rust was still active in much of the state. Nighttime temperatures ranged from 55–70°F with high humidity and significant dews. Stripe rust was widespread and severe in Montana in 2011. Most wheat fields were fungicide sprayed at least once. There was an estimated 10% winter wheat loss and 5% spring wheat loss to stripe rust in Montana in 2011.

Utah. High levels of stripe rust were found in commercial winter wheat fields in Weber and Box Elder Counties in north central Utah the second week of June. Most fields had been treated with fungicides, but some untreated fields were significantly impacted. Some irrigated fields in the Bear River Valley of northern Utah likely experienced yield reductions due to stripe rust. Many producers sprayed fungicides to mitigate the possible damage.

Alberta, Canada. Stripe rust was found at Vulcan in south central Alberta on the winter wheat AC Intrepid (full boot to 50% headed) and the hard white spring wheat Snowstar (6 leaf, 3 tillers) in early July.

Ontario, Canada. Stripe rust was found in a winter wheat nursery at Ridgetown in southwestern Ontario in late June. Incidences ranged from trace to 20% with severities up to 30%.

The 2011 stripe rust observation map can be found at http://www.ars.usda.gov/SP2UserFiles/ad_hoc/36400500Cerealrustbulletins/2011wstr.pdf.

NEBRASKA

UNIVERSITY OF NEBRASKA AND THE USDA–ARS GRAIN, FORAGES AND BIOENERGY UNIT. Lincoln, NE, USA.

The 2009–10 Nebraska wheat crop.

Wheat production. In 2011, 1,500,000 acres of wheat were planted in Nebraska and 1,400,000 were harvested with an average yield of 45 bu/acre for a total production of 63,000,000 bu. In 2010, 1,600,000 acres of wheat were planted in Nebraska and 1,490,000 were harvested with an average yield of 43 bu/acre for a total production of 64,070,000 bu. In 2009, 1,700,000 acres of wheat were planted in Nebraska and 1,600,000 were harvested with an average yield of 48 bu/acre for a total production of 76,800,000 bu. Despite continued genetic improvement, the main determinant in wheat production seems to be acres harvested, government programs, the price of corn, and weather (which also affects disease pressure and sprouting). This is an economic reality in understanding wheat yields and productivity in Nebraska.

Cultivar distribution. In 2011, Overland was the most widely grown wheat cultivar in Nebraska (10.8%), closely followed by Pronghorn (10.4%). Pronghorn and Goodstreak are tall (conventional height) wheat cultivars that have consistently done well in the drought-prone areas of western Nebraska. Interestingly, the Buckskin acreage increased slightly, indicating that tall wheats, which are adapted to drought in the west, remain very popular. TAM 111 became the third most popular wheat in Nebraska, followed by Millennium, Buckskin, Jagalene, and Goodstreak (Table 1, p. 237).

New cultivars. Two new cultivars were increased and formally released in 2010. No new line was released in 2011. The two lines released in 2010 were **NE01481** and **NI04421**.

NE01481 will be marketed as Husker Genetics Brand McGill in honor of a legendary professor of genetics at the University of Nebraska. McGill is recommended for release, primarily due to its superior adaptation to rainfed wheat production systems in eastern and west-central Nebraska and its excellent resistance to wheat soil borne mosaic virus (WSBMV), a trait that is very rare in recent Nebraska releases. Additional information can be found at: http://agronomy.unl.edu/c/document_library/get_file?uuid=af82c455-7c15-48b7-ac84-c84ec9a4332f&groupId=4128273.

The second line is NI04421,which will be marketed as Husker Genetics Brand Robidoux, in honor of a pioneer French trapper who had a trading post between Nebraska and Wyoming. Robidoux was released primarily for its superior

Table 1. Cultivars grown in Nebraska between 2004 and 2011

Cultivar	Percent							
	2004	2005	2006	2007	2008	2009	2010	2011
2137	7.8	4.3	3.5	1.4	2.1	1.7		
2145			1.0	1.2	2.2			
Above			1.3					
Agripro Abilene	1.7	1.7		1.0				
Agripro Art							2.4	
AgriPro Dumas				1.4	1.2			4.3
Agripro Hawken						1.2	2.1	
Agripro Jagalene	4.5	16.8	23.8	33.4	20.9	13.8	8.5	5.4
Agripro Ogallala	2.4	2.0	1.4	1.0	1.1			
Agripro Postrock					1.1	4.1	4.4	3.3
Agripro Thunderbird							1.1	
Agripro Thunderbolt	3.0	1.9	1.9	2.0	2.4	1.6	1.5	2.2
Alliance	13.6	10.1	10.1	7.2	6.1	6.1	6.0	3.9
Arapahoe	6.8	5.2	2.9	2.0	3.4	2.2	2.1	1.5
Armour								1.0
Buckskin	4.9	3.7	5.0	3.5	3.4	3.3	4.5	5.9
Camelot								1.1
Centura	2.1	2.4	1.9	1.3	1.0			
Goodstreak		1.7	3.7	3.6	5.1	5.0	6.5	4.4
Hatcher						1.2	1.5	1.8
Hawken								1.5
Infinity CL					2.3	3.5	3.7	3.3
Jagger	2.8	3.1	2.5	1.7	1.5	1.1		
Karl/Karl 92	3.3	2.7	2.7	1.6	2.9	2.5	1.6	2.1
Millennium	11.1	10.7	9.5	7.2	9.4	13.2	11.9	7.6
Niobrara	3.5	2.2						
Overland						3.4	5.6	10.8
Overly				1.0	1.1			
Platte	1.3	1.6						
Pronghorn	10.4	11.4	10.1	12.2	10.6	12.1	13.7	10.4
TAM 111			1.2	1.6	3.2	6.5	7.4	8.1
TAM 112								1.2
Wahoo	1.7	1.8	1.8	1.1	1.5	1.1		
Wesley	5.9	5.5	5.8	7.2	7.7	4.8	4.1	4.2
Winterhawk								1.3
Other Private Cultivars	4.4	4.0	3.8	2.8	4.1	5.0	3.6	5.4
Other Public Cultivars	8.8	7.2	6.1	4.6	5.7	6.6	7.8	9.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

performance under irrigation and rainfed conditions in western Nebraska (west of North Platte, where drought is common) and irrigated production sites in western Nebraska and eastern Wyoming. Robidoux seems to have good drought tolerance and does best in irrigated environments in the drier areas (eastern WY). Additional information can be found at: http://agronomy.unl.edu/c/document_library/get_file?uuid=5d4eff93-65f7-4920-9849-2fd42919cccb&groupId=4128273.

Use of wheat synthetics to expand our genepool.

K. Onweller, R. Ward, P.S. Baenziger, Y. Jin, R. Bowden, S. Wegulo, C. Baker, R. Graybosch, S. Haley, and P. Byrne.

A collaborative effort with Colorado State University to use the CIMMYT-developed, wheat synthetic lines as sources for drought tolerance led us to further characterize six synthetic CIMMYT wheat lines. In our characterization studies, we discovered some lines were resistant to *Puccinia graminis*, *P. striiformis*, and *Schizaphis graminum*. Two of the six lines possessed resistance to stem rust races in the Ug99 family. Studies to determine the identity of the genes are underway. Based on phenotyping of the synthetic parental lines at the Cereal Disease Laboratory in Minnesota, it has been hypothesized that the resistance in the synthetic parental lines may be from *Sr33*. *Sr45* will be tested for as well as *Sr33* and *Sr45* are both derived from *Aegilops tauschii* and are located on chromosome 1DS. Both genes have been shown to confer resistance to numerous races of stem rust, including Ug99. All synthetic lines exhibited seedling resistance and five lines exhibited adult resistance to *P. striiformis* race PST-100. Two different synthetic lines conferred excellent resistance to greenbug biotypes E, I, and K. A detailed inheritance study was undertaken with the assistance of Cheryl Baker (USDA–ARS, OK) to identify the genetic constitution of the resistance. Preliminary data suggest that single, dominant genes are acting in each synthetic line. In addition to resistance, the synthetic lines were assayed for high-molecular-weight glutenin and gliadin composition. The work revealed protein subunit compositions not commonly found in the Great Plains wheat cultivars.

Understanding the stem rust resistance in Gage wheat.

T. Kumsa, P.S. Baenziger, S. Wegulo, M. Rouse, and Y. Jin.

In this project we are interested in understanding the *Sr2* complex in Gage (a Nebraska cultivar released in 1965), which historically was superior to Scout 66 (a wheat cultivar that also carried the *Sr2* gene). Our goal is to understand the nature of Gage's superior resistance to stem rust when compared to that found in many other *Sr2* cultivars. We have created $F_{2:3}$ families for genotyping and phenotyping at seedling and adult-plant stage. These families have been planted in the field at research stations in Mead, Nebraska, and at Haymana, Turkey, for evaluation in summer 2012. Phenotyping at seedling stage was done at Cereal Disease Laboratory using QFCSC (a mild race of stem rust) and TTKSK (Ug99) stem rust races. The DNA sample from the same families was sent to Dr. Jesse Poland, USDA–ARS, Kansas State University for genotype by sequencing. The preliminary marker and phenotype data indicated that resistance in Gage is conditioned by *Sr2* and other gene/s. The effectiveness and phenotypic expression of resistance gene *Sr2* is only at the adult-plant stage (called an adult-plant resistance gene), whereas the phenotypic effect from other resistance genes can be detected at both the seedling and adult-plant stages. Based on evaluation at the seedling stage with 14 pathotypes, including variants of Ug99, Gage was postulated to carry a major resistance gene in addition to *Sr2*. The F_3 families seedling infection phenotype signify segregation between susceptible and resistance parents supporting involvement of a gene other than *Sr2*. However, almost all families showed less seedling resistance reaction to Ug99 (TTKSK) than Gage, whereas the resistance reaction of families to QFCSC is comparable to that of Gage. A heterozygous, resistant type of reaction is the maximum resistance observed to Ug99 infection. The seedling infection type data from both TTKSK and QFCSC does not fit either single or two gene models, perhaps due to low number of plants represented per family. We are advancing the population using single-seed descent to increase the homozygosity. The genotyping and adult-plant field stem rust evaluation will be done this year.

Association mapping for important biotic and abiotic related traits in a structured wheat breeding population.

I. Salah, D. Wang, K. Eskridge, J. Crossa, and P.S. Baenziger.

This study focuses on applying DNA molecular markers in plant breeding process, using different statistical methods to increase wheat productivity. The field part of this study was carried out in two successful seasons 2009–10 and 2010–11 using two $F_{3:6}$ wheat populations. The first population contained 276 lines and two local checks genotyped using DArT markers, and the second population consisted of 278 plus the same local checks and genotyped using the same marker system. The populations were phenotyped in nine different locations throughout Nebraska. Our results showed that the $F_{3:6}$ populations had sufficient genetic diversity that would make the selection effective in improving the population productivity and adaptability to Nebraska environmental condition.

The second objective was to apply association-mapping approaches to identify DArT markers associated with important traits in $F_{3:6}$ wheat populations. Those markers could be used in further studies to investigate the genetic architecture of important traits such as yield and quality. Based on the yield, grain volume weight, disease resistance, plant height, maturity and molecular marker data, we applied different statistical methods to identify markers that have significant correlation with the previous phenotypic data. We have been successful in identifying potential QTL for those traits. Some of the QTL have been published in spring wheat populations which was surprising, but indicated that there are QTL important in two growth habits of wheat. Others identified QTL were novel.

The third objective was applying genomic selection methods in our breeding program using different statistical approaches to build new applicable protocol that could be used to improve our selection processes. Our results indicated that, when factors such as heritability, relative costs of genotyping versus field evaluation, and the number of cycles of selection per year are taken into account, the efficiency of GS becomes favorable in comparison with phenotypic selection.

Preharvest sprouting derived from red/white wheat mating populations.

Juthamas Fakthongphan, R. Graybosch, and P. S. Baenziger.

Preharvest sprouting of wheat, the premature germination of wheat heads, takes place in a field under conditions of delayed harvest, high humidity or wet conditions. This problem has a high economic impact on farmers and end-users. Wheat breeders have tried to diversify the wheat production system in Nebraska by introducing hard white winter wheat cultivars. The grain yield potential and disease resistance have been increased but the current germplasm of hard white winter wheat lacks some essential quality traits such as low levels of grain enzyme polyphenol oxidase, and resistance to pre-harvest sprouting. Both traits will be important issues once the U.S. exports white wheat to the world markets. This research will focus on (1) identifying red wheat parents capable of donating genes for tolerance to PHS; (2) mapping or confirming using markers applicable for the Great Plains hard white wheat gene pool using populations derived from Jagalene/RioBlanco, Jagalene/NW99L7068, Niobrara/RioBlanco, Niobrara/NW99L7068, NE98466/RioBlanco, and NE98466/NW99L7068 crosses; and (3) analyzing the ABA sensitivity in these materials to correlate the misting assay for PHS to ABA response.

Fusarium head blight (FHB) research.

Ali Bakhsh, Stephen Wegulo, Guihua Bai, Bill Berzonsky, and P. S. Baenziger.

For many years, we have been perplexed why we make so many crosses to FHB resistant material, only to have very few resistant lines survive our selection procedures. In this study, we developed a population of lines carrying the *Fhb1* gene and a population of lines not carrying the *Fhb1*. We also created mechanical mixtures (blends) of each of the two populations to determine if the *Fhb1* gene was pleiotropic or linked to genes that may reduce grain yield. In this study, the *Fhb1* lines survived the winter better than the non-*Fhb1* lines, but the blends had very similar grain yields. We interpreted these results as *Fhb1* was not pleiotropic or linked to genes that reduce grain yield. The difficulty with creating high-yielding, *Fhb1* lines is most likely due to the wide diversity and poor adaptation of many of parents lines used as *Fhb1* sources. In a second study, we evaluated a number of Wesley BC_2 lines with the *Fhb1* gene. We identified seven high-yielding, Wesley *Fhb1* lines for use as parents in crossing. Four lines were very similar to Wesley, and three lines were similar for most traits but were significantly earlier than Wesley. These lines have been used heavily as parents in our breeding program.

Nitrogen use efficiency.

Katherine Frels, Mary Guttieri, Teshome Regassa, Brian Waters, and P. Stephen Baenziger.

As part of a multistate effort, we began a major experiment on nitrogen use efficiency (NUE) at Mead, NE. Although too early to report any results, we have worked very hard to develop an excellent NUE testing site, protocols for canopy spectral reflectance (CSR, high throughput phenotyping), and data collection. We expect the efficient use of nitrogen and other major inputs in modern agriculture will be important areas for future research in agricultural profitability and sustainability.

Studying the role of roots in drought in wheat.

Sumardi bin Haji Abdul Hamid, Harkamal Walia, and P.S. Baenziger.

We began a study to investigate the role of roots to confer drought tolerance in wheat. The initial studies are laying the groundwork for future studies. So far, we have developed the needed protocols to look at the effect of drought at seeding and seedling emergence by studying germination, seed vigor, shoot and root ratios, and how best to induce controlled drought. The 2-D root phenotyping has been employed to compare the different root system architecture parameters of different cultivars in order to evaluate their drought tolerance. This study will help to evaluate the effectiveness of the previous selection of cultivars for dryland versus irrigated production systems.

Hybrid wheat.

P. S. Baenziger, MengYuan Wang, and friends.

In 2010, we began a small hybrid wheat program using two cytoplasmic male-sterile systems. The goal of this effort is to provide a system for hybrid wheat. The story of hybrid rice is inspirational where scientists worked very hard to overcome the barriers to hybrid rice (30 years of difficult research) that led to one of the great hybrid crop successes. Hybrid wheat and traits (syn. transgenes, genetically modified wheat) are two of the last great frontiers in wheat research. However, although there is considerable private- and public-sector research in traits, there is relatively little public-sector research in hybrid wheat. Hence we decided to begin a program so that should hybrid wheat become a reality, there would be public sector research looking at heterosis and heterotic pools, hybrid production systems, and pollinators. Both hybrid systems are still under evaluation, but it appears that we have excellent restorers and male sterility.

On the genetics of grain polyphenol oxidase.

S. Nilthong, R.A. Graybosch, and P.S. Baenziger.

Grain polyphenol oxidase (PPO) activity can cause discoloration of wheat food products. Five crosses (PI 117635/Antelope, Fielder/NW03681, Fielder/Antelope, NW07OR1070/Antelope, and NW07OR1066/OR2050272H) were selected to study the genetic inheritance of PPO activity. STS markers, PPO18, PPO29, and STS01, were used to identify lines with putative alleles at the *Ppo-A1* and *Ppo-D1* loci conditioning low or high PPO activity. ANOVA showed significant genotypic effects on PPO activity ($P < 0.0001$) in all populations. The generation and 'generation × genotype' effects were not significant in any population. A putative third (null) genotype at *Ppo-A1* (no PCR fragments for PPO18) was discovered in NW07OR1066- and NW07OR1070-derived populations, and these had the lowest mean PPO activities. Results demonstrated both *Ppo-A1* and *Ppo-D1* loci affect the kernel PPO activity, but the *Ppo-A1* locus had the major effect. In three populations, contrary results were observed to those predicted from previous work with *Ppo-D1* alleles, suggesting the markers for *Ppo-D1* alleles might give erroneous results in some genetic backgrounds or lineages. Results suggest selection for low or null alleles only at *Ppo-A1* is sufficient to allow development of low PPO wheat cultivars.

Effects of single and double infections of winter wheat by Triticum mosaic virus and wheat streak mosaic virus on yield determinants.

E. Byamukama, T. Satyanarayana, G.L. Hein, R.A. Graybosch, P.S. Baenziger, R. French, and S.N. Wegulo.

Triticum mosaic virus (TriMV) is a recently discovered virus of winter wheat in the Great Plains region of the United States. TriVM is transmitted by wheat curl mites (*Aceria tosichella*), which also transmit wheat streak mosaic virus (WSMV) and wheat mosaic virus. In a greenhouse experiment, winter wheat cultivars Millennium (WSMV-susceptible) and Mace (WSMV-resistant) were mechanically inoculated with TriMV, WSMV, TriMV+WSMV, or sterile water at the 2-leaf growth stage. At 28 days after inoculation, final soil plant analysis development (SPAD) readings (an indicator of chlorophyll content), the number of tillers/plant (TPP), shoot weight, root weight, TriMV and WSMV titers, total nitrogen, and total carbon were determined. In Millennium, all measured variables were significantly reduced by single or double virus infections, with the greatest reductions occurring in the double infection treatment. In Mace, only SPAD readings and total nitrogen were significantly reduced by single or double virus infections, and these reductions were smaller than those in Millennium. SPAD readings and shoot weight were linearly and positively related in Millennium but not in Mace. Total nitrogen was linearly and positively related to shoot weight in both cultivars. TriMV and WSMV titer was linearly and negatively related to shoot weight in Millennium, but not in Mace. TriMV titer was linearly and negatively related to SPAD readings in Millennium but not in Mace. WSMV titer was linearly and negatively related to SPAD readings in both cultivars. The results from this study indicate that 1) Mace, a WSMV-resistant cultivar, also is resistant to TriMV, and 2) double infection of a susceptible cultivar by TriMV and WSMV exacerbates symptom expression and loss of biomass.

Genetic improvement in winter wheat grain yields – redux.

R.A. Graybosch and C.J. Peterson (Limagrain).

A previous investigation, using region-wide data from Great Plains wheat breeding trials, indicated a possible plateau in the rate of genetically determined yield potential. Data from the same USDA–ARS-coördinated, long-term, regional performance nurseries was used to further examine the rate of genetic improvement of Great Plains winter wheats in specific agroecological or production zones over the time period 1987 to 2010. The absolute grain yield of all entries and of the top five most productive entries increased in the majority of production zones over this time period. The relative rate of genetic improvement, obtained by comparing grain yields to those of the long-term control cultivar Kharkof, ranged from not significantly different from zero to 1.98%/yr. This rate of change, however, was statistically significant ($\alpha = 0.05$) in only two of the 12 zones evaluated. Variance components identified production zone and locations within production zone as being the largest sources of variation in grain yields. Variance due to either genotype or 'genotype × environmental' factors remained both constant over the 24-year time period and small, relative to the environmental variances. Genetic progress for enhanced wheat yield in the region might be limited by the magnitude of these environmental variances and by constraints arising from continuous evolution of pest and pathogen populations.

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Microspore culture for production of doubled haploid plants of Nebraskan winter wheat cultivars.

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Introduction. Microspore culture is a cell (haploid) culture-based approach for producing completely homozygous doubled haploid (DH) plants from immature pollen grains in a single generation. In plant breeding, the single-seed descent (SSD) method is often used to hasten the development of homozygous breeding lines; however, six generations of self-pollination are required to reach 98% homozygosity. Microspore culture is more efficient than the SSD method, results in the recovery of genotypes with 100% homozygosity in a single generation, and can be performed at any stage of the breeding process. Because winter wheat requires 6 to 8 weeks of vernalization to induce flowering in every generation of advancement, microspore culture may prove useful for improving the efficiency of winter-wheat breeding programs, because only one vernalization cycle is required to obtain completely homozygous lines. Therefore, DH technology enables shortening the time required for developing cultivars when applied in traditional plant breeding (Forster and Thomas 2005).

Two basic methods of androgenesis for the production of DH plants are (i) anther and (ii) isolated microspore (immature pollen) cultures. Microspore culture is defined as isolating the microspores from the anther prior to culture, whereas anther culture involves culturing the whole anther (Ferrie and Caswell 2011). The advantage of isolated microspore culture is that microspores can be isolated in greater amounts, providing large number of potentially embryogenic single haploid cells, which can undergo androgenesis, thereby producing thousands of genetically different homozygous plants in one season from a single hybrid plant. Microspore culture consists of three major steps (i) pretreatment (process of sporophytic development from immature microspores), (ii) induction (developing embryoids from embryogenic microspores), and (iii) regeneration (regeneration of microspore-derived embryos).

Our long-term objective is to develop a high-throughput procedure for production of DH plants from major winter wheat cultivars of Nebraska to complement the current breeding program in Nebraska. We report here preliminary results of androgenic response of three Nebraskan winter wheat cultivars to two different pretreatment methods.

Materials and methods. ***Plant materials and growing conditions.*** The three Nebraskan winter wheat cultivars used in the study were Anton, Antelope, and Camelot. Plants were grown in pots in a controlled green house regulated with a photoperiod of 16–17 h light/7–8 h dark. Temperature was set at 22°C day and 15°C night. Humidity was not maintained. Plants were watered on alternate days and fertilized once a week.

Microspore culture. The whole procedure of microspore culture was according to Kasha et al. (2003) except that the pretreatment method was modified. Anthers from four sterilized spikes (half emerged when most of the microspores were at the late uninucleate stage) were removed and put in '60 x 15 mm' sterile petri dishes containing 4 mL of solution B. The petri dishes were kept at 25°C for 4–5 days (no cold treatment). For a cold treatment, the plates were incubated for additional five days at 4°C. The cell density was counted with a haemocytometer and adjusted to a range of 2–4 x 10^5 cells/mL. The suspended microspores were cultured in 35-mm (2.0 mL) or 60-mm (4.0 mL) petri dishes depending on the volume of microspores obtained. Ten to twelve ovaries were put into each petri dish. The petri dishes were incubated in dark at 28°C for 10 days and then transferred to a shaker in the dark at 28°C. The microspore-derived, multicellular structures were observed after 7–10 days. After 21 days, 1–2 mm size embryos were transferred to 90-mm petri dishes containing a modified, semisolid, MMS5 media fortified with ascorbic acid (Santra et al. 2012). The petri dishes were kept at 25°C in the dark for 4 days and then transferred to a light cabinet at 25°C. After 1–2 weeks, plantlets with well-developed roots and shoots were transferred to magenta boxes containing a modified MS media without hormones, which were kept at 22°C in light cabinets for 2–3 weeks.

Results and discussion. The correct microspore development stage is the most important step of androgenic response in isolated microspore culture (Ferrie and Caswell 2011). The right stage of the spike (Fig. 1a, p. 243) was determined based on mid- to late uninucleate stage of the microspores (Fig. 1b, p. 243) in anthers from the middle part of the spike.

The morphological marker for the embryogenic microspores is appearance of star-like structures (Fig. 2a; Shariatpanahi et al. 2006). After putting such star-like microspores in induction media, three things were observed among the isolated microspores (i) more than ~90% of the cells shrunk in the medium, (ii) ~4–5% of the cells did not progress but remained static, and (iii) ~1–2% of the cells enlarged and developed into multicellular structures, which subsequently advanced to embryo-like structures (ELS) (Fig. 2b) and pro-embryoids. The induced pro-embryoids eventually developed into 1–2 mm sized embryos (Fig. 2c), which were transferred to 90 mm petri dishes (Fig. 2d). The regenerated green plantlets (Fig. 2e) from the transferred embryos were transferred to magenta boxes (Fig. 2f).

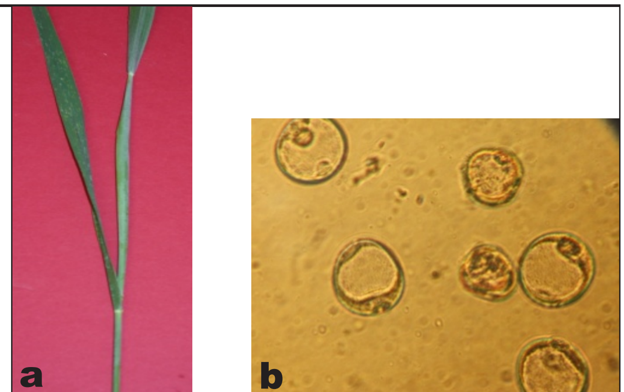

Fig. 1. Morphological and cytological stages suitable for isolated microspore culture in winter wheat. (a) Ideal morphological stage of spike, which carries late, uninucleate microspores in the middle portion; (b) microspores at late, uninucleate stage as seen by the vacuole being formed.

The androgenic response towards two different pretreatment methods of the three winter wheat cultivars is summarized in Table 1. Compared to no cold pretreatment, a cold pretreatment increased the number of embryogenic microspores in Anton by two fold, but no such differences were observed between the two pretreatments in Camelot and Antelope. *In vitro* development of microspores into multicellular and embryo-like structures was quicker in Camelot than in Anton and Antelope. Green plants were regenerated in all three cultivars following both cold and noncold pretreatments (Table 1). In Antelope, the number of green plantlets was higher with a cold (8) than with a noncold (4) pretreatment; because the number was much less, a further experiment is in progress.

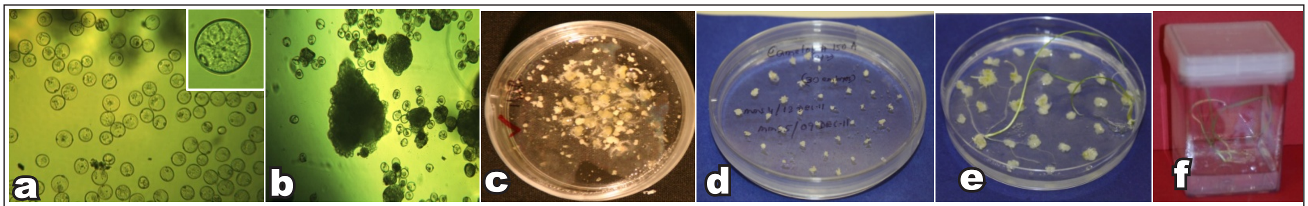

Fig. 2. Androgenic response of Nebraskan winter wheat cultivars to isolated microspore culture. (a) Freshly isolated embryogenic microspores (star-like structure; inset is an enlarged view of a star-like cell; (b) embryo-like structures after two weeks in induction medium; (c) embryoids formed after 20–21 days in induction medium; (d) 1–2-mm embryos transferred to MMS5, semisolid media; (e) regeneration of plantlets in petri dishes, and (f) transfer of green plantlets into magenta boxes.

Table 1. Androgenic response of three Nebraskan winter wheat cultivars to isolated microspore culture.

Cultivar	Treatment	Total number of microspores cultured (x 10^5)	Number of multicellular + embryo-like structures	Number of transferred embryos	Number of regenerated plantlets	Number of regenerated green plantlets
Anton	No cold	5.74	3,776	7	1	1
	Cold	10.8	736	7	1	1
Antelope	No cold	10.0	576	17	5	4
	Cold	8.84	960	37	13	8
Camelot	No cold	11.0	544	57	7	1
	Cold	6.48	640	59	1	1

Because isolated microspore culture depends on the genotype and a number of other factors (Ferrie and Caswell 2011), we studied the androgenic potential of the cultivars to produce DH plants. The higher number of embryogenic microspores woth a cold pretreatment in Anton was not regenerated into a proportional number of green plants. Replicated experiments are under progress to comprehensively compare the two pretreatments in the three cultivars. We hope to establish DH production methods on these and other major Nebraskan winter wheat cultivars so that this method will be a beneficial tool in our wheat breeding efforts.

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2011 Wheat Production in the Commonwealth of Virginia.

Growing conditions. Following an extremely dry summer and corresponding low yields in most of the Commonwealth in 2010, small grain growers experienced a generally drier and warm early start to planting (Fig. 1 and Fig. 2, p. 245). Many farmers were able to get an early start on wheat planting, since the harvest season for corn and soybeans was abbreviated greatly. By 20 September, about 9% of the wheat crop was seeded, compared to the average of 4%. By 20 October, most areas had received enough rainfall so that 65% of the state was rated adequate for topsoil moisture. The trend toward early seeding and early emergence continued with 46% of intended acreage reported as already planted, and 18% of acres emerged compared with the 5-year average of 8% by this date. The end of the first week of November showed continued cool and relatively wet weather throughout much of the state. Still growers managed to have 77% of acres planted. Conditions for early season growth

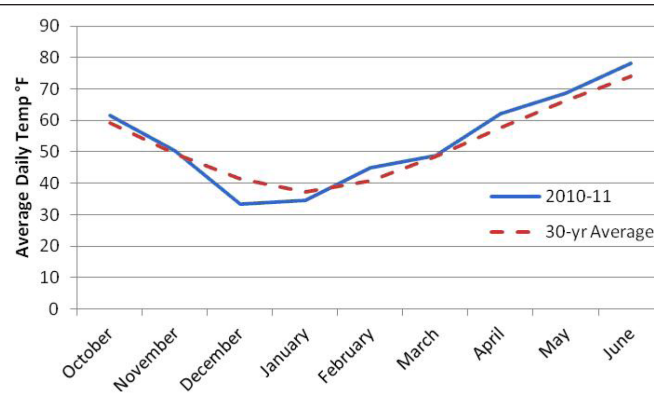

Fig. 1. 2010–11 and 30-yr mean monthly average temperatures in the Commonwealth of Virginia.