



# CCA ADVANTAGE

The Voice of the Certified Crop Adviser Program  
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## Biosafety, Biosecurity Defined

By Paul Umbeck  
ASA-CSSA-SSSA-CCA Biosecurity Point Person

**T**his summer while Washington insiders were focused on the national conventions, pre-election politics and the August congressional recess, Certified Crop Advisers (CCAs) had a much earthier focus — producing safely the crops that feed the world. Farm safety has recently added biosafety and biosecurity to its definition.

Staff at the American Society of Agronomy (ASA) have secured an appointment to the Department of Homeland Security (DHS) Agriculture Production Inputs and Services Subcouncil. This group's mission is to address security issues related to manufacturing, selling, supplying and using inputs, goods and services for agricultural products. The connection will strengthen the ASA involvement with DHS and will also establish a link between the subcouncil and growers through CCAs.

For many of us, the distinction between biosecurity and biosafety has been unclear, especially as it relates to plants, crops and soils. A DHS memorandum has set forth the following definitions related to the protection, treatment, use and handling of pre-harvest crops, agricultural commodities, land and timber: Biosafety is any environmental and/or unintentional contamination issue. Biosecurity is any intentional contamination issue.

It would be a biosafety issue if a pesticide was present in food at levels exceeding a permissible limit or if a food service worker spread a pathogen to the public through poor hygiene.

On the other hand, it was a biosecurity issue when restaurant customers in Oregon became ill after consuming food from salad bars that had been deliberately treated with Salmonella.

Having these unambiguous definitions will be essential as CCAs attempt to define their role in the larger biosecurity discussions. By participating in the development of the food biosecurity and biosafety plan, the ASA leadership will have the opportunity to share its expertise and shape the direction of future activities.

### *You Can Make a Difference*

By Dr. Karl Glasner, Director of Science Policy, ASA-CSSA-SSSA

**K**nowing how active some state associations are in the legislative process, chances are pretty good that as a CCA you have been asked to lend your support to an issue.

Prior to serving a year as a congressional science fellow on the Senate Agriculture Committee and seven years as a director of science policy I, like many others, thought my congressional delegation really didn't care what I thought nor particularly wanted to hear from me. Now that I am somewhat seasoned, I can tell you that your congressional delegation wants to hear from you about issues relevant to both your district/state and the nation as a whole.

The traditional way to get the attention of your congressional delegation is to write a letter. You can also visit with your congressional delegation, preferably back at the district or state office. There you will have more time for a one-on-one meeting, and the members tend to be more relaxed and receptive. Finally, if you are planning a visit to Washington, DC, set up a meeting with your congressional delegation.

#### **SHORT OF TIME?**

While the above methods of communication with Congress are the ideal, quite frankly most of us find it hard to do. Fortunately, there is now an easier way to contact our elected officials. The ASA-CSSA-SSSA recently purchased Science Policy Action, an online system for grassroots advocacy. It's easy, fast and effective. Explore the site on your own at [www.sciencepolicyaction.org](http://www.sciencepolicyaction.org). Once there, scroll down to "Congress & President" and type in your Zip Code.

#### **LIVE DEMO**

If you are planning on attending the ASA-CSSA-SSSA Annual Meetings in Seattle, you are also invited to take part in real-time advocacy using this new online tool. Come by the Societies' booth in the main exhibit hall for hands-on instruction in contacting your congressional delegation. You can help support funding for agriculture in the FY05 spending bills or write a note of your own on any topic important to you. What is important is that you take those first steps toward participating.



## CCAs Can Earn CEUs at ASA-CSSA-SSSA Annual Meetings

**C**ertified Crop Advisers (CCAs) can learn about the latest research and earn Continuing Education Units (CEUs) during the hundreds of paper and poster sessions at the Annual Meetings of the American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA). Over 3,000 papers will be presented at the event, held at the Washington State Convention & Trade Center, Seattle, WA, Oct. 31 to Nov. 4.

ASA's A-9 Division, Professional Practitioners, features sessions on Monday, Nov. 1, and Wednesday, Nov. 3, specifically targeted toward CCAs, according to Bill Simmons, division chair. Approved CEUs for these sessions are pending.

### SELF-REPORTING CEUs

All the states and the province surrounding Seattle (Washington, Oregon, Idaho and British Columbia, Canada) allow CCAs to self-report up to 20 CEUs. Several divisions feature sessions during the Annual Meetings relevant to the CCAs' performance areas, from nutrient management to soil and water management to pest management and crop management.

#### A-9 Professional Practitioners Division Sessions

See the *Annual Meeting Program Book* online at [www.asa-cssa-sssa.org/anmeet](http://www.asa-cssa-sssa.org/anmeet) for all updates.

#### Monday, Nov. 1

Session 1 – 12:30-3:20 p.m., Convention Center, Room 608

#### Organic Waste to Resource: Agronomic and Environmental Issues

- Uses of Biosolids in Urban Reclamation in Chicago
- Regional composting: organic residuals are a terrible thing to waste
- Herbicides in Compost. Recycling Biological Residuals in Fertilizers and Soil Amendments: Emerging Issues and Assessments
- Waste Recycling in Space Environments

Session 2 – Posters on Display 8:00 a.m.–6:00 p.m.; Authors Present 4:00–6:00 p.m., Convention Center, Exhibit Hall

- Localization of Quantitative Trait Loci for Stem length, Number of Node and Number of Branch in Soybean (*Glycine max* L.)
- The Effects of Flooding on Snap Bean Yield
- Effect of Plant Growth Regulators Treatment on the Germination of Kentucky Bluegrass Seeds
- Effect of Scarification Treatment to Enhance the Germination of Zoysiagrasses Seeds
- Effect of Seed Priming to Enhance the Germination of Zoysiagrasses Seeds

- Soil Vapor Extraction as a Means to an End: Communicating SVE Remediation Techniques to a Non-scientific Community

#### Wednesday, Nov. 3

Session 3 – 8:55 a.m.-Noon, Convention Center, Room 615

#### Soil Testing and Nutrient Management Planning

- Beyond Book Values: Characterization of Nitrogen Mineralization Potential for Manures and Composts
- The Importance of Laboratory Quality From a Regulatory Perspective: The State of Nebraska Experience
- Importance of Laboratory Quality to the Agronomy Practitioner: A Private Laboratory Perspective
- Issues in Soil Testing and Laboratory Considerations for Nutrient Management Planning
- Nutrient Management Planning: Where Are We Now and Where Are We Headed?
- Using On-Farm Data to Validate Crop Management Recommendations and Implementation

Session 4 – 1:30-3:50 p.m., Convention Center, Room 615

#### Crop Nutrient Supply in Irrigated Agriculture

- Supplying Nutrients for Crop Production With Municipal Biosolids
- Phosphorus Management in Irrigated Agriculture
- Irrigation Water Quality
- Nutrient Uptake Curves in Selected Irrigated Crops

Immediately following Monday afternoon's sessions, the division's business meeting will take place. Simmons extends an open invitation to all practitioners, member or not, to participate in this business session.

The Annual Meetings begin Sunday evening, Oct. 31, with the Plenary Session featuring Mark Drabenstott of the Federal Reserve Bank, presenting "Trends for Agriculture and Rural America." The meetings also feature supplier exhibits, tours and a career placement center, for all attendees.

### REGISTRATION INFO

For updates on session topics and times, visit [www.asa-cssa-sssa.org/anmeet](http://www.asa-cssa-sssa.org/anmeet). Registration for the full week is \$425 for ASA-CSSA-SSSA members, \$480 for non-members. One-day registration is available for \$155 for members, \$180 for non-members. All registrations take place at convention center.

Certified professionals can become members of ASA-CSSA-SSSA for as little as \$73, and the membership is good through 2005. Certified professionals who have never been members can join for only \$21. Call 608/273-8080.



## *Bringing Soil to Life*

# Soil Science Society of America Plans Smithsonian Soils Exhibit

**T**he Soil Science Society of America (SSSA) is working with the Smithsonian Institution to plan a soils exhibit as part of its Global Links Gallery at the National Museum of Natural History, located in Washington, DC. The museum attracts 6 million to 9 million visitors each year.

Plans for the interactive exhibit include educational displays, exhibit panels, artifacts, videos, activity tables, experiments and interactive games to help the visitors understand how soil is intricately linked to the health of humanity, the environment and the planet. Related publications and Web activities will reach millions of additional people.

SSSA has organized a committee to help develop exhibit information, help distribute educational information and involve the profession to develop the soils exhibit, slated to be opened in 2006. Four major elements of the soils exhibit include:

1. National Museum of Natural History Exhibit, which includes two sections. A state soil monolith from each state will be displayed as a permanent exhibit (see box at the bottom of this page for more information). A multi-year interactive exhibit of up to 5,000 feet, dependent on fund raising, will explain soils to the 6 million to 9 million museum visitors. Tentative topics for the exhibit include:
  - Soil as Life
  - Role of Soil in the Environment

- Soil Supports Organisms
- Food From the Soil
- Medicine From Soil
- Careers in Soil
- Soil in Cultural History

2. Following the multi-year exhibit, the interactive display components will be made available to other museums and libraries. Typically, exhibits like this will travel for five to seven years after the initial exhibit closes and will be used in at least half a dozen locations.
3. Educational Outreach Materials that are planned may include soil educational kits to be sent to librarians, K-12 teachers and other groups.
4. Web educational activities, career information and resource lists will be available on the Smithsonian Institution and SSSA Web sites indefinitely.

SSSA has asked the Agronomic Science Foundation (ASF) to help raise the \$1 million to \$3 million needed for the exhibit, and in May 2004, ASF reached a short-term goal of \$400,000. To learn more about the project, and how you can volunteer and contribute, visit [www.soils.org/smithsonian](http://www.soils.org/smithsonian).

Interested individuals can receive e-mail updates on the project. To subscribe to this listserv, send an e-mail with SUBSCRIBE in the body of the message to: [smithsonian-request@soils.org](mailto:smithsonian-request@soils.org). Or visit our Web site at [www.soils.org/smithsonian](http://www.soils.org/smithsonian).

## ***State Soil Monoliths Focus of Display***

**T**he Smithsonian Soils Exhibit slated for the National Museum of Natural History will contain a permanent state soil monolith collection. This collection of the official soils from each state will be displayed as mounted soil monoliths — large, vertical sections of soil horizons.

The state soil monoliths are planned for an exterior hallway in the museum, which will allow for their display long after the interactive multi-year exhibit travels to other museums around the country.

These soil monoliths highlight one soil from each state and illustrate to museum visitors the variety and makeup of soils in the United States. The monoliths will give visitors an “underground peek” at a real soil profile.

USDA's Natural Resources Conservation Service (NRCS) created the monolith collection in honor of the 100th anniversary of the national soil survey. The collection was developed for a showing on the mall in Washington, DC, in 1999 and is donated to the Smithsonian for this exhibit. NRCS has also provided a generous \$50,000 grant to fund design of the overall interactive exhibit.

These monoliths and the entire soils exhibit will be near the Hope Diamond, the most visited museum exhibit in the world. This location is also near the IMAX theater exit and should give good visibility to soil science. Plus, the museum charges no admission fee to view its exhibits.



# Influence of Diverse Cropping Sequences on Durum Wheat Yield and Protein in the Semiarid Northern Great Plains

By Y. T. Gan, P. R. Miller, B. G. McConkey, R. P. Zentner, F. C. Stevenson, and C. L. McDonald

### EARN ONE CEU!

All CCAs may earn up to 20 Continuing Education Units (CEUs) per two-year cycle as board-approved self-study articles which will include CCA Advantage articles. The CCA CEU logo (above) marks all pre-approved material, with the CEU value indicated by the number in the middle. To receive one CEU in crop management, read this article, fill out the attached exam and mail the tear-out form, along with \$10, to the American Society of Agronomy.

**T**he semiarid northern Great Plains is one of the major durum wheat production areas in the world. The largest proportion of Canadian durum wheat is grown in the semiarid Brown and Dark Brown soil zones of the prairies. However, there is little information available regarding the most suitable crop sequences for durum wheat production under no-till, dryland cropping systems. The objective of this study was to determine the effects of crop type and cropping sequences from the previous two years on the yield and quality of durum wheat in the semiarid northern Great Plains.

Field experiments were conducted from 1996 to 2000 at two sites in southwestern Saskatchewan. The first site was on an Orthic Brown Chernozem with loam to silt loam texture and a saturated-paste pH of 6.5 in the 0- to 15-cm depth. This site was at the Agriculture and Agri-Food Canada Semiarid Prairie Agricultural Research Centre near Swift Current. The second site was on Rego Brown Chernozem with heavy clay texture and a saturated-paste pH of 6.8 in the 0- to 15-cm depth in a farmer's field near Stewart Valley.

Three pulse crops (chickpea, lentil, and dry pea), one oilseed crop (oriental mustard), and one cereal crop (hard red spring wheat) were planted on tilled, fallow soil the first year. The next year, spring wheat, an oilseed (mustard or canola), and a pulse (lentil or dry pea) crop were no-till seeded on soil in each of the five previous crop stubbles. The third year, durum wheat was no-till planted on soil in standing stubbles of all 15 combinations of previous crop types. At each site, the three-year cropping sequences were duplicated for three cycles, staggered one year apart. The first cycle of the crop sequences began in 1996 and completed in 1998, the second began in 1997 and completed in 1999, and the third began in 1998 and completed in 2000.

Before initiation of each cycle, soil samples were collected from the sites. The soil samples were analyzed for  $\text{NO}_3\text{-N}$  and P. Soil water was determined. Values for soil bulk density were obtained. These bulk densities were used to express water content on a volumetric basis. Plant available soil water (PASW) was determined. In our study, the lower limit was 130 mm at Swift Current and 348 mm at Stewart Valley.

In the first year of the crop sequence, the five crops were grown in a randomized complete block design with three replications. Plot size was 16 by 4.5 m. All crops were grown using the recommended agronomic practices in regard to seeding date and depth, plant density, pest control, and fertilizer application. Mustard and spring wheat were fertilized using ammonium nitrate to supply  $70 \text{ kg ha}^{-1}$  total available N (i.e., residual soil N in a 120-cm depth plus fertilizer N), according to pre-planting soil tests. All crops received 4.5 to  $7.5 \text{ kg P ha}^{-1}$  as monoammonium phosphate placed with the seed. The pulse crops received 5 to  $8 \text{ kg ha}^{-1}$  of an appropriate *Rhizobium* spp. inoculant. Crops were individually harvested after they reached maturity. Uncut crop stubble was left standing. Crop residues cut by the combine were chopped and spread evenly in the field with a combine-attached chopper. In mid-September, glyphosate was sprayed for weed control on all plots at a rate of  $200 \text{ g a.e. ha}^{-1}$ .

In Year 2, the recropped oilseed (canola or mustard) and spring wheat were fertilized to supply 60 to  $70 \text{ kg ha}^{-1}$  of total available N, based on previous fall soil test results. Nitrogen credits from pulse stubble were taken into account in the fertilizer calculations using equations provided by Saskatchewan Soil Testing Laboratory:

$$\text{N credit (kg ha}^{-1}\text{)} = 0.005 \times \text{grain yield (dry pea)}$$

$$\text{N credit (kg ha}^{-1}\text{)} = 0.004 \times \text{grain yield (lentil, chickpea)}$$

As a result, canola, mustard and spring wheat grown on pea stubble received an average of  $20 \text{ kg N ha}^{-1}$  less fertilizer than when grown on spring wheat stubble and 10 to  $15 \text{ kg N ha}^{-1}$  less than when grown on lentil and chickpea stubble. All plots received  $7.5 \text{ kg P ha}^{-1}$  as monoammonium phosphate placed with the seed. Crops were separately harvested after they reached maturity. Crop stubble was handled similar to the first year, as was post-harvest weed control. In October, soil samples were collected from each plot (to a 120-cm depth). Residual soil  $\text{NO}_3\text{-N}$  and PASW were measured from those soil samples.

In the third year, durum wheat was planted on the 15 combinations of previous crop stubbles. Seed was treated with



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### Crop Management

VitaFlo at 2.6 g kg<sup>-1</sup> seed and planted 5 cm deep at a rate of 250 viable seeds m<sup>2</sup>. Row spacing was 20 cm. Fertilizer N as ammonium nitrate was placed between the rows at the rate of 45 to 62 kg N ha<sup>-1</sup>, along with 7.5 kg P ha<sup>-1</sup> and 6 to 7 kg S ha<sup>-1</sup>. The same rates of N, P and S were applied to all 15 combinations of previous crop stubble to determine residual soil N contributions from the different crop sequences. Weeds were controlled with a 200 g a.e. ha<sup>-1</sup> application of glyphosate before seeding. When needed, weeds in the standing crop were controlled with appropriately labeled herbicides. Plant height at maturity was measured in each plot, and the center eight rows were harvested with a plot combine. The grain samples were air-dried, cleaned and weighed. Test weight and kernel weight were determined and grain yield was reported on a dry weight basis. Grain N concentration was measured and was multiplied by 5.7 to convert to grain crude protein concentration (GCPC). Crude protein yield was calculated by multiplying the grain yield by GCPC.

### RESULTS AND DISCUSSION

The three-year crop sequence study was duplicated for three cycles, with the first from 1996 to 1998, the second from 1997 to 1999, and the third from 1998 to 2000. In each of the cycles, durum wheat was grown as a Year-3 crop. Growing season precipitation in the durum-grown years was generally average to above average. In 1998, total soil water (to a 120-cm depth) at spring seeding time was 20% lower than long-term averages, though growing season precipitation was near the 40-year average. In contrast, in 1999 and 2000, the growing season rainfall was 50 mm (26%) more than the 40-year average due to greater-than-average precipitation in May and July, with total soil water at spring seeding time being close to or slightly above long-term averages. The patterns and amounts of growing season precipitation were similar between the two sites.

### GRAIN YIELD AND YIELD COMPONENTS

Grain yields of durum wheat ranged from 1,430 kg ha<sup>-1</sup> at Swift Current in 1998 to 4,700 kg ha<sup>-1</sup> at Stewart Valley in 1999. Limited pre-seeding soil water and the low rainfall in the early period of the growing season in 1998 reduced durum vegetative growth at Swift Current. Crop height at anthesis was 98 cm in 1998, 15% lower than canopy measured in 1999 and 2000. Higher-than-normal temperatures in the late part of the 1998 growing season caused durum wheat to have significantly lower (29%–35%) kernel weight and lower (7%–9%) test weight than those measured in the other study years. A similar soil water deficit at Stewart Valley in 1998 was the likely cause of the reduced yield at that site.

Crops grown two years before durum wheat influenced grain yields of durum wheat in three of five site-years, with the yield of durum wheat grown on mustard and pulse stubble averaging 6% to 8% higher than when grown on spring wheat stubble ( $P < 0.01$ ). A similar response was observed for durum wheat grown on the previous year's stubble, with durum wheat grown on oilseed and pulse stubble yielding 4% to 5% higher than on spring wheat stubble ( $P < 0.01$ ). The Year-1 x Year-2 crop sequence effects were significant ( $P < 0.01$ ) in four of five site-years. On average, the durum wheat grain yield was 13% lower when the crop was preceded by two years of continuous

spring wheat compared with broadleaf crops. No significant yield differences were observed among the various pulse-oilseed, oilseed-pulse, or pulse-cereal alternated crop sequences. Durum wheat protein yields responded to crop sequences similarly to the way grain yield responded. Examination of yield components revealed that crops grown two years before durum wheat did not influence spike density, kernel weight or test weight of durum wheat. Crops grown the year immediately before durum wheat influenced kernel weight ( $P < 0.01$ ), with durum wheat grown on pulse stubble having the highest kernel weight. The two-year crop combinations (i.e., Year-1 x Year-2 crop types) did not influence yield components in general, but durum wheat following two years of continuous spring wheat had the lowest kernel weight.

Studies conducted in other regions of the world produced similar rotational benefits of pulses in cereal-based dryland cropping systems. Two studies in 1997 found that enhanced residual soil NO<sub>3</sub>-N was one of the primary contributors to increased grain yields of cereals following a pulse crop. A study in 2000 reported that PASW measured at spring seeding time was 10% greater in dry pea and lentil stubble than in wheat stubble. Residual soil water in a 60-cm depth did not differ among crops, whereas large differences in residual soil water in the 60- to 120-cm depth existed among crop species. These authors believed that conserved soil water, primarily below 60-cm soil depth, contributed to the increased grain yields of cereals following a shallower-rooted crop such as lentil or dry pea in semiarid dryland regions. In the present study, we measured residual soil NO<sub>3</sub>-N and PASW in the previous fall. Covariance analyses revealed that soil residual NO<sub>3</sub>-N and PASW combinations accounted for up to 28% of the durum wheat yield variation in two of five site-years and none for the rest of the site-years. The remainder of the yield variation could not be explained with the soil-related measurements. The poor relationship between durum wheat grain yield and the soil-related variables in this study was probably due to soil sampling that was conducted the previous fall. Changes in PASW from fall through winter to spring are expected along with a weak response of spring crops to available soil water measured the previous fall. Additionally, the majority of soil water, particularly in Vertic soils, moves through macropores and is not uniformly distributed throughout the soil profile. Inadequate soil sampling could generate inaccurate estimates of soil water conserved in the profile. We did not assess diseases in this study, but a 1998 study observed in an adjacent field trial at Swift Current showed that the severity of leaf-spotting diseases was higher in wheat after wheat than in wheat after lentil.

### GRAIN CRUDE PROTEIN CONCENTRATION

Growing conditions strongly influenced durum wheat GCPC, with the GCPC being highest in 1998 when grain yield was the lowest. The crop grown two years before durum wheat affected durum wheat GCPC in two of five site-years. The GCPC of durum wheat grown on spring wheat stubble (two years prior) averaged 6% lower than when grown on pulse stubble. The three pulses (pea, lentil and chickpea) had similar rotational effects on durum wheat GCPC, and with a few exceptions, they did not differ from that of mustard or canola. Crops grown the



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### Crop Management

year immediately before durum wheat affected durum wheat GCPC at all sites except Stewart Valley in 1999. Averaged over the five site-years, the GCPC of durum wheat grown on mustard or canola and pulse stubbles from the previous year was 10% and 15% higher, respectively, than when grown on spring wheat stubble ( $P < 0.01$ ). Year-1 x Year-2 crop combinations significantly affected durum wheat GCPC in four of five site-years, and the GCPC values at Swift Current in 1998 were not statistically different among treatments. The durum wheat GCPC averaged 16% to 19% higher when the crop was grown in two years of continuous pulses or pulse-oilseed alternated crop sequences than when grown in two years of continuous spring wheat. Other researchers observed similar rotational effects of pulse crops on cereal GCPC.

The increased protein concentration in durum wheat following pulse-pulse, oilseed-pulse or pulse-oilseed cropping sequences was partially due to increases in the symbiotically fixed N contained in the pulse crop residues and the gradual release of mineralizable N as crop residues decomposed during the growing season. Researchers in 1992, in a long-term wheat-lentil rotation study at Swift Current, observed that there was a cumulative enhancement of the N-supplying power of the soil after lentil due to the pulse residual contribution. The lentil-wheat rotation resulted in a gradual reduction in fertilizer N requirements of the mixed cropping system compared with a wheat-based monoculture. A study in 1993 also found that there was less deep-leached  $\text{NO}_3\text{-N}$  associated with the wheat-lentil rotation due to better synchrony of N uptake from the lentil residue decomposition compared with well-fertilized continuous wheat. A 1994 study demonstrated that addition of N fertilizer increases cereal protein yields in a continuous cereal rotation, but the protein yield could not be elevated to the same levels as those obtained in pulse-cereal rotations. In the present study, covariance analyses revealed that post-harvest residual soil N plus PASW accounted for 12% to 24% of the GCPC variation in three of five site-years and none in the two remaining site-years. The poor correlation between durum wheat GCPC and the soil-related variables was probably due to our soil sampling, which was conducted the previous fall. We did not measure potential changes of soil  $\text{NO}_3\text{-N}$  levels during the winter months and the following spring and summer. Durum wheat grown on the no-tilled soil that had mineralizable, high-N crop stubble might benefit from potentially mineralized N over a longer growing period.

#### YIELD-PROTEIN RELATIONSHIP

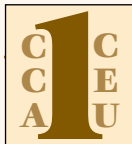
There was a negative relationship between grain yield and GCPC in durum wheat. As grain yield increased from 1,500 to 3,200  $\text{kg ha}^{-1}$ , the GCPC decreased from 190 to 130  $\text{g kg}^{-1}$ , equivalent to protein content on a dry matter basis from 18% to 10%. In 1998, durum wheat produced half as much as the grain yields produced in 1999 and 2000 due to lower-than-normal moisture in the earlier growing season and greater-than-normal temperatures in the latter part of the growing season. In the same year, the durum wheat GCPC was the greatest. Cropping sequences strongly influenced the relationship between durum wheat grain yield and GCPC. At the yield level of 1,700  $\text{kg ha}^{-1}$ , durum grown after a pulse or an oilseed crop produced 15% higher GCPC than durum following spring

wheat. As yields increased beyond 1,700  $\text{kg ha}^{-1}$ , there was a tendency for durum wheat GCPC to decline more sharply when the crop was preceded by an oilseed crop rather than a pulse crop. Coefficients of the regression equations were statistically significant between preceding pulses and oilseed. Preceding spring wheat had the lowest intercept value, whereas its slope did not differ from that of the pulses, indicating that at any given yield level, the GCPC of durum wheat grown after a cereal will be 15% lower than when grown after a pulse. In cases where the overall grain yields exceeded 3,200  $\text{kg ha}^{-1}$ , crop sequences had little effect on the association between GCPC and grain yields. This implies that the effects of previous crops on durum wheat GCPC diminish under environmental conditions conducive to higher grain yields.

In summary, crops grown immediately before durum wheat influenced the grain yield and GCPC of durum wheat more than crops grown two years before the durum wheat. Continuous cereal systems reduced durum wheat grain yields by 4% to 8% and GCPC by 8% to 16% compared with cropping systems that included an oilseed or a pulse crop one or two years before durum wheat. The increased yield of durum wheat preceded by an oilseed or a pulse crop was related to residual soil  $\text{NO}_3\text{-N}$  and PASW, but these two factors only accounted for up to 28% of the observed yield variation. In years when growing season precipitation was above long-term averages, the crop sequence effects on durum wheat were more evident than those observed in a dry year. Durum wheat GCPC increased with greater residual soil  $\text{NO}_3\text{-N}$  and PASW in three of five site-years; in these cases, 12% to 24% of the GCPC variation was explained by these two factor combinations. In the present study, potential contribution of residual soil  $\text{NO}_3\text{-N}$  to the increased durum wheat grain yield and GCPC may have been underestimated. Sampling soils in the previous fall did not consider potentially mineralizable N from crop residue decomposition during the winter months and the following spring and summer. Nevertheless, significant crop sequence effects existed, even for studies wherein the residual soil N and PASW were not attributable to the increased grain yield and GCPC in durum wheat.

These observations lead us to speculate that, besides residual soil N and PASW measured in the previous fall, other factors such as microbial activity and potential N releases during the post-harvest period and the following spring and summer play important roles in boosting grain yields and quality of subsequent cereal crops. Further studies are needed to elucidate these great rotational benefits in the semiarid northern Great Plains.

**Editor's note:** Content was adapted from the paper "Influence of Diverse Cropping Sequences on Durum Wheat Yield and Protein in the Semiarid Northern Great Plains," which was published in *Agronomy Journal*, Vol. 95, March-April 2003, and is courtesy of the authors Y. T. Gan, P. R. Miller, B. G. McConkey, R. P. Zentner, F. C. Stevenson, and C. L. McDonald.



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This exam is worth 1 CEU in **Crop Management**. An exam score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in the two-year cycle.

### DIRECTIONS

1. Read the self-study article on pages 18-20 carefully.
2. Answer the questions by clearly marking an "X" in the box next to the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
4. Clip out this self-study examination page, fold and place in envelope.
5. Enclose a check for \$10.00 made payable to the American Society of Agronomy, for processing fees. Payment in U.S. funds only.
6. **Mail your self-study exam and fee to:**  
ASA c/o CCA Self-Study Exam, 677 S. Segoe Road, Madison, WI 53711. *Please allow 60 days for processing.*
7. An electronic version of this test is also available at [www.AgProfessional.com](http://www.AgProfessional.com). Go to the Certified Crop Advisers section (lefthand column) and access the "CCA Advantage" link.

## Influence of Diverse Cropping Sequences on Durum Wheat Yield and Protein in the Semiarid Northern Great Plains October Self-Study Examination

1. The semiarid northern Great Plains is one of the major:
- a. lentil production areas in the world.
  - b. chickpea production areas in the world.
  - c. oriental mustard production areas in the world.
  - d. durum wheat production areas in the world.
2. The experiments were conducted in soils with textures of:
- a. silt, sand and clay.
  - b. loam, silt loam and clay.
  - c. sandy loam, clay and silty clay loam.
  - d. clay, loamy sand and silt.
3. Before initiation of each cycle, soil samples were collected from the sites and analyzed for the following nutrients:
- a. nitrate nitrogen and phosphorus.
  - b. phosphorus and heavy metals.
  - c. heavy metals and potassium.
  - d. potassium and sulfur.
4. The three-year crop sequence study was duplicated for:
- a. 2 cycles.
  - b. 3 cycles.
  - c. 4 cycles.
  - d. 5 cycles.
5. Grain yields of durum wheat over the course of this study ranged from:
- a. 1,142 kg ha<sup>-1</sup> to 5,000 kg ha<sup>-1</sup>.
  - b. 1,233 kg ha<sup>-1</sup> to 4,950 kg ha<sup>-1</sup>.
  - c. 1,395 kg ha<sup>-1</sup> to 4,800 kg ha<sup>-1</sup>.
  - d. 1,430 kg ha<sup>-1</sup> to 4,700 kg ha<sup>-1</sup>.
6. When durum wheat was preceded by two years of continuous spring wheat:
- a. yield was 20% lower than when the crop was preceded by broadleaf crops.
  - b. yield was 13% lower than when the crop was preceded by broadleaf crops.
  - c. yield was 20% higher than when the crop was preceded by broadleaf crops.
  - d. yield was 13% higher than when the crop was preceded by broadleaf crops.
7. Examining yield differences between the various pulse-oilseed sequences found:
- a. the oilseed-pulse rotation to yield higher durum wheat crops.
  - b. the pulse-oilseed rotation to yield higher durum wheat crops.
  - c. the pulse-cereal rotation to yield higher durum wheat crops.
  - d. no significant yield differences.
8. The grain crude protein concentration of durum wheat grown on spring wheat stubble (two years prior) averaged:
- a. 6% lower than when grown on pulse stubble.
  - b. 10% lower than when grown on pulse stubble.
  - c. 3% higher than when grown on pulse stubble.
  - d. 6% higher than when grown on pulse stubble.

Over



# Continuing Education Self-Study Course

## Nutrient Management

9. Comparing the effects of the three pulses (pea, lentil and chickpea) on grain crude protein concentration (GCPC), this study found:

- a. greater GCPC from peas.
- b. greater GCPC from lentils.
- c. greater GCPC from chickpeas.
- d. they all had similar rotational effects.

10. As grain yield increased from 1,500 to 3,200 kg ha<sup>-1</sup> the GCPC:

- a. decreased from 190 to 130 g kg<sup>-1</sup>.
- b. increased from 190 to 230 g kg<sup>-1</sup>.
- c. stayed the same.
- d. could not be measured.



### SELF-STUDY EXAM REGISTRATION FORM

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### SELF-STUDY EXAM EVALUATION FORM

Rating Scale: 1=Poor 5=Excellent

Information presented will be useful in my daily crop advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: \_\_\_\_\_

Topics you would like to see addressed in future self-study materials: \_\_\_\_\_