Historical Trends in the Composition of Soybean, Canola-Rape, and Flax Seeds Grown in the United States and Canada

Sir:

Soybean (*Glycine max* L. Merr.), canola (*Brassica napus* L.), and flax (*Linum usitatissimum* L.) are major oilseed crops grown in the United States and Canada. We have studied historical data sets of these three oilseed crops. These data sets consist of protein and oil analysis from The Uniform Soybean Tests (Northern and Southern Regions) that were conducted from 1948 to1998; and a Historic Canola–Rape Seed and Flax Seed Data Set (1956 to 1998) compiled by the Canadian Grain Commission. The Uniform Soybean Test data are published yearly and summarize the agronomic performance of potential public cultivars in comparison to established cultivars at many locations between 25° and 50° N and 74° and 101° W. The Canola–Rape Seed and Flax Seed Data Set represents yearly means from growers' surveys in the Canadian provinces of Alberta, Saskatchewan, and Manitoba between 48° and 60° N and 85° and 115° W. These data were obtained from crop bulletins that are published annually by the Canadian Grain Commission. We noticed an interesting trend in the yearly oil and protein concentrations within these data sets and present them here for your information.

Figures 1A and 1B are plots of the yearly mean oil and protein concentrations from the Southern and Northern Region Soybean Uniform Tests. We noticed that mean yearly oil or protein concentrations in both tests were similarly influenced from the previous year's mean. Both protein and oil concentrations would increase or decrease from their previous year's values. The oil concentrations in both the Southern and Northern Region Uniform Soybean Tests changed together (increased or decreased together from their previous year's values) in 36 of the 50 yr. The protein concentrations of the Southern and Northern Region Uniform Tests changed together from their previous year's values in 33 of the 50 yr. These trends indicated that the yearly growing environment might similarly influence the oil and protein concentrations of soybeans grown and evaluated in the United States and Canada.

These changes also were found in the yearly oil and protein concentration of canola-rape and flax grown in Canada between 1956 and 1998. There was a comparable change in oil concentration of canola–rape and flax from their previous year's values in 32 of the 42 yr and a comparable change in protein concentration of canola–rape and flax from their previous year's values in 38 of the 42 yr. Further, we compared the oil-to-protein ratios (Fig. 2) of canola–rape and flax over the 43 yr and found there was only 1 yr (1975) when there was not a comparable change from their previous year's values. An analysis of the protein-to-oil ratios for soybeans in the Southern and Northern Uniform Tests showed that in 27 of the 51 yr, there was a comparable change in the protein-to-oil ratios.

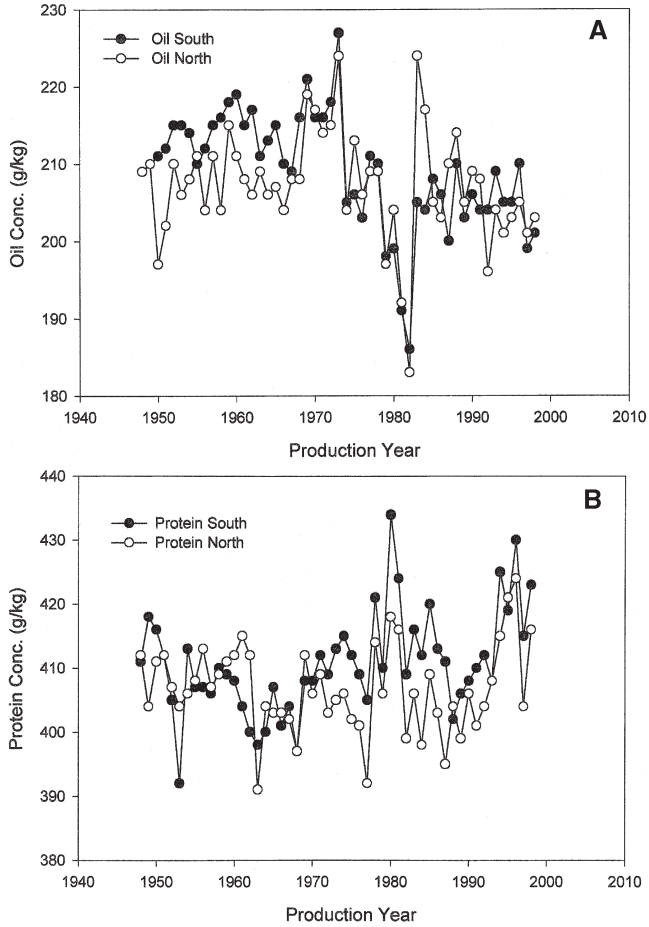

FIG. 1. Yearly mean values for seed oil and protein concentration from the Uniform Soybean Tests Southern Region and Uniform Soybean Tests Northern Region. (A) Yearly oil means. (B) Yearly protein means.

The question then is: What is affecting the oil and protein in these seed crops? Market demand alters breeding objectives for oil and protein for these two important seed components. Some of the above observations may have been caused by shifts in breeding objectives. However, we believe the data indicate that the yearly growing environment affects the oil and protein concentrations of soybeans grown in the Uniform Tests and canola–rape and flax grown in Canada. Temperature is known to affect soybean oil concentration (1), and a

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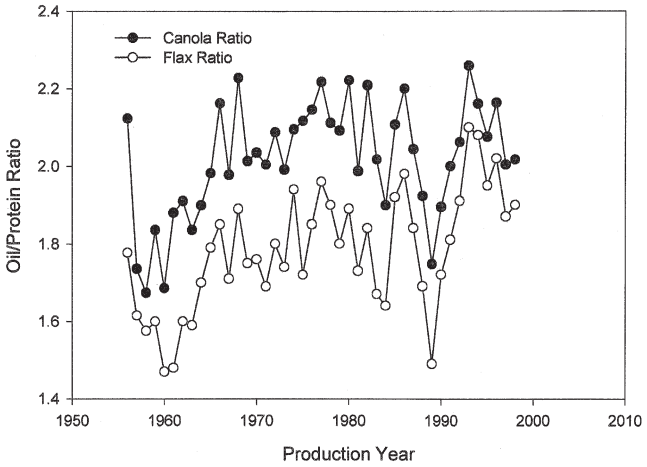

FIG. 2. Yearly mean oil-to-protein ratios for canola–rape and flax seed grown in Canada.

qualitative summary of the climatic effects on canola–rape and flax quality has been published recently (2).

The decrease in soybean oil between 1977 and 1982 (Fig. 1A) coincides with an interdecadal cooling period in North America (3). The increase of oil content between 1982 and 1983 coincides with the second-largest El Niño (warm event) of the 20th century (www.coaps.fsu.edu/lib/booklet). Likewise, the decrease in the oil-to-protein ratios in canola–rape and flax (Fig. 2) between 1986 and 1989 coincides with back-to-back El Niño years followed by a La Niña (cold event). El Niño and La Niña can be considered two extremes of the tropical Pacific atmosphere–ocean phenomenon known as El Niño Southern Oscillation (ENSO). Studies have shown that ENSO affects the climate and therefore the yield of major crops in North America (4–9) and other parts of the world (10–13).

The data indicate that the environment influences the year-to-year concentration of oil and protein in three major oilseed crops grown in the United States and Canada. The data also indicate that these trends can last for a number of years and extend over a large geographical area. To our knowledge, this is the first time that major environmental weather phenomena (ENSO) and also yearly weather patterns have been indicated in influencing the year-to-year composition of seed crops. These data also indicate that the year-to-year constituents in other crops may be influenced similarly by year-to-year differences in weather patterns. This information should be useful to the agricultural community that produces and processes these crops and will be useful to those that are trying to predict the effect of environment on seed composition.

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REFERENCES

1. Piper, E.L., and K.J. Boote, Temperature and Cultivar Effects on Soybean Seed Oil and Protein Concentrations, *J. Am. Oil Chem. Soc. 76*:1233–1241 (1999).
2. Daun, J.K., and D.R. DeClercq, Effect of Environmental Factors on the Composition of Canadian Canola and Flax. Long-Term Trends and Qualitative Evaluations, *Bull. GCIRC 17*: 98–103 (2000).
3. Assel, R.A., C.R. Snider, and R. Lawrence, Comparison of 1983 Great Lakes Winter Weather and Ice Conditions with Previous Years, *Mon. Weather Rev. 113*:291–303 (1985).
4. Adams, R.M., K.J. Bryant, B.A. McCarl, D.M. Legler, J. O'Brian, A. Solow, and R. Weiher, Value of Long-Range Weather Information, *Contemp. Econ. Pol. 8*:10–19 (1995).
5. Carlson, R.E., D.P. Todey, and S.E. Taylor, Midwestern Corn Yield and Weather in Relation to Extremes of the Southern Oscillation, *J. Prod. Agr. 9*:347–352 (1996).
6. Handler, P., Corn Yields in the United States and Sea Surface Temperature Anomalies in the Equatorial Pacific Ocean During the Period 1868–1982, *Agric. For. Meteorol. 31*:25–32 (1984).
7. Handler, P., USA Corn Yields, the El Niño and Agricultural Drought: 1867–1988, *Int. J. Climatol. 10*:819–828 (1990).
8. Hansen, J.W., A. Hodges, and J.W. Jones, ENSO Influences on Agriculture in the Southeastern United States, *J. Climate 11*: 404–411 (1998).
9. Legler, D.M., K.J. Bryant, and J.J. O'Brien, Impact of ENSO-Related Climate Anomalies on Crop Yield in the U.S., *Clim. Change 42*:351–375 (1999).
10. Cane, M.A., G. Eshel, and R.W. Buckland, Forecasting Zimbabwean Maize Yield Using Eastern Equatorial Pacific Sea Surface Temperature, *Nature 370*:204–205 (1994).
11. Garnett, E.R., and M.L. Khandekar, The Impact of Large-Scale Atmospheric Circulations and Anomalies on Indian Monsoon Droughts and Floods and on World Grain Yields—A Statistical Analysis, *Agric. For. Meteorol. 61*:113–128 (1992).
12. Nichols, N., Impact of the Southern Oscillation on Australian Crops, *Int. J. Climatol. 5*:553–560 (1985).
13. Rao, V.B., D.A.L. Sa, S.H. Franchito, and K. Hada, Interannual Variations of Rainfall and Corn Yields in Northeast Brazil, *Brazil. Agric. For. Meteorol. 85*:63–74 (1997).

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