performed in Dr. Chen's program.

Finally, we would like to recognize Jack Clayton and his 15+ years of dedicated service to the University of Idaho's wheat breeding program at Aberdeen. We also want to acknowledge USDA-NIFA Triticeae CAP, USDA-NIFA NNF, Idaho Wheat Commission, University of Idaho Agricultural Experimentation Hatch projects for support of our phenotyping project. In addition, we sincerely thank those collaborators in the TCAP program for all technical help during the past two year's evaluations.



Mr. Junli Zhang (Ph.D Student support-

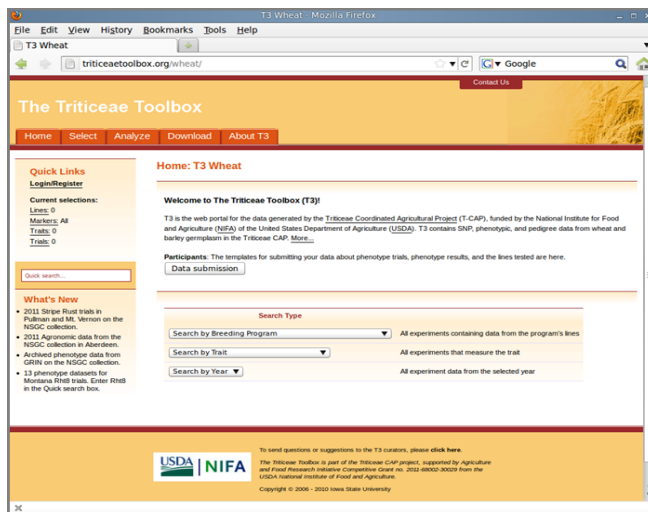


The Triticeae Toolbox

Victoria Blake, USDA-ARS, Albany, CA victoria.blake@ars.usda.gov

The Triticeae Toolbox (T3; <http://triticeaetoolbox.org>) is the web portal for data generated by the Triticeae Coordinated Agricultural Project (T-CAP). The database, developed initially as The Hordeum Toolbox (THT; Blake *et al.*, 2012) to hold barley data generated by the Barley CAP project (2006-2010) is being maintained as **T3 Barley** while a sister database, **T3 Wheat**, holds data generated for *Triticum* spp. T3 contains data information about TCAP breeding programs and core **germplasm** from the USDA National Small Grains Collection (NSGC) including **germplasm** line information, pedigrees, as well as **genotypic** and **phenotypic** data. T3 is funded by the National Institute for Food and Agriculture (NIFA) of the USDA.

Contents in each database can be found by clicking on the

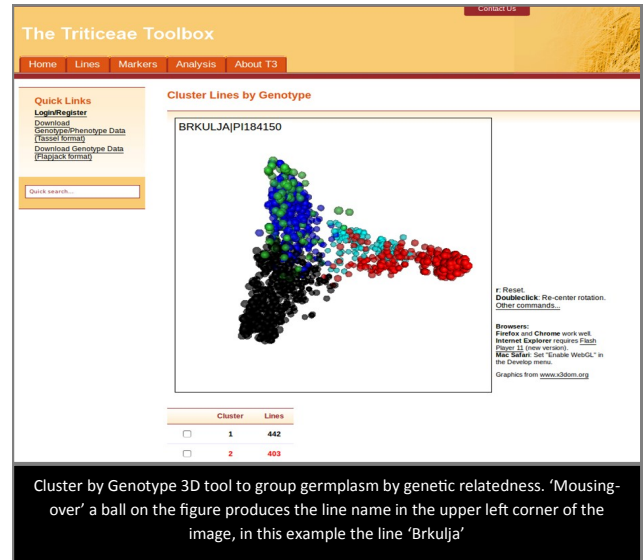


T3/Wheat homepage at <http://triticeaetoolbox.org/wheat>

Click on the 'About T3' button on the homepage menu (above) and current holdings will be summarized as in the table to the right. In addition to **phenotype** data submitted by T-CAP members, data for the genotyped NSGC lines that were archived in the USDA's **Germplasm** Resource Information Network (GRIN) is being added to T3.

Blake, VC, JG Kling, PM Hayes, J-L Jannink, SR Jillella, J Lee, DE Matthews, S Chao, TJ Close, GJ Muehlbauer, KP Smith, RP Wise, J Dickerson (2012) The Hordeum Toolbox: The Barley Coordinated Agricultural Project Genotype and Phenotype Resource. The Plant Genome 5:81-91.

A major advantage of T3 over other database resources is the ability to create specific user-defined sets of **genotype** and **phenotype** data for further analysis in a software-ready format. Other T3 database resources include the ability to search for a **germplasm** line by haplotype, i.e. the allele-state, or genetic version of a set of genes. The



Cluster by Genotype 3D tool to group germplasm by genetic relatedness. 'Mousing-over' a ball on the figure produces the line name in the upper left corner of the image, in this example the line 'Brkulja'

'Cluster by Genotype 3D' feature creates movable and color-coded clusters of **germplasm** to indicate the genetic relatedness of the plants selected.

The T3 project empowers its users with curator status in parallel T3 databases called 'Sandboxes' so they can format and test upload data prior to submitting to the production versions of T3. Future directions in the project include tools to predict informative markers in a bi-parental cross and heat-map color coding on the 'Cluster by Genotype' tool to inform phenotypic values of the selected lines.

Current Holdings of T3		
Trials	Wheat	Barley
Trials submitted	187	486
CAP data programs	5	23
Lines		
Line records	5,442	13,515
Breeding programs	22	16
Lines with genotyping data	4,892	10,913
Lines with phenotype data	4,724	6,185
Species	aestivum durum	barley
last addition	4/5/2012	8/20/2012
Genotype Data		
Markers	9,611	66,423
Markers with genotyping data	7,123	8,942
Markers without genotyping data	2,488	57,481
Total genotype data	25,778,672	33,093,296
last addition	8/7/2012	3/14/2012
Phenotype Data		
Traits	74	71
Total phenotype data	86,129	225,334
last addition	8/30/2012	8/25/2012



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Education News

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INSIDE EDUCATION

TCAP Supports NAPB	6
Collaboration Key to Success	6
NAPB Student Perspective	7
Seminar Series	7
Summer Workshops	8-9
New Course	9
MSI Students at TCAP Institute	10-11
TCAP Annual Meeting Agenda	12-13
Undergraduates	14
TCAP Terminology	15

TCAP Supports NAPB

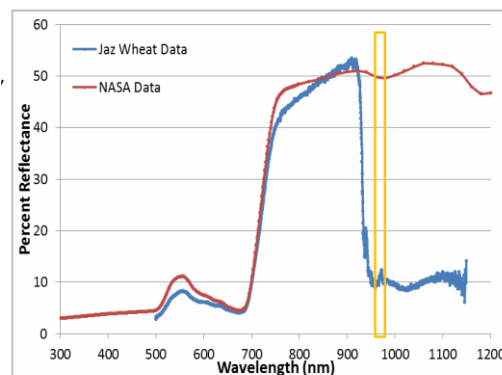
TCAP supported the attendance of 78 students from around the country at this year's National Association of Plant Breeders meeting hosted by Dow Agro Science in Indianapolis. Students participated in the organizational meeting, educational and scientific talks, as well as field trips. Students had ample opportunity to network with each other and with professionals in the private and public sector, creating important connections that will benefit their research and future employment. Duke Pauli, Tom Blake's student at Montana State University was recognized for helping to organize the graduate student working committee as a liaison to the executive committee (see page 7). Jamie Sherman presented a talk, coauthored by Mary Brakke, Don Lee, and Deana Namuth-Covert, called *Visioning Online Plant Breeder Education*, informing participants of TCAP educational efforts and challenging plant breeding educators to make

full use of new technologies to empower training. She borrowed Deana's idea of fully implementing technology for training called "Get the ATM out of the Bank" that was well received. Jamie with Fred Bliss and Allen Van Deynze presented a request for NAPB to fund a pilot project that will track source and sink of plant breeding professionals; she was also elected to serve as secretary of the Plant Breeding Coordinating Committee this year. All educational speakers participated in a panel discussion about Plant Breeder training where all shared their efforts to meet challenges. Some of the challenges voiced included recruiting US citizens, building community online, and providing opportunities to fully develop human capital. All of these challenges are being addressed by educational research through the TCAP.



Collaboration Key to Success

An innovative part of the TCAP project is to create and support research collaborations across the country, utilizing online technology. Educators have extolled the importance of community in empowering learning. A collaborative working group of students has developed organically within the TCAP to implement the Jazz, a device that measures canopy spectral reflectance. Tyson Howell, Jorge Dubcovsky's student, has worked hard to develop scripts, trouble shoot and share advice about the Jazz. Sarah Grogan noticed issues with improper grating that helped resolve some problems. Students have shared their challenges, and solutions on the discussion blog site. Jianli Chen reports "Thanks to the combined efforts of T-CAP students at several universities, many of the difficulties with CSR readings during 2011 were overcome during 2012. Measuring canopy spectral reflectance is now quick and efficient. On sunny days we are now able to measure nearly three times the number of plots as we were in 2011." These students hard work is an example of positive collaboration that will benefit the Project!



Graph from Sarah Grogan

2012 National Association of Plant Breeders

Duke Pauli

This past August I was lucky enough to attend the National Association of Plant Breeders (NAPB) meeting held in Indianapolis, Indiana. NAPB is a young organization that was founded in 2005 as a way to represent plant breeders in federal, state, commercial, and non-government organizations. The mission of NAPB is to support and foster the US plant breeding research effort, education, and public awareness in order to meet the needs of our growing society. I have been fortunate enough to serve on the Graduate Student Working Group these past few months and am excited about the future direction of this organization as well as the role it could serve for the plant breeding community. The title of this year's meeting was "Sustaining Life through Plant Improvement."

During the afternoon of the first day, the subject of the presented talks was plant breeding education. This topic was germane to myself and the other TCAP graduate students present, Katherine Frels and Araby Belcher, as we are participating in the online Plant Breeding Training Network which is an integral part of the TCAP. For more information about

the education portion of NAPB see page 6.

The morning of the second day of the meeting we heard talks regarding the application of molecular techniques including marker-assisted selection in perennial crops. There was also a presentation on the RosBREED, the sister project to the TCAP and SolCAP that is focused on the *Rosaceae* family, highlighting how new genomic technologies are being incorporated and used to enhance the breeding of our favorite fruits. The afternoon was taken up with a tour of Dow AgroSciences' Fowler corn breeding station where we were able to see their development of GM traits in corn. Perhaps the highlight of the meeting was the tour of the Purdue Research Farm. There we were shown some of their corn, soybean, and sorghum breeding programs and the technologies they are using to improve abiotic stress tolerances like measuring CO₂ flux in corn leaves. The most memorable moment for myself was listening to Dr. Gebisa Ejeta explain the importance of plant breeding in its current capacity and the continued, vital role it plays in people's lives. He also highlighted the

impact that advanced breeding methods and current research can have on improving the quality of life for people not as fortunate as ourselves. Dr. Ejeta is a prime example of the effect that a plant breeder can have as he is the recipient of the World Food Prize.

On the final day of the meeting we heard research presentations on increasing yield in soybean as well as the USDA-Forest Service's breeding of hardwood trees which was humbling considering that the breeder of hardwood trees will probably never get to see his contributions. There was also a presentation on the breeding of chrysanthemums in order to increase the amount of lutein and zeaxanthin; it was amazing to see photos of 15-foot high piles of harvested flowers. All in all, this was an extremely fun and exciting meeting to attend because of the plethora of plant breeders working on a variety of crops. It is also nice because half of the participants are graduate students, which creates a more relaxed enthusiastic feeling. The NAPB meeting serves as a valuable resource for meeting new colleagues as well as new friends passionate about plant breeding.

TCAP Seminar Series

Link for registration and attendance <http://passel.unl.edu/communities/pbtn>

TCAP graduate students are sponsoring a seminar series "Ahead of the curve: Technologies for next gen plant breeding". We hope to expose students to a wide variety of current applied plant breeding techniques and research involving an array of crops, regions, and institutions. The series aims to unite graduate students studying plant breeding,

plant genetics, and related disciplines at various universities, and provide an opportunity to collaborate and explore current research in an interactive setting. The seminars will take place within the Plant Breeding Training Network online community on Wednesdays at 3:00 pm CST. Students that have organized the series include Katherine Frels, Celeste Falcon, Rui Wang and Sarah Grogan.

Graduate Student Seminar Series Schedule

1. Wednesday, October 3rd– Kent Eskridge, *Field trial designs in plant breeding*, *Note time change to 3:15 CST
2. Wednesday, October 17th **Paul Gepts** Department of Plant Sciences, UC Davis, *In situ* farmer management of genetic diversity as a complement to *ex situ* conservation
3. Wednesday, October 31st **Sally Clayshulte**, Bayer CropScience, *Round Table Discussion: What Industry Wants*
4. Wednesday, November 14th **Jianli Chen** Aberdeen Research & Extension U of Idaho, *Molecular breeding for biotic and abiotic resistances in wheat*
5. Wednesday, November 28th **Pat Hayes** Department of Crop and Soil Sciences, Oregon State University, *Rapid response in breeding: the challenges and opportunities of shifting landscapes*
6. Wednesday, December 12th **Gustavo de los Campos** Department of Biostatistics, University of Alabama at Birmingham, *Factors affecting prediction accuracy of genome enabled prediction: Lessons learnt from empirical studies and implications for breeding programs*

Plant Breeding for Drought Tolerance

A 2 week summer course in plant breeding for drought tolerance from June 11-22 was led by Pat Byrne at Colorado State University, Ft Collins CO.



Scott Haley, CSU Wheat Breeder, gives some pointers to Tyson Howell, TCAP grad student at UC-Davis



Steve Becker, CSU grad student, explains synthetic hexaploid wheat to Lolley Ceesay, TCAP undergrad intern from Rust College



Stephen Baenziger, Univ. of Nebraska-Lincoln Wheat Breeder, explains his breeding strategies.



Scott Reid, Research Associate at Colorado State University, explains canopy spectral reflectance with the Jaz instrument



Sarah Grogan, TCAP grad student at CSU, explains her research project



Bill Curran, plant breeder with Pioneer Hi-Bred Intl., explains selection strategies at Pioneer's managed stress location in Lasalle, CO



Bill Bauerle, Plant Physiologist at CSU, demonstrates gas exchange measurements to Dr. Amsal Tarekegne of CIMMYT/Zimbabwe



Students, TA's, and instructors of short course on Plant Breeding for Drought Tolerance at Colorado State University, June 11-22, 2012



Pablo Olivera demonstrating the technique for obtaining rust isolates from wheat leaves.

Rust workshop - Brian Steffenson

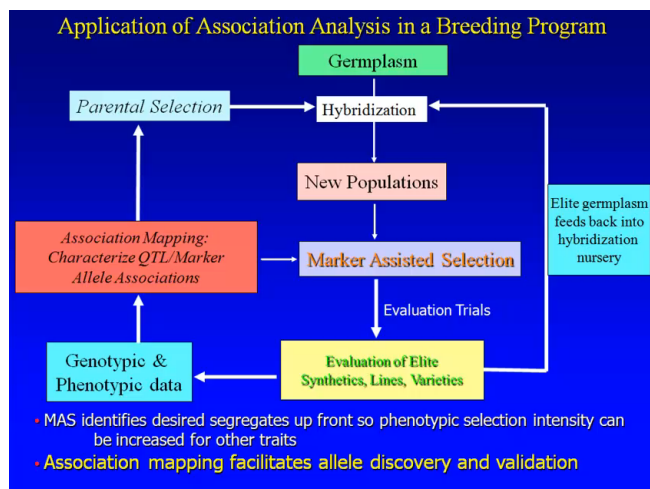
A TCAP workshop on Cereal Rust Phenotyping was held on the St. Paul campus of the University of Minnesota on July 8-10, 2012. The workshop was led by Brian Steffenson and Pablo Olivera and was attended by nine participants. The first morning of the workshop involved general presentations on cereal rust diseases and methodology for handling the pathogens. In the afternoon session, participants were given hands-on experience in scoring infection types on plants and different methods for coding rust assessment data for **association mapping** datasets.

In the evening, a picnic was held so the participants could meet other TCAP and cereal rust workers at the university and USDA-ARS Cereal Disease Laboratory. The following morning, participants toured the rust research plots on campus, the Cereal Disease Laboratory, and the University of Minnesota Plant Growth Facilities.



Announcing New Course

Registration is now open for *Theory and Application of Association Analysis*, a unique course offered through TCAP by experts in the field, Jeffrey Endelman, Jean-Luc Jannink, Clay Sneller and Mark Sorrells. *Theory and Application of Association Analysis* will be a hybrid course covering aspects of association analysis, including **genomic selection**. The course will consist of both online lectures and hands on data analysis. Time commitment will be approximately three hours per week for six weeks. The course will be offered during the weeks of Oct 29th through Dec 7th meeting at 1:00 pm Eastern on Tuesdays and Thursdays. Lectures will be archived for asynchronous viewing. To register go to <http://passel.unl.edu/communities/pbtn> login and join the **Association Mapping** community. You will need to Join the PBTN before you can register.



Student Symposium in Aberdeen

By Jianli Chen

Training future plant breeders has been actively undertaken in Dr. Jianli Chen's program. Dr. Chen organized a student symposium in Aberdeen for one week in June. Three graduate students supported by the NNF from Oregon State University (OSU) joined Dr. Chen's program and received training on wheat breeding and evaluation of TCAP materials. Dr. Chen and her students gave presentations to the OSU students and other participants in Aber-

deen. The USDA-ARS research leader, Dr. Mike Bonman, gave an introduction of ARS research at the site to the OSU students.



Four Students travel to WSU for the summer

By: Arron Carter

This summer, four students from the University of Arkansas-Pine Bluff had the opportunity to go to Washington State University to work as summer interns. The connection between the two universities was facilitated by Dr. Martin Matute from UAPB and Dr. Arron Carter from WSU. These two have been collaborating on nematode resistant wheat as one of the MSI TCAP funded grants. Knowing the interest of these students in agriculture through their work in Dr. Matute's lab, Dr. Carter invited them to WSU for the summer to broaden their perspective in the agricultural sciences. Once at WSU, the students were placed in one of four programs: Dr. Carter's winter wheat breeding program, Dr. Mike Pumphrey's spring wheat breeding program, Dr. Kim Campbell's USDA wheat breeding program, and Dr. Scot Hulbert's cropping systems program. The students were at WSU for 8 weeks and had the opportunity to be immersed in each project and learn more about the experiments and objectives of each program. Besides getting a general overall feel for the programs, they also worked one-on-one with other researchers, mainly graduate students, on specific projects. These projects focused

on heat and drought resistance, as well as nematode resistance. Two students worked with two TCAP funded graduate students from Drs. Carter's and Pumphrey's labs to collect phenotypic data on water-use efficiency panels. They were trained in CSR equipment, and collected data on canopy temperature, leaf chlorophyll content, and a myriad of other agronomic traits. Nematode resistance was also a big topic and the students were taught how to do field scouting and collections, and took part in counting and quantification of nematodes in the soil and on infected roots. Although there were some long, hot days, the students enjoyed their time at WSU and agreed it was a very worthwhile experience. They all commented that they would recommend other students gain similar experiences while pursuing undergraduate degrees. One of the students was also accepted into the PhD program at WSU and will be starting in August on plant breeding projects focused on nematode and *Fusarium* resistance. The researchers at WSU were excited to have these students present for the summer and wished they could have stayed longer. They hope to continue to foster the collaboration between the two institutions and look forward to future student exchanges between the two universities. (See student articles on page 11).



TCAP at the Plant Breeding for Drought Tolerance Symposium held at Colorado State University. From left to right: Dr. Jiaqian Zhu (Rust College), Lolley Ceesay, Sarah Grogan, Dr. Pat Byrne.

Rust College Student Interns at CSU

TCAP graduate student Sarah Grogan mentored undergraduate Lolley Ceesay, a senior from Rust College in Holly Springs, MS. Lolley interned with the Byrne Lab at Colorado State University for six weeks and became integrated into the winter wheat harvest. Additionally, Lolley started a molecular project amplifying regions of fructan exohydrolase (FEH) and dehydration responsive element binding protein (Dreb1) genes in 30 cultivars from across

the Great Plains region. These regions will be sequenced to identify polymorphisms among cultivars. Lolley also participated in the Plant Breeding for Drought Tolerance short course and symposium, where she learned about the global impact of climate change on agriculture and current research illuminating these challenges.

Summer Activities by Yaleaka Currie

This summer I was given the opportunity to study as an intern in the Entomology Department at Kansas State University under the supervision of Dr. Ming Chen. I am an undergraduate student at Fayetteville State University, North Carolina and am mentored by Dr. Zhu. During my internship I gained experience and many new skills that I believe will help me considerably in my future career. I have also enjoyed the beautiful campus here, and I have made many of great new friends. The students, faculty, and staff have all been extremely nice and welcomed me into their facilities with open arms. I will miss Manhattan, Kansas when I am gone. I am happy that I came here this summer!



My Summer in Pullman: Mariam Kaleem

My summer at Washington State University was a journey to be remembered. On arrival to Dr. Scott Hulbert's lab, I didn't know what to expect, but soon found I was happy I came. For instance, I had never been in a green house before my first day, which I spent in the green house planting *Camelina sativa* seeds. I also went to the field to learn how to score plants. Days that followed were spent at the field in Lind, helping the graduate student, Surya, with her research determining physiological aspects of drought tolerant wheat varieties. My tasks at Lind usually included helping to take **canopy spectral reflectance** and chlorophyll measurements. Other days, I helped with weeding. By the end of my first week, I had learned how to emasculate and cross wheat as well as Camelina.

As the old saying goes, pay atten-

tion to the small details as well as the big picture. I appreciated my work in the lab, because I knew our efforts were helping wheat farmers especially in Washington improve their bottom line. For instance, the Camelina seeds I grew will be used in future research to study incorporating camelina into wheat crop rotations to provide extra incomes as oil and animal feed.

I cannot forget my usual encounter with the various individuals in the lab with whom I worked. Everyone in the Lab was helpful and I was glad to be part of the lab. To me, those few weeks were worthwhile and memorable. Furthermore, Dr. Scott Hulbert explained and taught me a lot as well. There were so many new things I learned about Wheat, Camelina, Barley, Canola and various other crops. I enjoyed the experience and met great individuals in

Pullman. I am grateful to Dr. Hulbert and his lab for giving me this opportunity. I wouldn't have received this honor if not for my mentors Dr. Martin Matute, in Arkansas and Dr. Aaron Carter, at Washington State University and from the TCAP project. I hope to participate in research of this caliber in the near future and I know the knowledge I have gained will take me a long way.



Growing Camelina Seeds in Trays in the green house

Jasmine Gaston's Summer

This summer I received a great opportunity to participate in research at Washington State University, at Pullman. This internship started on June 4 and ended July 31, 2012, during which I gained extensive knowledge on the importance of plant breeding. Plant breeding deals with changing the genetics of plants in order to produce a desired characteristic. This summer I worked with a first time graduate student doing field work research on stripe rust disease affecting wheat crops. Our daily research consisted of collecting chlorophyll content using an instrument known as a SPAD Meter. We also used an instrument known as a Crop Scan. Towards the end of my time I gained the opportunity to observe some of the laboratory aspects of plant breeding. Modern plant breeding uses molecular genetic techniques. In the laboratory, I observed **DNA** extractions and different **DNA** analysis. I enjoyed every aspect of my learning experience of plant breeding research. I will continue to consider plant breeding as an option to study in graduate school in the near future.

My Summer in Washington by Yvonne Manning

Rhizoctonia, take all, fusarium, pythium: these are all wheat diseases that I first learned of this summer at Washington State University (WSU). During my time at WSU, I was amazed to find that plants suffer from diseases, just as humans and animals. I was able to meet graduate students who study these diseases as well as prevention methods via techniques such as breeding and crop rotation. From them, I gained a glimpse of how these students in crop sciences come up with an experiment, conduct the experiment, and analyze the data. I was also an integral part of the process. Through this internship, I saw firsthand the importance of the world of soil and airborne diseases and how it affects a farmer's crop yield each year.

Triticeae CAP Annual Meeting Agenda (Tentative)

January 13, 2013

Town and Country Convention Center (Windsor Room)

8:00 – 10:00 am	Reporting session for stakeholders
8:00 – 9:00 am	Research and Education overviews Jorge Dubcovsky, Gary Muehlbauer, Jamie Sherman
9:00 – 9:30 am	Discussion with Stakeholders
9:30 – 10:00 am	Break
10:00 am – 2:40 pm	Reporting session for Scientific Advisory Board and USDA
10:00 – 10:30	Overview of project Jorge Dubcovsky (UC, Davis) Gary Muehlbauer (University of Minnesota)
10:30 am – 10:50 am	Education Jamie Sherman (Montana State University)
10:50 am – 11:05 am	TCAP – MSI interaction success story Arron Carter (Washington State University)
11:05 am – 11:20 pm	Graduate Student/Mentoring of Undergrads Sarah Grogan (Colorado State University)
11:20 am – 11:40 am	Developments in T3 Jean-Luc Jannink (USDA-ARS, Ithaca, NY)
11:40 am – 1:00 pm	Lunch on your own
1:00 pm – 1:20 pm	What have we learned from the genotyping efforts? TBA
1:20 pm – 1:40 pm	Genomic selection in barley Kevin Smith (University of Minnesota)
1:40 pm – 2:00 pm	Association mapping of disease resistance in wheat Mike Pumphrey (Washington State University)
2:00 pm – 2:20 pm	Low temperature tolerance in barley Pat Hayes (Oregon State University)
2:20 – 2:40	Wheat Breeding success story (TBA)
2:40-5:00	Breakout groups, discussion and planning for year 3, and SAB feedback
2:40 – 3:40 pm	Breakout groups T3, Genotyping, Barley, Wheat
3:40 – 4:00 pm	Break
4:00 – 5:00 pm	Feedback from Scientific Advisory Board and Discussion
5:00 – 7:00 pm	Reception and poster session (Hampton Room) (food and cash bar)



Town and Country
RESORT HOTEL

Students at TCAP Annual Meeting

Life Skill Enhancement: The Gateway to Becoming an Extraordinary Plant Breeder

Graduate Student Meeting

Best Western Seven Seas
411 Hotel Circle South
San Diego, CA 92108



Schedule

Jan 11, 2013

1:00-5:00 - Kim Kidwell and Mary Kay Patton will lead [Life Skill Enhancement: The Gateway to Becoming an Extraordinary Plant Breeder](#)

Please register via e-mail to deanna.crow@montana.edu by December 1, 2012.

Have you started to realize that becoming an extraordinary scientist requires more than simply mastering the content and scientific skills related to plant breeding? Industry leaders and potential employers expect excellent scientific results, as well as good interpersonal communication skills in new personnel. These expectations are highly influencing hiring decisions. Clearly, creating successful relationships with mentors, peers, industry members, potential employers and colleagues is a gateway to success, yet we often assume that these skills are innate rather than learned. Building successful teams and collaborative relationships requires conscious effort. Such effort is greatly supported by im-

proving awareness of effective ways of communicating with others, especially when issues are challenging. For example, have you ever received feedback on your writing that felt more like a personal attack than constructive criticism? Have you struggled to articulate that you don't understand or agree with the scientific approach that is being taken? Have you encountered a difficult colleague that makes working in your research program challenging because you cannot figure out how to get along with them? Have you wondered why some genius minds have struggled with contribution and success, whereas other seemingly less brilliant thinkers are able to make a sustainable difference on a day-to-day basis? You are not alone. These are common concerns we hear from graduate students, but the news is good: strategies and approaches for transforming your ability to navigate these situations are available. If you are wondering what you can do to create synergistic, supportive relationships with others, please join us for a ridiculously exciting workshop as we tease out powerful insights and explore healthy strategies that will enable you to consciously launch a career as an extraordinary plant breeder. This is not your typical workshop: come ready and willing to play!

Graduate Student Poster Mixer



Triticeae CAP
Coordinated Agricultural Project

TCAP Funded Students are asked to present their research project in a poster on Sunday January 13th. All posters must be hung in the Hampton Room prior to 8:00 am. Students will stand by posters from 5:00-7:00 pm during the mixer for all TCAP participants, advisors and stakeholders. Please RSVP to deanna.crow@montana.edu by December 1, 2012 with the title of your poster.

Poster Specifications

Dimensions are for a vertical poster of 2 feet 10 inches wide by 3 feet 10 inches high. (1.17 meters x 86 meters). Posters are displayed directly next to each other, so there is no room on the horizontal sides for overflow. Should you require more vertical space, however, posters greater than 46in. in height can hang a few inches beyond the edge of the presentation board. TCAP and USDA should be acknowledged, please use logos.



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

What are TCAP undergraduates saying?

A total of 54 undergraduate students participated in TCAP-funded research during the period June 2011 – 2012. Thirteen students completed an online survey in June 2012. Responses to several questions are highlighted.

What do you hope to gain from your research experience?

- Experience in lab and field research
- Experience developing independent research plans
- I hope to be a more well-rounded scientist
- Better skills interacting with people in a research environment

What could make your research experience better?

- Getting in touch with a professor
- I wish I were doing more lab work and data analysis
- Collaborating with other labs/institutions

Being mentored was the activity that the most students (9/12) reported as “very valuable.”

Suggestions to mentors on improving the mentoring experience:

- Clarify expectations
- Suggest papers to read to help me understand the concepts

7 out of 10 students felt their research experience had contributed to their ability to succeed in graduate school

Before participating in their research experience, most students knew very little about plant breeding as a career. After their research, nearly half of the students who responded (6/13) said they were moderately or extremely motivated to pursue a career in plant breeding.

Research interns - Pls with TCAP funded graduate student should have an undergrad research intern working in your lab. This student should be mentored by the TCAP grad student.

The PBTN Undergraduate Community

- Helps students gain confidence as a researcher
- Promotes awareness of pathways to a career in plant breeding

The Undergrad Community will hold online seminars throughout the semester. **Your research intern should attend these and receive pay for that time.**

The Undergraduate Community website can be accessed from passel.unl.edu/communities/

TCAP Participating Programs (see <http://www.triticeaecap.org> for more information)

Universities

Soil and Crop Sciences, **Colorado State University**
Plant Breeding, **Cornell University**
Plant Pathology or Agronomy, **Kansas State University**
Plant Sciences and Plant Pathology, **Montana State University**
Department of Crop Science, **North Carolina State University**
Plant Pathology, Plant Sciences, **North Dakota State University**
Environmental Natural Resources, or Horticulture & Crop Sciences, **Ohio State University**
Plant and Soil Sciences, **Oklahoma State University**
Crop and Soil Science, **Oregon State University**
Plant Sciences, **South Dakota State University**
Soil and Crop Science, **Texas A&M University**
Plant Sciences, **University of California, Davis**
Botany and Plant Sciences, **University of California, Riverside**
Aberdeen Research & Extension Center, **University of Idaho**
Plant and Soil Sciences, **University of Kentucky**
Plant Sciences and Landscape Arch., **University of Maryland**
Agronomy & Genetics, Plant Pathology, **University of Minnesota**
Division of Plant Sciences, **University of Missouri**
Agronomy and Horticulture, **University of Nebraska Lincoln**
Plant, Soils and Climate, **Utah State University**
Crop and Soil Environmental Sciences, **Virginia Tech**
Crop and Soil Science, **Washington State University**

USDA-ARS

GMPRC, Manhattan, KS
WRRRC, Albany, CA
Aberdeen, ID
Raleigh, NC
BRL Fargo, ND
NCSL, Fargo, ND
Ithaca, NY
St. Paul, MN
Pullman, WA

Collaborating Institutions with Student Projects

Chicago State University
Tuskegee
Texas A&M
University of Arkansas, Pine Bluff
Lehman College
Rust College
Fayetteville State University

TCAP Terminology

- **Association mapping** is a technique used to identify marker-trait associations in lines that are not derived from a single cross.
- **Bacterial Artificial Chromosomes (BAC)** are pieces of DNA that can be used as vectors for a variety of purposes. For example, genomic DNA from barley is cut into smaller pieces and inserted into BACs, creating a complete library of the Barley DNA. BACs can be amplified creating a source for DNA sequencing. Since BAC libraries are created with random pieces of the Barley DNA, there will be overlap between BACs, thus providing a complete sequence that has a physical relationship and can be anchored.
- **Canopy Spectral Reflectance (CSR)** is a new phenotyping tool TCAP is exploring. It is based on the observation that plants under stress reflect different colors of light. Measuring the light reflected might be a way to predict plant performance.
- **Copy Number Variation (CNV)** are differences in DNA between individuals that occurs when a large number of building blocks called nucleotides are either duplicated or deleted. CNVs generally range in size from thousands of base pairs to millions of base pairs. In contrast, SNPs are another DNA difference that only involves single base changes. The number of CNVs reported here in Barley of 15% is in a similar range as what has been reported in humans.
- **Deoxyribonucleic acid (DNA)** is the genetic material for most organisms. An organism's complete set of DNA is called its **genome**.
- A **gene** is the instructions for a specific structure in the organism. For an organism to survive certain instructions (genes) are required. However, the details or order of the instructions may vary from organism to organism and it is these differences that we are looking for to improve wheat and barley.
- **Genomics** is the study of the **genome**. The genome is a complete set of instructions for the organism. You can think about it like an instruction manual for that organism.
- **Genomic selection** is when markers spread throughout the genome are used to predict the performance of individuals to facilitate breeding.
- **Genotyping** is when the genetic makeup of an organism is characterized. The genotype controls the way an organism looks, which is called the **phenotype**. In our instruction manual analogy, determining the genotype would be like reading the instruction manual, while determining the **phenotype** is like testing the product created after following the instructions.
- **Germplasm** is a collection of genetic resources, which in wheat and barley is usually a collection of seed.
- **KASP Markers** are a cost efficient method of SNP genotyping developed by KBioscience. KASP stands for Kompetitive Allele Specific PCR. Advantages of KASP over other systems may be less expense, greater flexibility, and higher conversion rate.
- A **marker** is a difference in the DNA that acts like a bookmark indicating the position of a certain set of instructions. It can be a difference in the instructions (**gene**) itself but it can also be a difference in a neighboring part of the DNA.
- Making **Marker/trait associations** is identifying good bookmarks for the instructions that are important. Once marker/trait associations are made, markers can be used to make selections.
- **Marker Assisted Selection** is a technique that uses DNA markers to identify individuals carrying certain genes to facilitate breeding.
- **National Small Grain Core Collection**, NSGC collection is an important germplasm resource for the TCAP. TCAP participants will be evaluating and distributing an extensive collection of seeds representing material from around the world. TCAP is searching this material for unique **genes** that will be used to improve wheat and barley.
- **Nested Association Mapping** is a hybrid technique that uses attributes of both bi-parental mapping and association mapping.
- **Nitrogen use efficiency (NUE)**, Nitrogen is required by plants for growth and enters plants from soil through roots. Farmers replenish nitrogen using fertilizers and have found maximizing nitrogen can increase yields; however, nitrogen can be costly not only for farmers but also to the environment. An important goal of the TCAP is to improve the NUE of wheat and barley, both saving money and the environment.
- **Nucleotides** are the building blocks of DNA and can be thought of as the letters making up the instruction book. The instruction book for wheat is composed of 16 billion letters or nucleotides (= **16GB**). It is the order of the building blocks that store the genetic information.
- **Principle Coordinate Analysis (PCoA)** is a method to explore and visualize dissimilarities in data. For example, on page 3 each accession is plotted by how different the genotyping data is from every other accession, creating scatter plots with more similar accessions closer together. The scatter plots are two dimensional, while the data can have multiple dimensions. To better view the information the plots can be rotated to obtain multidimensional views.
- **Quantitative Trait** is a trait that can be measured and is controlled by many different locations in the genome. The different locations controlling a specific quantitative trait are called **QTL (Quantitative Trait Loci)**. In our analogy of the instruction manual, several different instructions (QTLs) together control a trait. Most traits important to stakeholders are quantitative (e.g. yield and quality).
- **QTL Mapping** is a technique used to make marker/trait associations using a **bi-parental mapping** population from a cross between two lines that are different for a trait of interest.
- **Sequencing** is reading the order of the **nucleotides**. Some of the new technology we are exploring are methods that look for differences by determining the sequence, for example **gene capture** and **genotyping by sequencing**.
- **Single nucleotide polymorphism (SNPs)** is the difference in one building block (nucleotide) in the DNA sequence. In our analogy it is like changing "TAG" to "GAG" in our instruction manual. An advantage of **SNPs** is more potential differences and so more markers at a higher resolution, making it easier to make marker/trait associations.
- **Water Use Efficiency (WUE)**, Water is the limiting resource in much of the world today and is likely to continue to be in the future due to climate change and loss of arable land. An important goal of the TCAP is to improve WUE of wheat and barley, providing resistance to drought and new varieties for low moisture areas.