11/10/2020, 10:15:07 am

Nebraska Soybean Board

Year-End Summary Research Report Form For Multi-Year Projects

Please use this form to summarize the practical benefits of your research project and what has been accomplished.

Your answers need to convey why the project is important and how the results will impact soybean production.

Note that this form must be submitted with the 4th Quarter Report in all multi-year projects.

Project # and Title: #1743: Assessing management options to enhance seed protein

Principal Investigator: Patricio Grassini

Year of Multi Year: 1 ***of*** 2 ***(For example: Year 1 of 3, Year 2 of 2)***

1. ***What was the focus of the research project or educational activity?***

   The goal of the proposed project is to determine the influence of management practices on seed protein concentration.

2. ***What are the major findings of the research or impacts of the educational activity?***

   Despite the usual trade-off between seed yield and seed protein concentration, we found that irrigation increases BOTH yield and seed protein in NE soybean producer fields. Results indicate that,besides higher yield (+5 bushels per acre), irrigated fields exhibited higher protein (+0.4%) than dryland fields, with slightly lower oil concentrATION (-0.1%). There was no difference in test weight between irrigated and dryland fields. There was no apparent trade-off between seed yield and protein concentration, but there was a strong negative correlation between seed protein and oil concentration. Following the same trends as for protein, concentration of most amino acids (15 out of 18) was higher in irrigated versus dryland fields. In the case of fatty acids, linoleic and stearic acids decreased and increased, respectively, in irrigated versus dryland fields. Total carbohydrates were lower in irrigated than in dryland fields due to lower fiber and raffinose concentration. SEE ATTACHED TECHNICAL REPORT WITH THE DETAILED RESULTS.

3. ***Briefly summarize, in lay terms, the impact your findings have had, or will have, on improving the productivity of soybeans in Nebraska and the U.S.***

   We expect that the information from this project can help NE producers to identify opportunities to increase yield without detrimental effects on seed quality, helping strengthen the competitiveness of the NE soybean sector.

4. ***Describe how your findings have been (or soon will be) distributed to (a) farmers and (b) public researchers. List specific publications, websites, press releases, etc.***

   Field-specific results were mailed to each soybean producer with a Thank You letter and a summary of results at state level. A COPY OF THE LETTER IS APPENDED TO THIS REPORT. The preliminary results from the project will be presented at the 2020 ASA-CSSA-SSSA International Annual Meeting (November 9-13) and also at a NE Extension sponsored event at Mead NE in Dec 2020.

5. ***Did the NE soybean checkoff funding of your project, leverage additional State or Federal funding support? Please list sources and dollars approved.***

   The project does not received funding from other agencies or organizations.

Please email this completed form to the Agriculture Research Division (jmcmahon10@unl.edu) based on the reporting schedule given to you. If you have any questions, please call Jen McMahon at the ARD 2-7082.

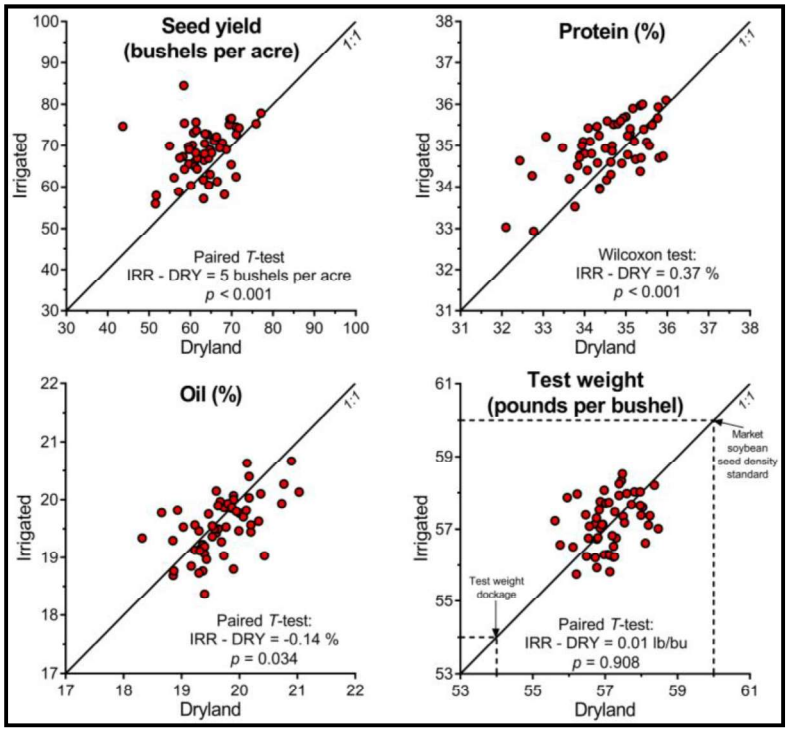
UNIVERSITY OF Nebraska Lincoln

INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES
DEPARTMENT OF AGRONOMY AND HORTICULTURE

Dear Soybean Producer:

Our research team at the UNL Department of Agronomy and Horticulture wants to **THANK YOU** for providing soybean seed samples in 2019. The primary goal of the project is to determine the influence of water regime (irrigated *versus* rainfed) on seed quality parameters, including protein and oil concentration, and test weight. That information can help NE producers to identify opportunities to increase yield without detrimental effects on seed quality.

During 2019, we received samples from 177 fields in NE. The 4-panel figure on the right-hand shows a comparison of yield, protein and oil concentration, and test weight in irrigated **(vertical axis)** *versus* dryland fields **(horizontal axis)**. Each data point corresponds to the average of the irrigated and dryland fields managed by a given soybean producer. Each producer provided samples from, at least, one irrigated & one dryland field.



Data points above the 1:1 line mean higher values in irrigated than in rainfed fields and *vice versa*. **Results indicate that, besides higher yield (+5 bushels per acre), irrigated fields exhibited higher protein (+0.4%) than dryland fields, with slightly lower oil (-0.1%).** There was no difference in the test weight between irrigated and dryland fields. **We are also appending the specific results for your fields together with this letter.**

We are now initiating the second year of the project. **We will greatly appreciate if you can help us again by submitting seed samples from the 2020 crop season.** Our team will reach you out soon to discuss this. Thank you again for participating in this project and we hope we can count with you again this year!

Sincerely,

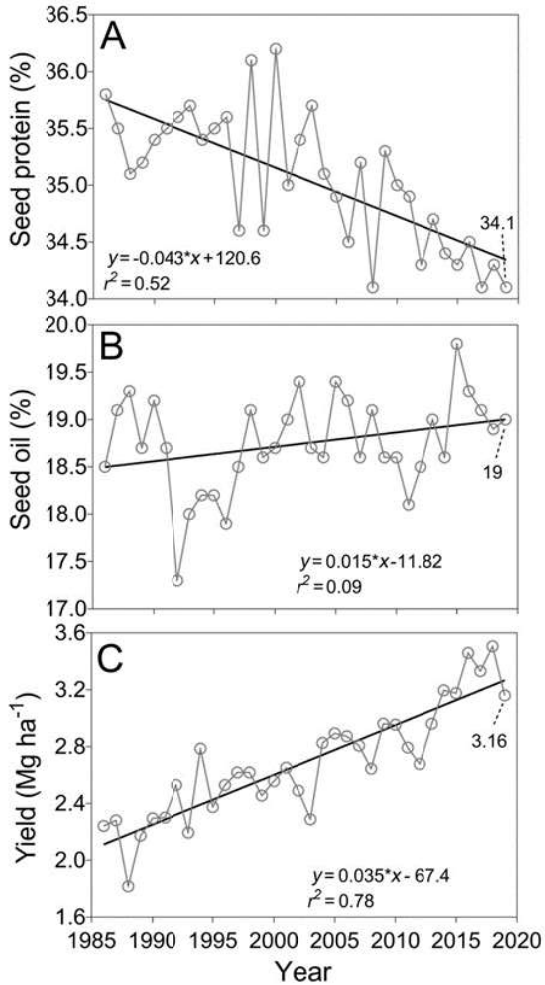
Dr. Patricio Grassini (Principal Investigator), Associate Professor, Department of Agronomy & Horticulture. Phone: 402-472-5554. E-mail: pgrassini2@unl.edu

Soybean seed protein and oil concentration in Irrigated vs Dryland fields in Nebraska

Nicolas Cafaro La Menza[1], James Specht[1], Seth Naeve[2], and Patricio Grassini[1]

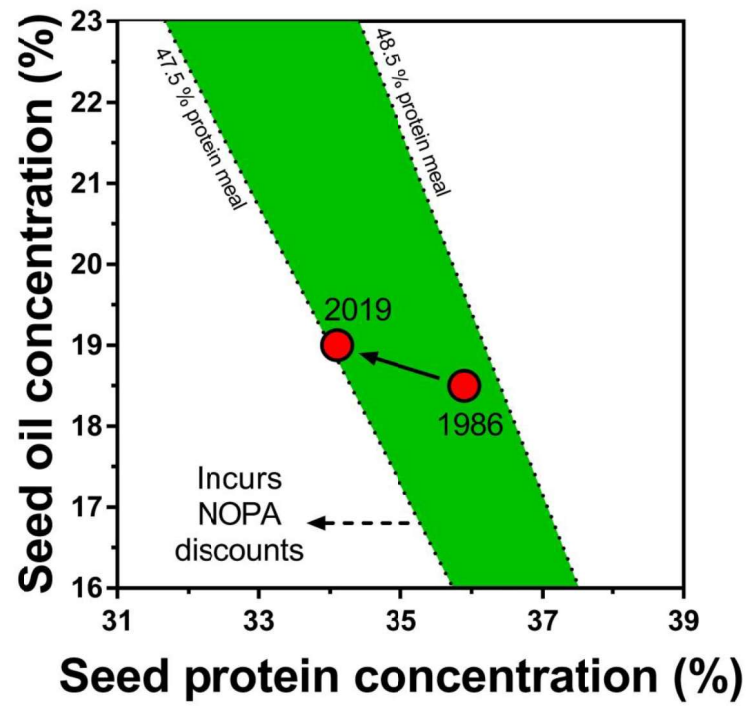
[1]Department of Agronomy & Horticulture
University of Nebraska-Lincoln
[2]Department of Agronomy and Plant Genetics
University of Minnesota

Seed yield, protein, and oil trends of soybean in the USA



Source: USDA-NASS and University of Minnesota (Miller-Garvin and Naeve, 2019)

Seed protein concentration has been decreasing as yield increases.
Seed oil concentration, however, has slightly increased.
Although soybean producers do not get paid for protein concentration, soybean processors start to have a problem with meeting soybean meal protein standard for commercialization.



Adapted from Brumm and Hurburgh, 2006

Seed yield and protein trade-off in soybean

Possible explanations:

- A shift of the USA soybean production towards north-western areas with lower protein concentration (Rotundo et al., 2016).

- A genetic trade-off between seed yield and protein concentration (Chung et al., 2003; Rincker et al., 2014).

- Negative correlations between yield and protein also exist across crop management practices (Assefa et. al., 2019; Mourtzinis et al., 2017; Bosaz et al., 2019)

Protein concentration and water deficit: context of Nebraska

Nebraska is ranked as 4th largest soybean producer state in the US and about 50% of its production is under irrigation. The response of seed protein and oil concentration to water deficit is still unclear.

Water deficit

Reduces seed protein concentration

Foroud et al., 1993
Specht et al., 2001
Carrera et al., 2009
Wijewardana et al., 2019

?

Increases seed protein concentration

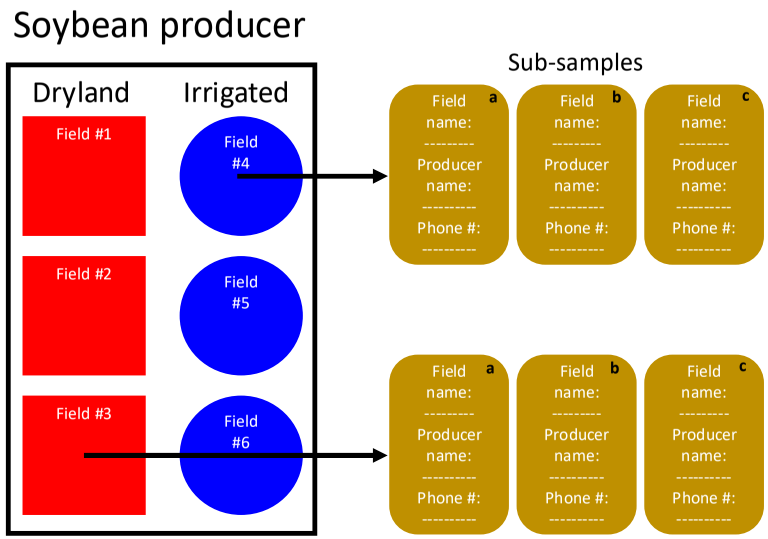
Dornbos and Mullen, 1992
Rotundo and Westgate, 2009 and 2010
Mertz-Henning et al., 2018

Objective of the study

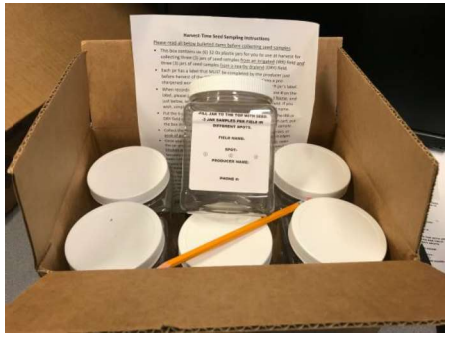
Determine the influence of water regime (irrigated *versus* dryland) on soybean seed quality parameters, including total seed protein and oil concentration, amino and fatty acid profiles, and test weight.

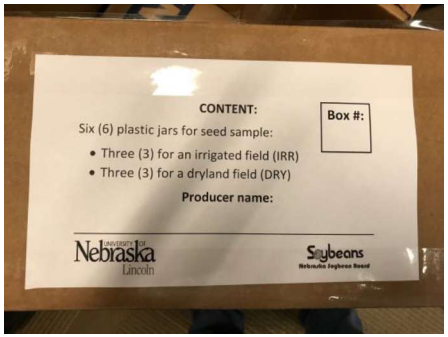
Sample collection

We worked with 16 UNL Extension Educators, and Nebraska Soybean Board members to collect samples across the state.



Total 32 Oz jars collected from this example: <u>18 (6 fields*3 sub-sample per field)</u>





Survey for assessing crop management options that enhance seed protein

	EXAMPLE:	2019 Soybean	2019 Soybean	2019 Soybean	2019 Soybean
Field name:	"House field"				
Specify field location by Section: Township: Range. →	NE¼ 25 : 20N : 26W	____ : ____ : ____	____ : ____ : ____	____ : ____ : ____	____ : ____ : ____
Please sketch-in the boundaries of your field location within the Section →	NW1/4 NE1/4 SW1/4 SE1/4	NW1/4 NE1/4 SW1/4 SE1/4	NW1/4 NE1/4 SW1/4 SE1/4	NW1/4 NE1/4 SW1/4 SE1/4	NW1/4 NE1/4 SW1/4 SE1/4
OR GPS coordinates of field centroid:	41.678, -100.257				
Dryland? OR Pivot, Gravity? Indicate field size (acres)	Pivot (130 ac)				
Total Inches of irrigation applied to crop?	4.5 inches				
SOYBEAN YIELD (bushels/acre) for this FIELD:	60				
Seed moisture content	15.3%				
Planting date in this FIELD (Month/Day/Year):	5/15/2019				
Variety name (Brand & Number):	Asgrow AG2431				
Seeding rate (seeds/ac):	125,000				
Row spacing (inches):	30				
Prior two crops in this FIELD:	Soybean-Corn				
Tillage after prior crop? No-Till (NT); Ridge (RT); Strip (ST) Disk (D); Chisel (C); Vertical (V)	ST				
Any in-season foliar fungicide (F) / insecticide (I)?	F and I				
Any significant lodging? No, Some, Severe	Severe				
Any starter fertilizer applied? Yes or No	No				
Any other fertilizer applied AFTER prior crop? Indicate product, formulation (N-P-K), and rate (lb/ac)	MAP (11 - 52 - 0) 80 lbs per ac				
Any other fertilizer applied TO the prior crop? Indicate formulation (N-P-K) and rate (lb product/ac)	Urea (46- 0 - 0) 400 lbs per acre MAP (11 - 52 - 0) 120 lbs per ac				
Any Lime (L) or Manure (M) applied in the past 3 years? If yes, specify timing (month-year)	M (Nov-2018)				
Any significant yield loss due to Insects, Diseases, Weeds, Frost, Hail, Flood, Nematodes? Specify problem	Weed infestation Hail (July-2019)				

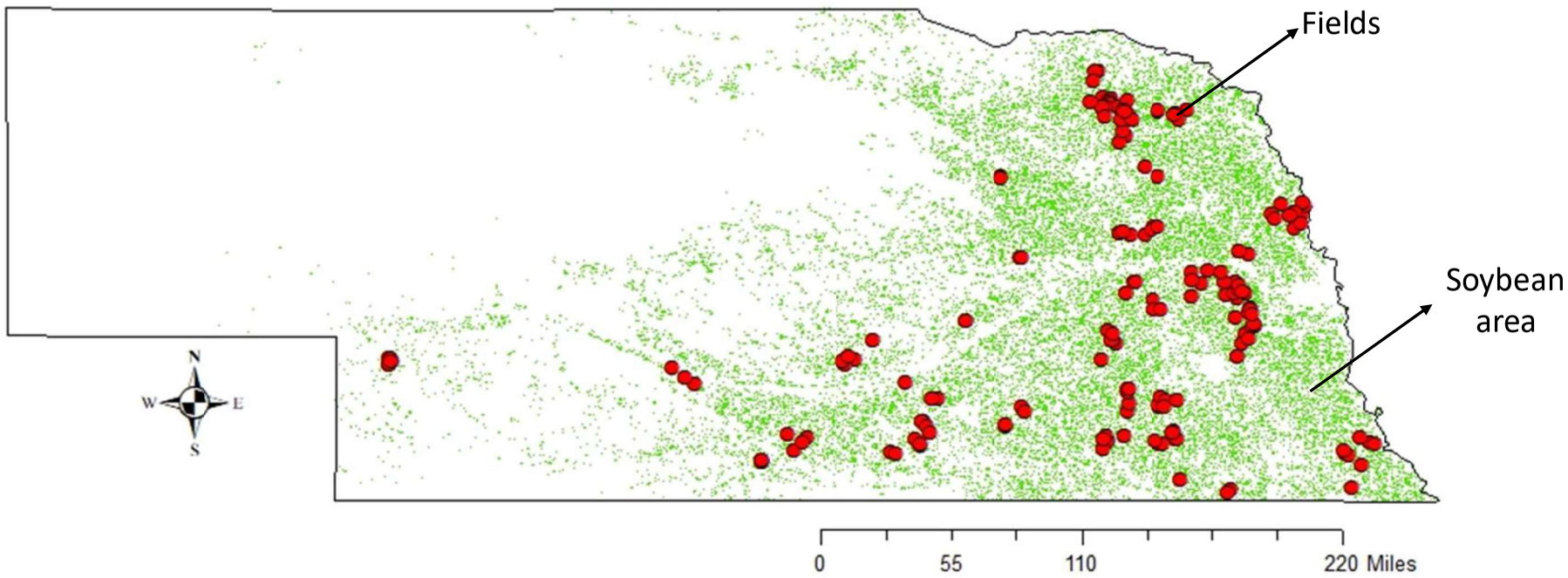
University of Nebraska Lincoln EXTENSION Nebraska Soybean Board

Seed sample analysis

Samples were labeled upon arrival. We measured the test weight (with Winchester, and DICKEY-John) and seed moisture content. Then seed protein, oil, fiber, and moisture concentrations were determined with NIR. Samples were shipped to the Minnesota lab for amino and fatty acid profile analysis.

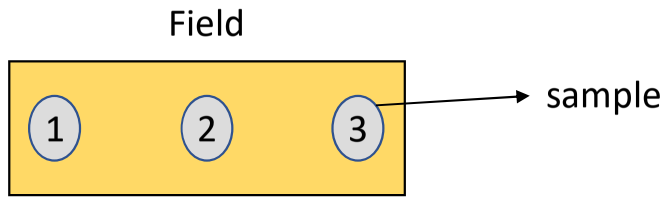
Soybean seed sample collection on fall 2019

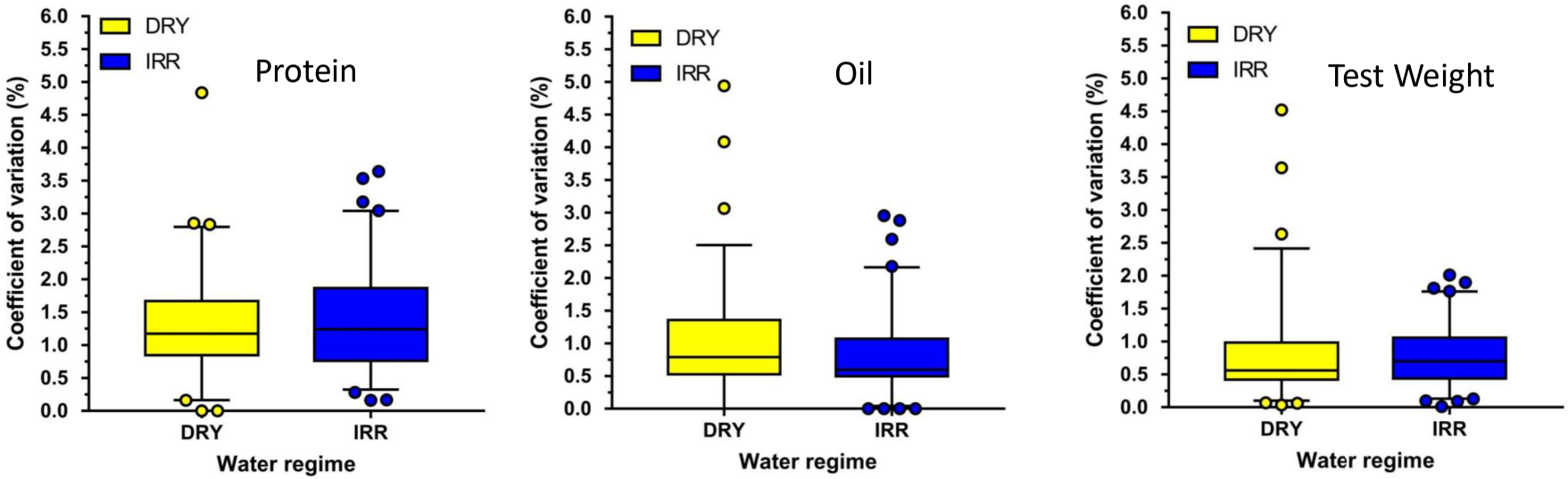
We sampled a total of **172** Irrigated (IRR) and Dryland (DRY) soybean fields across Nebraska



Within-field variation in Dryland (DRY) and Irrigated (IRR) fields

Within-field variability was *ca.* 1% or less for most of the variables.

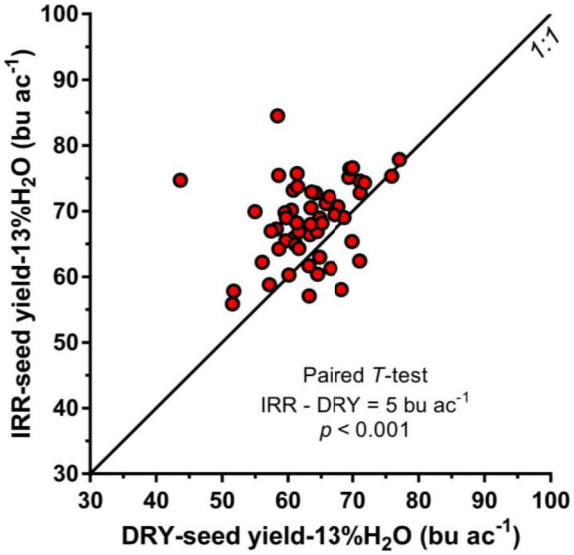




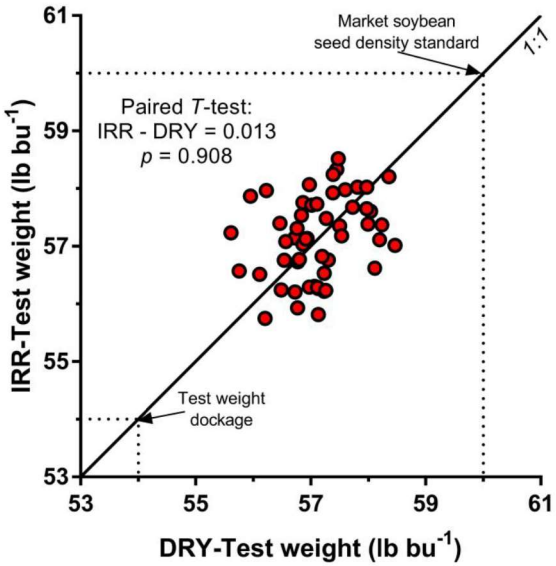
Irrigated (IRR) vs Dryland (DYR) comparison: seed yield and test weight*

Yield was 5 bu ac^{-1} higher in IRR *versus* DRY fields. There were no differences on Test Weight between water regimes. Average test weight from IRR and DRY fields was *ca.* 3 lb per bu^{-1} lower than the standard soybean test weight of 60 lb bu^{-1}.

Seed yield



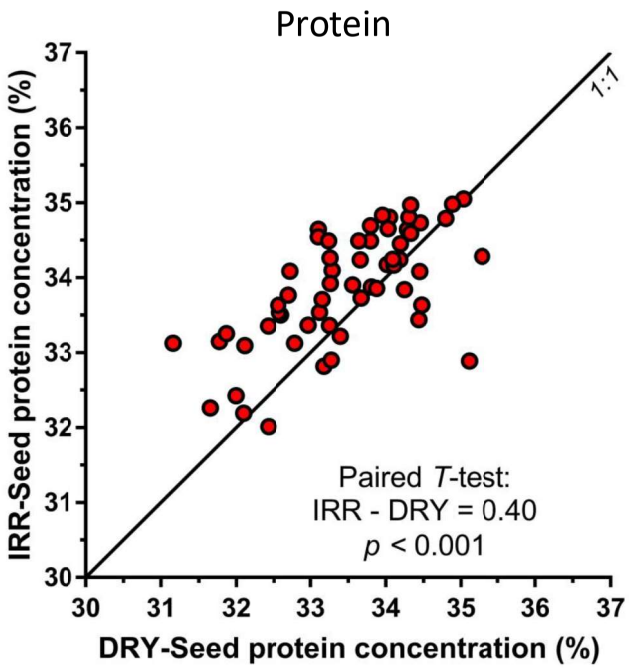
Test weight

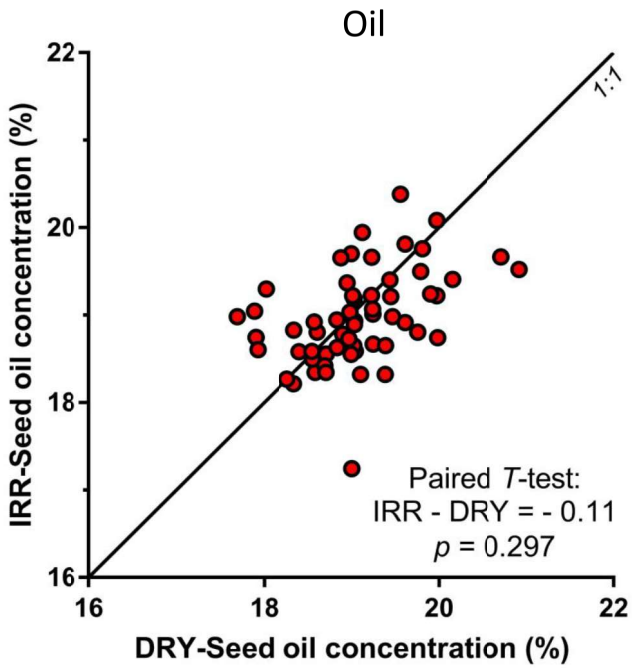


*Total paired IRR-DRY comparisons: 68. Each paired comparison represents one farmer, with at least one IRR and one DRY field (but no more than three for each water regime). Three subsamples were collected from each field.

Dryland (DYR) vs Irrigated (IRR) comparison: protein, and oil*

Despite higher seed yield in IRR *vs* DRY fields, IRR fields exhibited 0.4 percentual points higher than DRY seed on seed protein concentration, while seed oil concentrations were slightly lower in IRR *vs* DRY.

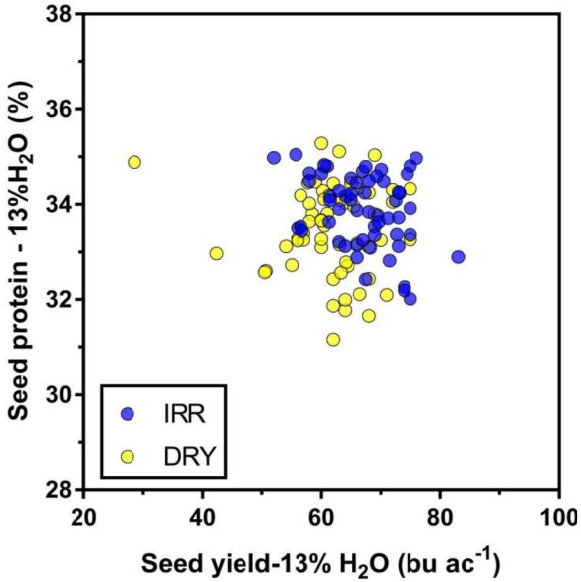


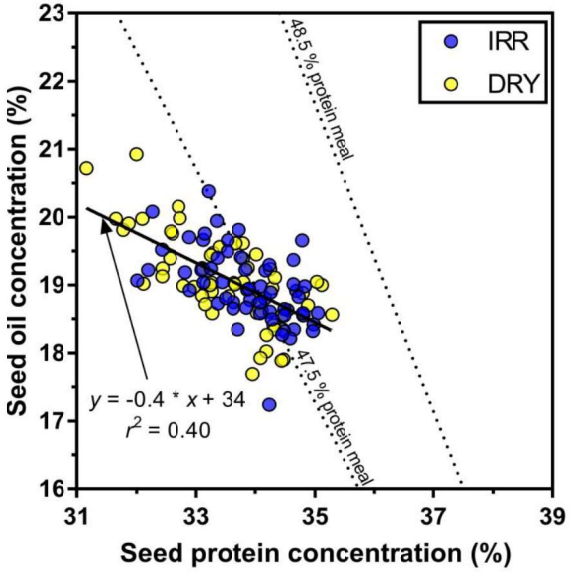


*Total paired IRR-DRY comparisons: 68. Each paired comparison represents one farmer, with at least one IRR and one DRY field (but no more than three for each water regime). Three subsamples were collected from each field.

Relationships between seed yield, protein, and oil in Dryland (DRY) *vs* Irrigated (IRR) fields of each producer (n = 68)

There was no clear relationship between seed protein concentration and yield. IRR fields had on average greater seed protein that DRY fields. However, there was a relationship between seed protein and oil concentration that was not affected by the water regime.





*Each datapoint corresponds to the average of irrigated (blue) or dryland (yellow) field for one producer, with at least one irrigated AND one dryland field (but no more than three for each water regime). Three subsamples were collected from each field.

Amino acids concentration in Dryland (DRY) *vs* Irrigated (IRR) fields

Variable	Irrigated (IRR)	Dryland (DRY)	IRR *versus* DRY difference*
Total protein	**33.88**	**33.48**	**+1.2%**
Lysine	**2.58**	**2.55**	**+0.9%**
Cysteine	**0.65**	**0.64**	**+2.4%**
Methionine	**0.57**	**0.56**	**+1.8%**
Threonine	**1.53**	**1.51**	**+1.1%**
Tryptophan	**0.33**	**0.32**	**n.s.**
Isoleucine	**1.74**	**1.73**	**n.s.**
Leucine	**2.20**	**2.18**	**+1.0%**
Histidine	**1.02**	**1.01**	**+1.0%**
Phenylalanine	**1.97**	**1.96**	**n.s.**
Valine	**1.82**	**1.81**	**+0.7%**
Alanine	**1.65**	**1.63**	**+1.0%**
Arginine	**2.82**	**2.79**	**+1.3%**
Aspartic acid	**4.35**	**4.29**	**+1.2%**
Glutamic acid	**6.55**	**6.46**	**+1.3%**
Glycine	**1.66**	**1.64**	**+1.2%**
Proline	**2.10**	**2.08**	**+1.0%**
Serine	**1.78**	**1.76**	**+1.0%**
Tyrosine	**1.41**	**1.40**	**+0.8%**
Other AAs	**2.23**	**2.16**	**n.s.**

*** Difference between irrigated and rainfed fields, expressed as % of the dryland average value. Differences were statistically significant from zero (P<0.05), unless indicated (n.s.: not significant)**

Amino acids concentration followed the same trends as protein concentration in in 15 out of 18 amino acids analyzed. That is, higher concentration in IRR *vs* DRY fields. In contrast, the following amino acid concentrations were not affected by the water regime: tryptophan, isoleucine, and phenylalanine.

Fatty acid concentration and carbohydrates in Dryland (DRY) vs Irrigated (IRR) fields

There was no significant difference in seed oil concentration between water regimes, but linoleic and stearic acids were lower and higher, respectively, in IRR vs DRY fields. Total carbohydrates were lower in IRR vs DRY fields because of lower fiber and raffinose concentration.

Variable	Irrigated (IRR)	Dryland (DRY)	IRR versus DRY Difference
Total Oil	18.98	19.08	-0.6%
Linoleic acid	51.80	52.81	-1.9%
Linolenic acid	6.75	6.74	nil
Oleic acid	20.20	19.35	nil
Palmitic acid	12.08	12.03	nil
Stearic acid	4.60	4.53	+1.4%
Other fatty acids	4.58	4.54	nil
Total carbohydrates	29.53	29.84	-1.0%
Sucrose	4.90	4.94	nil
Raffinose	0.48	0.50	-3.0%
Stachyose	3.85	3.85	nil
Fiber	6.26	6.32	-1.0%
Other CH	18.46	18.68	-1.2%

*** Difference between irrigated and rainfed fields, expressed as % of the dryland average value. Differences were statistically significant from zero (P<0.05), unless indicated (n.s.: not significant)**

Summary

- Within-field variability on seed quality parameters was less than 1% with three subsamples per field.
- Seed yield and protein concentration were greater in IRR *vs* DRY fields.
- There was no difference in test weight between water regimes.
- There was no apparent trade-off between seed yield and protein concentration.
- There was a strong negative correlation between seed protein and oil concentration.
- Most amino acids concentration (15 out of 18) increased in IRR vs DRY fields; the same trends as protein concentration.
- Linoleic and stearic acids decreased and increased, respectively, in IRR vs DRY fields.
- Total carbohydrates were lower in IRR vs DRY fields due to lower fiber and raffinose concentration.

Thanks!!! Questions?

Please, contact me at ncafarolamenza2@unl.edu

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