ORGANIC FARMING RESEARCH FOUNDATION

Project Report Summary

BREEDING FOR WEED MANAGEMENT IN ORGANIC FIELD CORN

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Methods to breed field corn that competes better with weeds on organic farms

On organic farms weeds can be a major problem in growing field corn, especially in cool wet springs when weeds in the row are not controlled on time. When weeds get out of hand they can reduce corn yields and their seed bank can assure higher weed pressure in subsequent years. Surveys of organic farmers in the Upper Midwest suggest a need to develop corn varieties that compete better with weeds. There is little evidence in the scientific literature that it is possible to breed corn with that capability. However, it is commonly thought that corn varieties that develop a tall, dense canopy shade the most and should be the most competitive. In the season of 2002 researchers at Michael Fields Agricultural Institute (MFAI) gained some evidence that by breeding under organic farming conditions, we may have unintentionally selected corn with an enhanced ability to suppress weeds. We also hypothesize that this competitive ability may be caused more by what is going on in the soil than by the canopy, and that the ability to suppress weeds can be inherited.

Objectives

In 2006 researchers at MFAI tested methods for evaluating corn for its ability to compete with weeds. Specific project objectives were to:

1) Develop practical ways to select corn both for the ability to suppress weeds and for resisting the yield reduction associated with the presence of weeds;

2) Select corn for these abilities from populations that yield well when crossed together.

Above: Corn stand demonstrating elements of growth type we are seeking: vigorous, lax leaved, leafy, as well as allelopathic to compete better with weeds. We also look for uniform maturity, good roots, strong stalks, good stay-green, and timely grain dry-down.

Methods

We carried out two side-by-side experiments. The first experiment evaluated 181 different varieties we have been developing and their hybrids. These populations were classified on the basis of their pedigrees into two heterotic groups, a "stiff stalk" and a "non-stiff stalk" group. We made crosses between these two groups because they are regarded as complementary, resulting in hybrid vigor and yield increase over parental yields. We conducted crosses between varieties (varietal hybrids), crosses between our varieties and commercial inbreds (topcrosses), and hybrids bred under conventional conditions. The varieties listed were mostly bred at MFAI for four to six years. Many crosses were with Nokomis Gold (NG) which has been under selection at MFAI for 16 years.

The second experiment tested the competitiveness of hybrids by selecting the lines of each variety that do best in combination with a bulk combination of the other lines. Experiment 2 contained 104 entries and three replications. This included four conventionally bred hybrids and varietal hybrids made by crossing numerous lines.

To facilitate the test for weed competitiveness, sunflowers were planted into the growing corn, to create an even "weed" pressure and a more uniform response variable to measure corn competitiveness.

Customary weed control practices were applied on the organic sites: harrow, rotary hoe and inter-row cultivation. In addition, three additional treatments were applied to each plot:

1) Hand weeding a meter-long strip in the plot when the corn was about 6 in. tall;

2) Hand weeding a 2nd meter-long strip and planting sunflowers between corn plants; and

3) Allowing whatever weeds were there to grow on the rest of the plot without additional control measures.

Weeds were visually scored in September as percent of total green in the lower 1m of the canopy in the unweeded portions of the plot. Dry matter of the sunflowers was also meas-

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Project Notes

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ured in the fall. Grain yield was determined by hand harvesting meter-long subplots and by harvesting the rest of the plot afterwards with a plot combine.

Key Results & Discussion

- **Both the visual scoring and utilization of sunflowers as a test weed appeared to be practical methods for assessing competitiveness of corn entries**. The sunflowers provided a uniform "weed" in areas where native weeds produced patchy irregular stands.

- **The ability of the populations that were bred at MFAI under organic conditions to compete with weeds appeared to be superior to commercial organic hybrids.** Weed foliage density scores were 2-3 times higher for commercial organic hybrids than for MFAI hybrids. Sunflowers grew twice as heavy in mixture with the commercial hybrids than with the MFAI hybrids.

- **Yield performance among hybrids differed strongly according to whether the corn was grown under conventional conditions, organic conditions without weeds, or organic with weeds.** Therefore, it is probably best to test varieties for organic production in organic fields where there are moderate populations of weeds because those are conditions that are most realistic.

- Crosses between populations (varietal hybrids) generally averaged somewhat lower yields than the topcrosses or commercial hybrids. **However, some varietal hybrids produced similar yields to the highest yielding commercial hybrids.**

In general there was a substantial decrease in yield associated with the presence of weeds. However, some high yielding hybrids responded very negatively to the presence of weeds whereas some of our hybrids did not.

The study was useful and applicable to other organic farms. Our project identified which corn varieties compete best with weeds, and developed new methods for assessing competition. Next steps would include:

1) Looking at a small set of cultivars and attempting to understand the nature of the competitive mechanism;

2) Refining our methods for selecting corn so as to improve its ability to compete with weeds; and

3) Applying such methods to breed corn with high yield potential that is very competitive with weeds and is little affected by them in terms of yield. ❧

Above: Many commercial hybrids, as shown here, have upright leaves and allow more light to reach weeds. Organic farmers must depend more on high populations for weed control.

Walter Goldstein's complete report (11 pages) includes 4 data tables. The table below is compiled from Tables 1 and 2 from the report. Please refer to the full report at ofrf.org for additional data.

Weed trial in Experiment 1, 2006.

	No. of crosses tested	weed score %	weight grams/ sunflower	grain yield hand weeded bu/a	grain yield with weeds bu/a
Cross conventionally bred inbreds (single cross hybrids)					
Blue River hybrids	4	24	2.2	168	130
Ohio State Univ. test hybrids	20	17	1.7	203	145
average		**20**	**1.9**	**185**	**138**
Cross conventionally bred inbred with MF populations (topcrosses)					
LH185 x MF	3	4	1.6	196	137
LH198 x MF	4	16	0.6	184	138
FR1064 x MF	8	22	1.1	166	128
FR2108 x MF	4	12	1.0	182	136
FR3911 x MF	7	10	0.6	171	131
FR6943 x MF	3	13	0.8	152	107
average		**13**	**0.9**	**175**	**129**
Cross conventionally bred population x MF populations (varietal hybrids)					
CGSS x MF	8	11	1.4	138	106
HPALC x MF	7	10	1.8	155	121
average		**11**	**1.6**	**146**	**113**
Cross of MF population x MF populations (varietal hybrids)					
BS28 x MF	9	10	0.8	142	118
AR1635 x MF	8	10	1.5	155	122
AR21 x MF	7	8	1.7	155	112
FS97 x MF	9	9	0.3	136	116
AR21B x MF	11	7	1.0	148	121
AR35B x MF	9	7	1.3	166	115
FS x MF	8	12	1.1	142	120
UR05B x MF	9	9	1.5	156	123
NG x MF	18	8	0.9	149	113
average		**9**	**1.1**	**150**	**118**

Notes: Blue River hybrids are a commercially bred organic line. Ohio State test hybrids are a conventional line. MF refers to varieties developed at the Michael Fields Agricultural Institute.