Comparison of Organic and Conventional Corn, Soybean, Alfalfa, Oats, Rye Crops at the Neely-Kinyon Long-Term Agroecological Research (LTAR) Site-2000

Dr. Kathleen Delate, assistant professor, Depts. of Horticulture & Agronomy
Dr. Cynthia Cambardella, soil scientist, USDA National Soil Tilth Lab
Bob Burcham, farm supervisor, Neely-Kinyon Research and Demonstration Farm
Heather Friedrich, graduate student, Depts. of Horticulture

Introduction

Sales of organic products are expected to reach $8 billion industry in the U.S. in the year 2001, showing a continued 20% annual growth rate. In Iowa alone, organic acreage for all crops has increased from 13,000 in 1995 to 150,000 in 1999. The Leopold Center for Sustainable Agriculture has identified the need for dedicated lands throughout Iowa where research on organic practices can be conducted over the long term. Soil health, maintained through crop rotations, organic matter additions (manure/compost), and cover crops, has been the basis of successful organic farming. Theoretically, comparable yields to conventional systems can be obtained once the transition to organic production is complete. In 1998, the first year of the Neely-Kinyon (N-K) Long-Term Agroecological Research (LTAR) experiment, organic corn and soybean yields were similar to conventional yields. In addition, organic products garner a 20-300% premium price in the marketplace, with organic clear-hilum soybeans averaging three times the price of conventional clear-hilum soybeans in 2001. In the third year of the N-K LTAR research, organic certification was obtained through the State of Iowa Organic program. We continued our examination of the agronomic and economic performance of conventional and organic systems, using required practices for certified organic production.

Materials and Methods

Planting scheme. Treatments, replicated four times, in the LTAR planting include conventional Corn-Soybean (C-SB), organic Corn-Soybean-Oats/Alfalfa (C-SB-O/A), organic Corn-Soybean-Oats/Alfalfa-Alfalfa (C-SB-O/A-A) and soybean-rye (SB-R) where the rye was plowed in the spring prior to planting soybeans. All crops in all rotations are grown each year . Variety selection and planting methods in 2000 were as follows: untreated Pioneer '34W67' corn was planted at a depth of 1.75 in. at a rate of 32,000 seeds/acre for organic plots and treated Pioneer '34W67' corn at a rate of 30,200 seeds/acre, on May 4, 2000. Pioneer '9305' soybeans were planted at a depth of 2 in in organic and conventional plots at a rate of 170,000 seeds/acre on May 15, 2000. 'Jerry' oats were underseeded with Pioneer '53H81' alfalfa at a depth of 0.5 in. and at a rate of 3.2 bushels/acre and 20lbs/acre, respectively, on March 29, 2000. Following harvest of the organic corn plots in 1999, winter rye was no-till drilled at a rate of 1 bu/acre on October 26, 1999. A hay crop (alfalfa, fescue and oats), seeded in 1998 in the 30-ft border strips around each plot and around the perimeter of the experiment, was periodically mowed and maintained as the required buffer between conventional and organic production, per certification standards.

Fertilization scheme. The fertilization goal in this study was to apply equal rates of nutrients in each treatment. Compost was applied to organic corn plots at a rate of 12 tons/acre on April 4, 2000. Oat plots were fertilized with compost at 4 tons/acre, on March 29, 2000. Conventional corn plots were fertilized April 24 with 28% urea at 125lbs/acreN.

Pest management and sampling. The following pest management applications were made in the 2000 season, according to local practices. Harness® and Atrazine®, both at 2 pts/acre, were applied to conventional corn plots on April 24, 2000. Conventional corn plots were also sprayed on May 25 with Buctril® (1pt/acre), Accent (67 oz/ acre), AMS (1.25 lbs/acre), and NIS® .(25 pt/acre). Conventional soybean plots were sprayed with Prowl® at 3pts/acre on May 16, 2000, and 2 pts/acre each of Galaxy®, Prestige®, COC®, and AMS® on June 14.

Organic corn plots were harrowed on May 10 and field cultivated on May 23. On May 30, corn plots were rotary hoed, then cultivated on June 1 and June 23, 2000. Organic soybeans were harrowed on May 22, rotary hoed on May 30, and cultivated on June 7, June 19 and 30, 2000.

Weed counts were taken on June 2 and June 30 in corn and soybean plots using square meter quadrats at three randomly selected areas within a plot. Corn borer populations were monitored on July 10. Soybean cyst nematode sampling occurred on August 30 by collecting 1 pint of soil from each soybean plot to a 6 inch depth. Samples were then analyses for SCN populations at the Plant Disease Clinic at ISU.

Plant performance indicators. Stalk nitrate sampling occurred on October 8, 2000, by following methods of Blackmer and Mallarino. All tissue samples were analyzed in the USDA-ARS National Soil Tilth Laboratory, Ames, IA. Oat plots were combined on July 14. Corn and soybeans were harvested on October 9, 2000. Samples were collected from each plot for grain analysis. Corn grain quality analyses for protein, oil and starch was conducted at the ISU Grain quality lab for each corn and soybean plot.

Soil Health Indicators. Soil sampling occurred on April 21, 1999, at pre-plowing. Post-harvest soil sampling occurred on November 12, 1999. In 2000, soils were sampled post-harvest on November 12. Five intact soil cores, 7.5 cm in diameter, were collected to a depth of 0-7.5, 7.5-15 and 15-30 cm from five randomly located points in each of the 40 plots in the April and November sampling. Soils were analyzed for carbon, nitrogen and key elements of soil health, according to the methods of Cambardella and Elliott (2).

Results and Discussion

Plant performance. There were no significant differences between organic and conventional yields in corn or soybeans. Organic corn averaged 144 bu/acre and conventional corn averaged 141 bu/acre (Figure 1). Organic soybeans averaged 37 bu/acre while conventional soybeans averaged 40 bu/acre (Figure 2). Oats yielded 62 bu/acre with .63 tons/acre of straw (Figure 3). There was no significant difference in oat yields from oat plots previously in alfalfa (1998) compared with plots having no alfalfa in the rotation. Organic alfalfa hay yielded an average of 3.52 tons/acre over four harvest dates, with the greatest harvest on May 22 (Figure 4).

Weed populations were significantly greater in organic corn and soybean plots compared to conventional plots. Early grass (Figure 5) and broadleaf weed populations (Figure 6) were greater in the organic corn plots. In soybean plots, early grass (Figure 7) and broadleaf weed populations (Figure 8) were greater in the organic plots. Later counts demonstrated the same effect (Figures 9 and 10). Additional rye in the soybean system (i.e., the soybean-rye rotation, which contained rye for 12 months over a three-year period, compared with 4 months in the other organic rotations), led to significantly less weed pressure in this rotation. Because rye was not grown for an entire season, this rotation was disallowed for organic certification in 2000, and was changed to a soybean-wheat rotation, where wheat will be harvested in alternate years. Conventional corn plots had statistically higher plant populations than organic plots on June 2 and 30 ($P = 0.006$ and $P = 0.03$). On June 2, the mean conventional corn stand was 27,000 plants/acre and organic plots averaged 24,000 plants/acre. On June 30, an average of 28,000 plants/acre were counted in conventional plots, compared with 24,500 plants/acre in the organic plots. Stand counts were not significantly different in organic and conventional soybean plots. The mean soybean stand was 117,000 plants/acre on June 2 and 113,500 plants/acre on June 30.

Grain analysis. Organic soybeans had significantly higher levels of protein ($P = 0.0005$) in 2000, and significantly lower levels of oil ($P = 0.004$), and carbohydrates ($P = 0.003$) compared with conventional soybeans (Figure 11). No significant differences were detected between conventional and organic corn samples for carbohydrates, protein, oil and starch content (Figure 12).

Acknowledgements

We would like to thank the Leopold Center for Sustainable Agriculture for their support of the Neely-Kinyon LTAR site. We thank the Neely-Kinyon Farm Association for their input and support. Thanks also go to Tad Day, Jody Omacht, Heather Friedrich, Rhonda Graef, Andrea McKern, Jenny Petersen , Fransiska Yulianti, Ellen Cook, Maureen Morton, E. Hernandez, Emily Ford, and Bob Turnbull for their help on production and analytical aspects of this project. We also thank Jim Boes and Curtis Bennett of the Heartland Organic Marketing Cooperative for their exceptional support, advice and seed trade. Appreciation is expressed to the following ISU professors and staff who provided support and assistance on this project: Mike Duffy, Mark Honeyman and Bernie Havlovic, Charlie Brummer, Matt Liebman, Ken Moore, John Obrycki, Mark Hanna, Greg Tylka and Gary Munkvold, Tom Richard, Jerry DeWitt and Clark McGrath. For offering resources and coordinating field days, thanks to Kathy Rohrig and Deb Hall. Thanks also to Charles Hurburgh and the ISU Grain Quality Lab for grain analysis, and to Eric Gross of Pioneer Hi-Bred International for providing seeds for this study.

References

1. Blackmer, A.M. and A.P. Mallarino. 1996. Cornstalk testing to evaluate nitrogen management. ISU Pm-1584, Iowa State University, Ames, IA.
2. Cambardella, C. A. and E. T. Elliott. 1992. Particulate organic matter changes across a grassland cultivation sequence. Soil Sci. Soc. Am. J. 56:777-783.

Figure 1. 2000 LTAR corn yields.

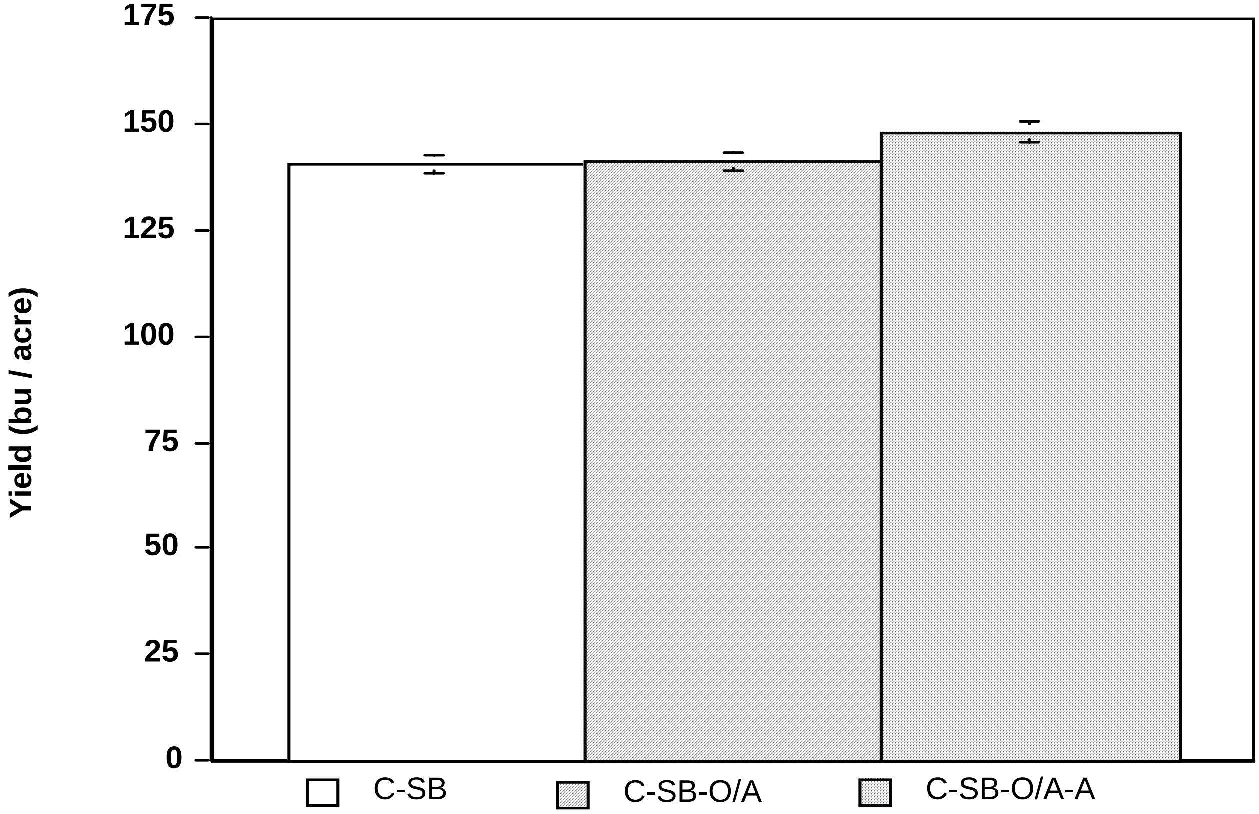
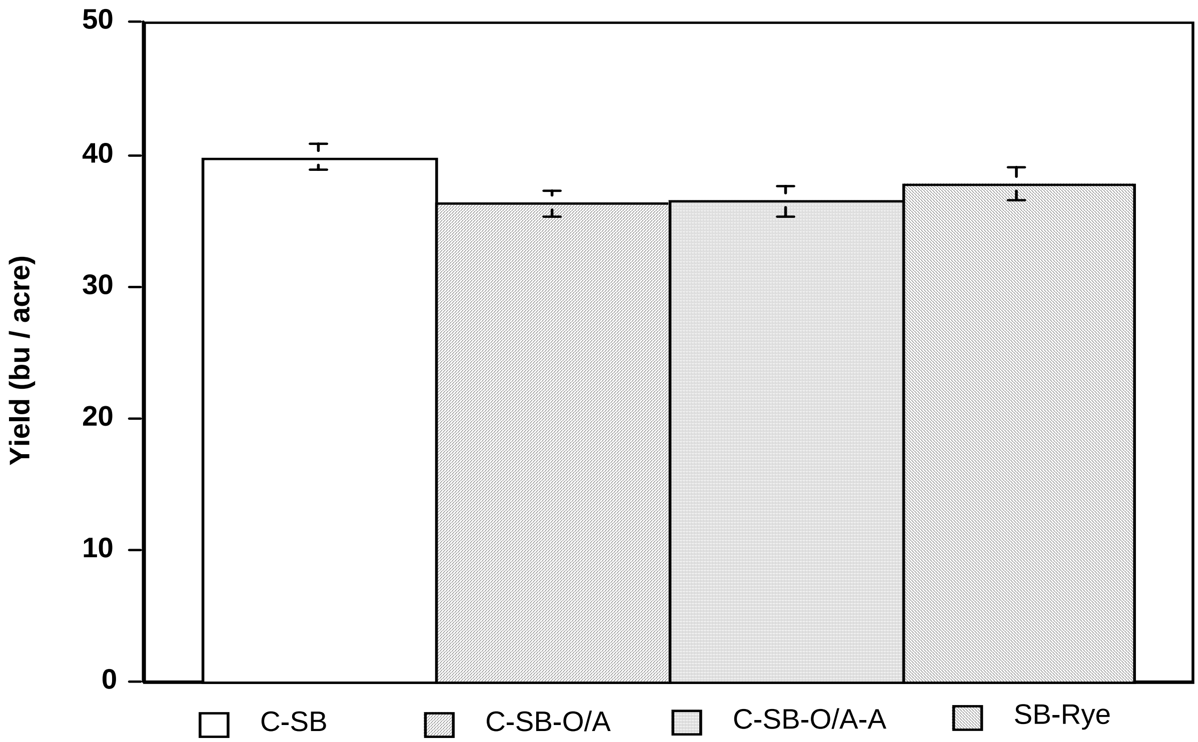


Figure 2. LTAR soybeans yields, 2000.



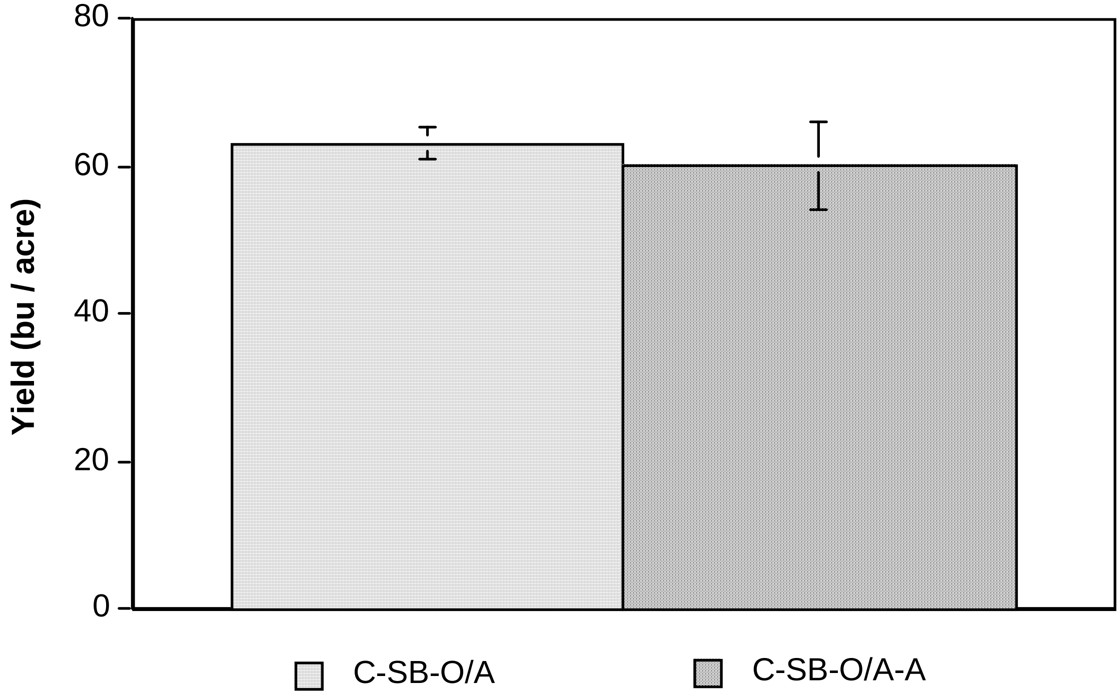


Figure 3. 2000, LTAR average oat yields.

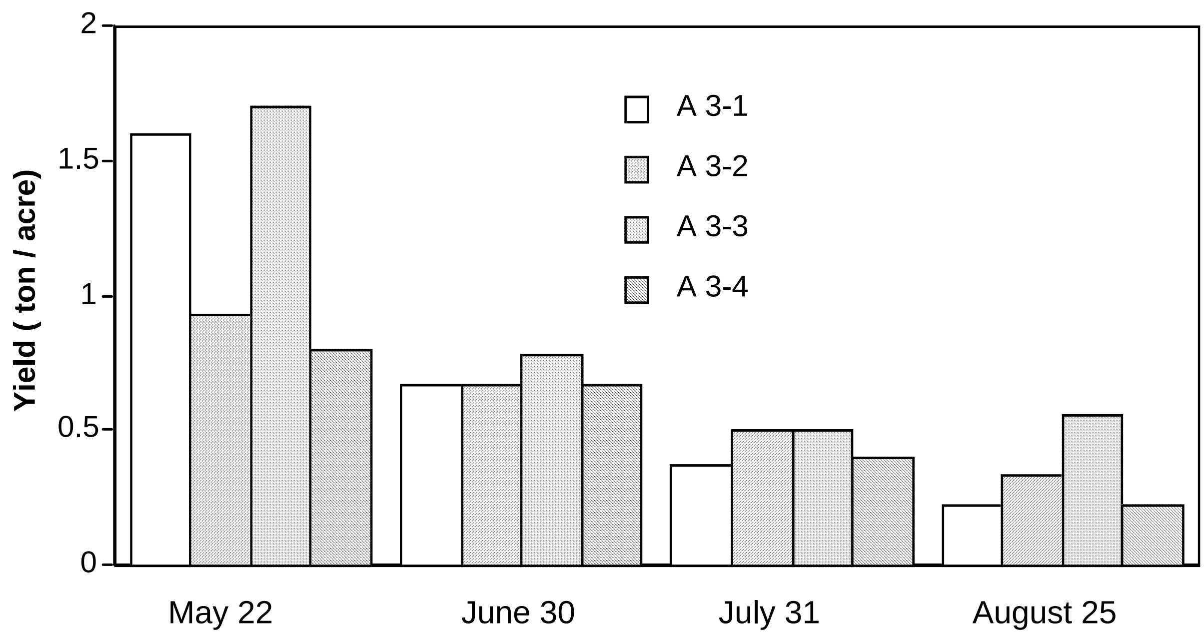


Figure 4. 2000 LTAR, average hay harvest over 4 dates.

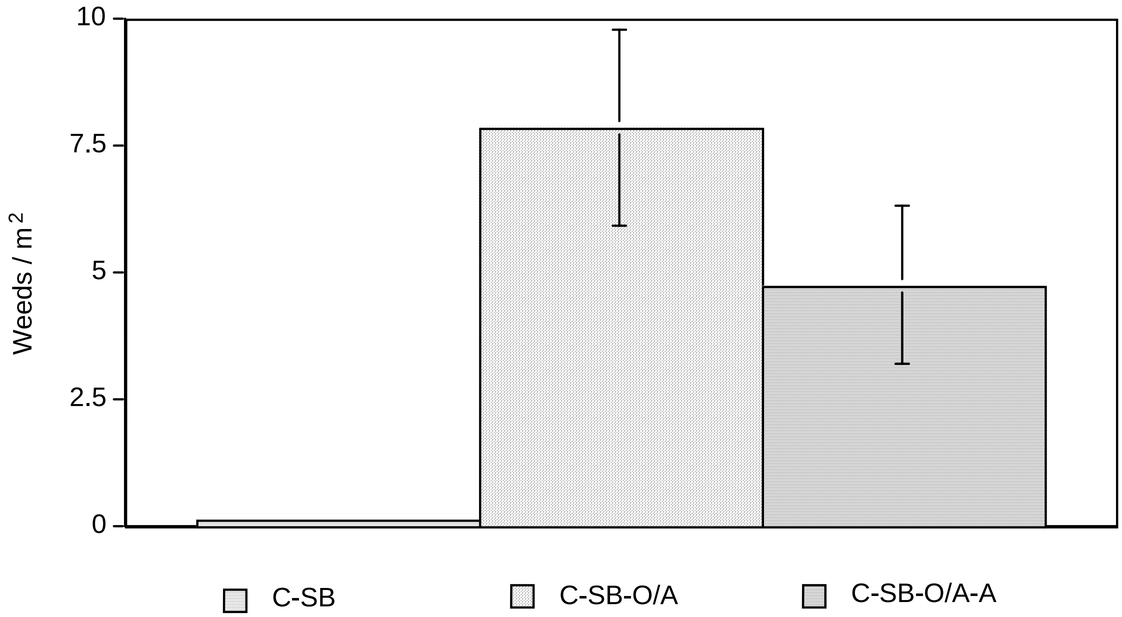


Figure 5. 2000 LTAR corn, grass weeds/m^2, June 2.

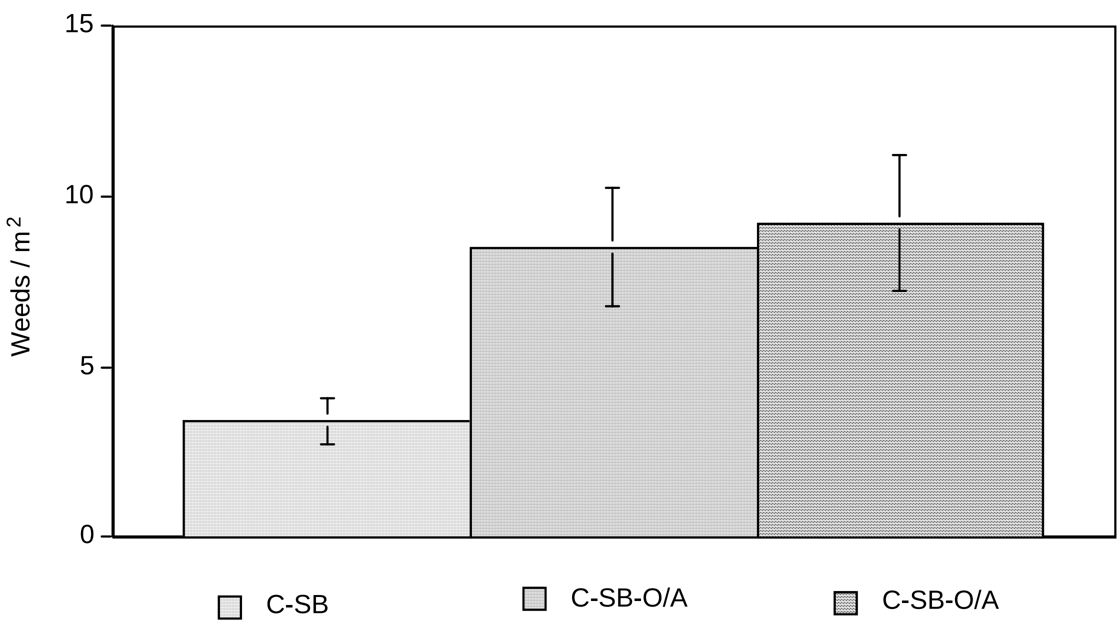


Figure 6. 2000, LTAR corn, broadleaves/m^2, June 30.

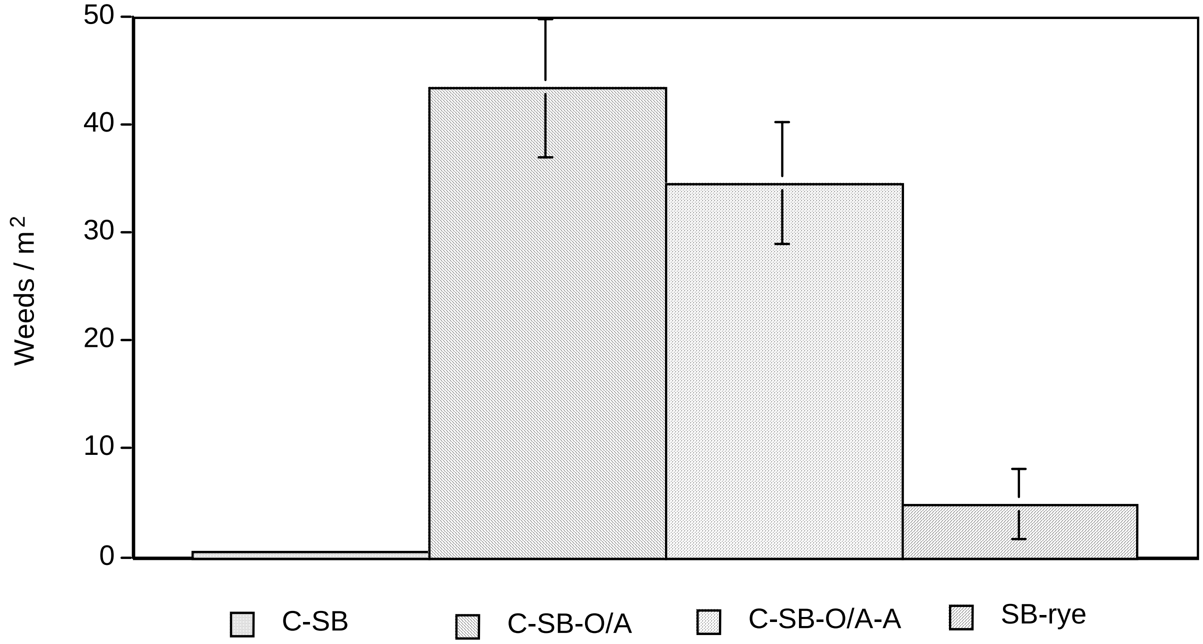


Figure 7. 2000 LTAR soybeans grasses/m^2, June 2.

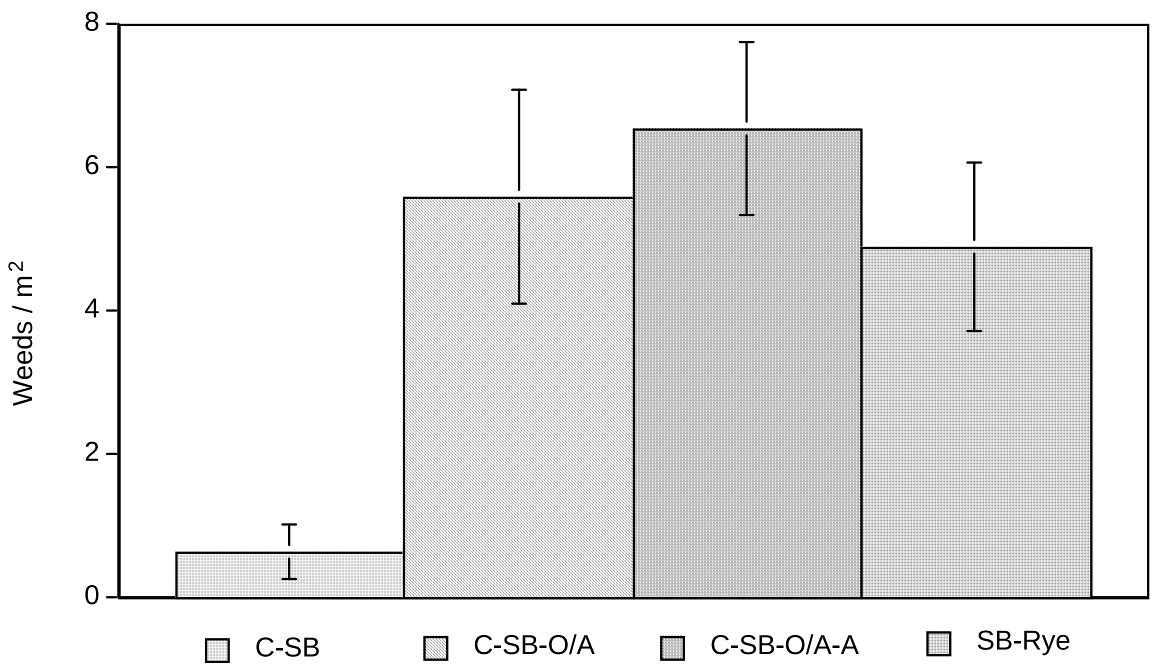
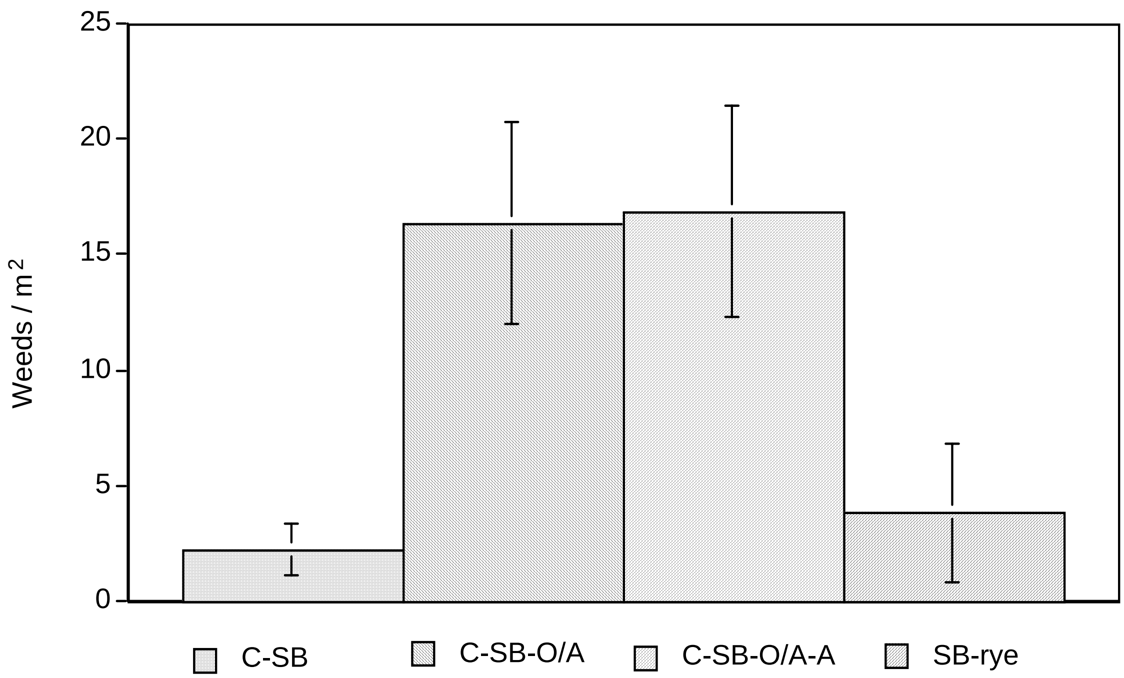


Figure 8. 2000 LTAR soybeans broadleaves/m^2, June 2.



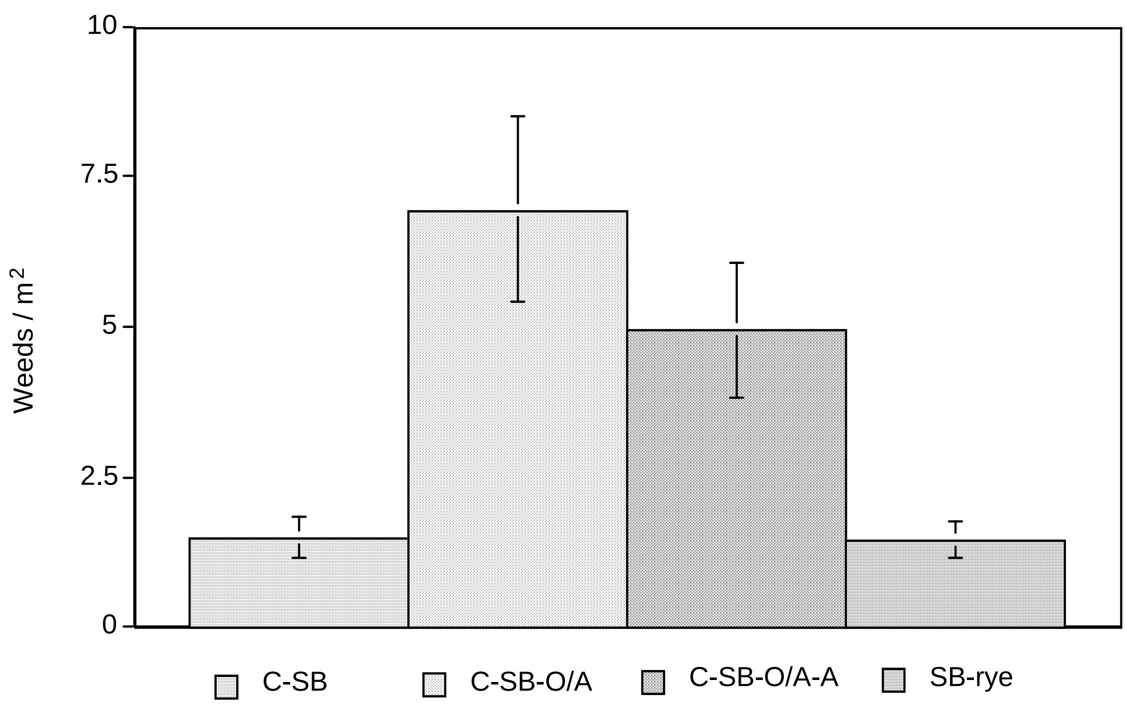


Figure 10. 2000 LTAR soybeans grasses/m^2, June 30.

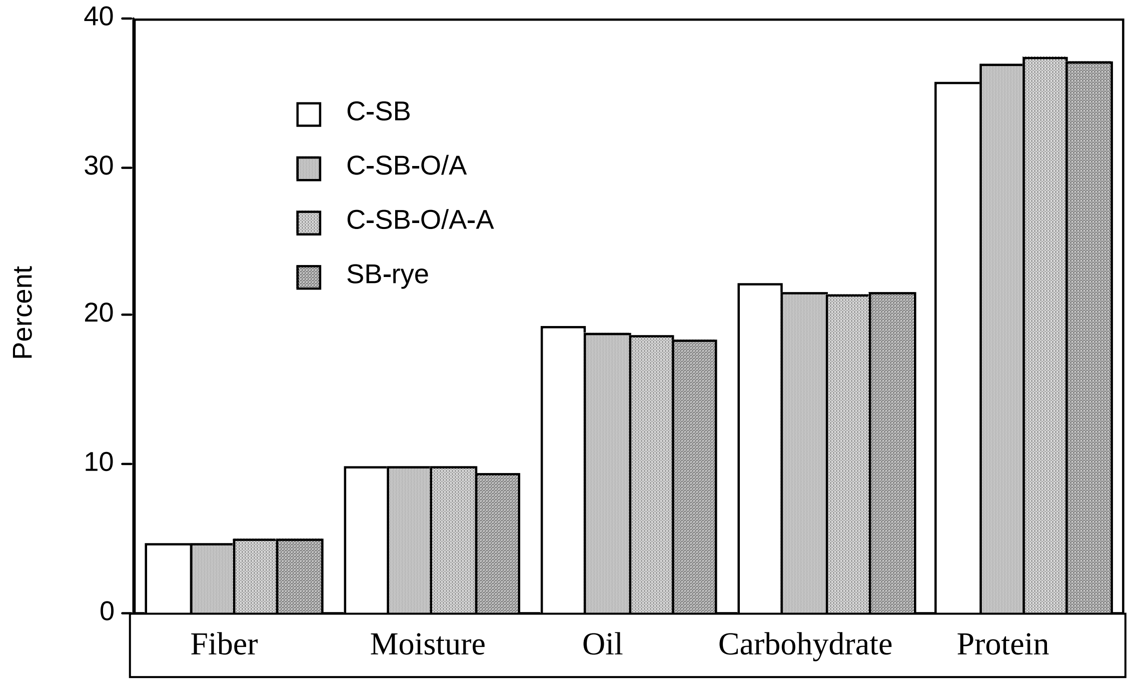


Figure 11. 2000 LTAR Soybean grain quality.

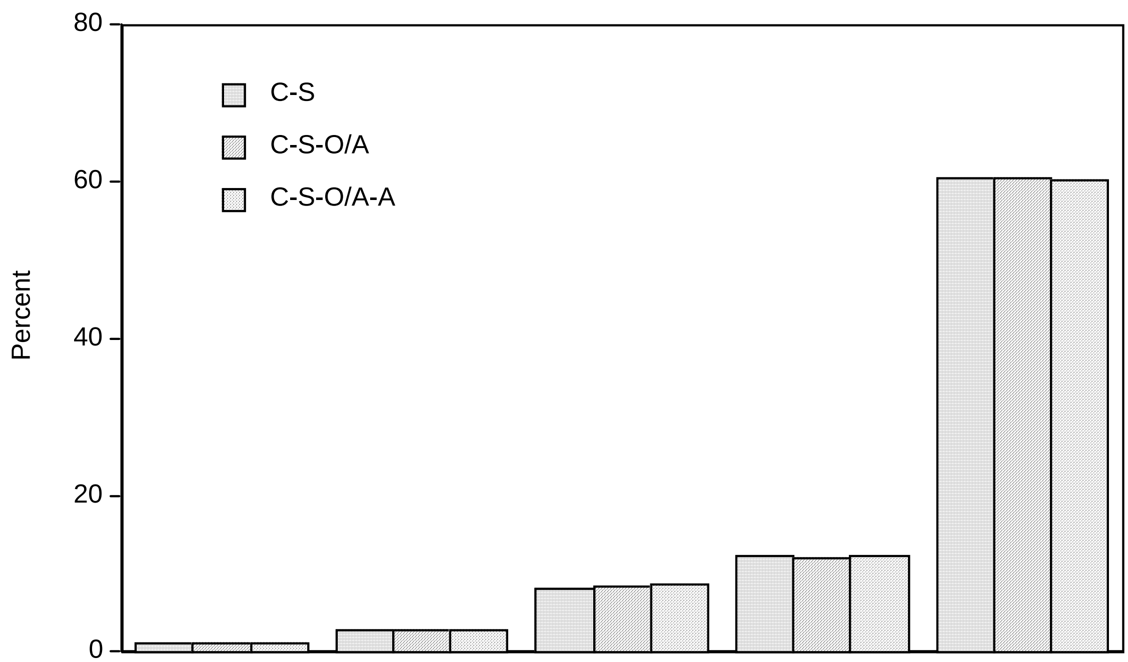


Figure 12. 2000 Corn Grain Quality Analysis