Vegetable Crops Research Report 1989

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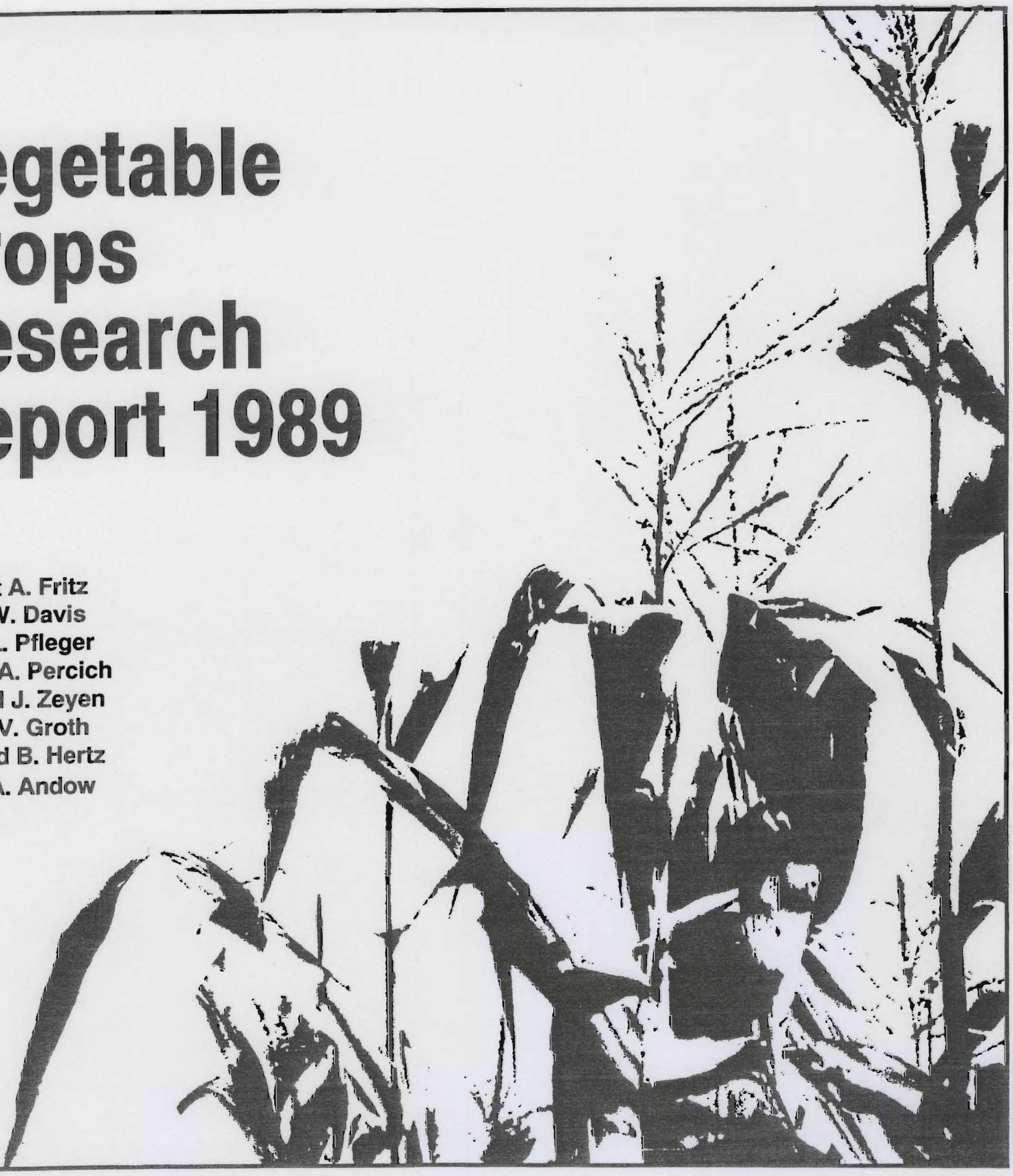

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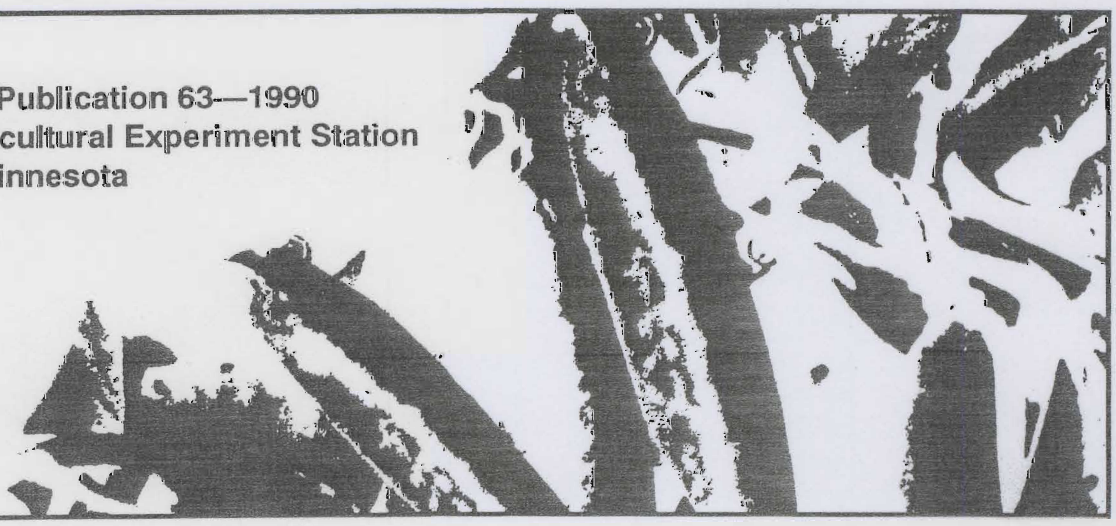

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CONTENTS

SOIL ECOLOGY WORKING GROUP: INVESTIGATIONS OF COMMON ROOT ROT OF PEA, CAUSED BY APHANOMYCES EUTEICHES

J. Percich, R. Allmaras, D. Davis, V. Fritz, D. Malvick
F. Pfleger and C. Rosen

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INTRODUCTION

The Soil Ecology Working Group was formed in 1988 as an interdisciplinary research team involving the Departments of Horticulture, Plant Pathology, and Soil Science, and the Southern Experiment Station. The group is currently investigating common root rot of pea, caused by Aphanomyces euteiches which may serve as a model for the ecological studies of other soil-borne fungal pathogens such as Fusarium, Pythium, Phytopthora and Rhizoctonia species. These organisms individually or together cause annual economic losses in many vegetables and other field crops in the Midwest. The research team is studying the role(s) of alternate cropping, tillage practices and plant resistance on the survival, incidence and severity of common root rot in peas. This interdisciplinary approach will result in needed information for a more sustainable agriculture not only for pea production but for other crops as well that are affected by soil-borne pathogens.

Common root rot has been a major impediment to the improvement of pea yields in the Midwest for a number of decades, rendering fields unfit for pea production after as few as six consecutive years. This disease represents the single most important production related problem for peas through the entire vegetable processing industry in both Minnesota and Wisconsin.

The Soil Ecology Working Group is unique to the Midwest, and perhaps the country. The developing cooperation between staff and projected sharing of facilities on the Saint Paul Campus and the Southern Experiment Station at Wascea offer many advantages for research and extension activities.

COMMON ROOT ROT RESEARCH OBJECTIVES: LONG-TERM

1. Alternate Cropping and Soil Amendments (V. Fritz and C. Rosen).

Investigators have reported that disease severity can be reduced by the of growing oats and crops in the cabbage family prior to planting peas. Also, amendments may play a role in reducing fungal populations and/or the ability of the fungus to cause infection. The effects of alternate cropping and various soil amendments are not clearly understood.

2. Soil compaction and tillage practices (R. Allmaras and C. Rosen).

Limited attention has been given to the effects of tillage practices and soil compaction as they affect incidence and severity of disease development. Plowpans and other zones of compaction may not only restrict pea root development but may also create an environment favorable for infection and/or disease development. The possibility will be evaluated that inoculum concentration may be dependent on the uneven distribution of organic residues produced in the soil during primary tillage, such as near the plow pan in mold board plowing.

3. Developing disease resistant pea germplasm (D. Davis & F. Pfleger).

Germplasm development has lead to resistant varieties in many crops, but has been only marginally successful in combating pea root rot. However, there are a number of breeding lines with some resistance available for study. Several susceptible varieties will be used as test genotypes in studies involving compaction, tillage practice and soil incorporation of crop residue. Differential behavior of genotypes may lead to improved screening techniques in breeding.

4. Ecology of *Aphanomyces euteiches* (D. Malvick, J. Percich, & F. Pfleger).

Many questions remain unanswered concerning the relationship between the size of the *A. euteiches* population in the soil and actual numbers capable, at any one time, of infecting a susceptible plant. Little is known about the influence of tillage practices and residue incorporation on the pathogen's distribution, survival, or ability to infect successfully and cause disease. The roles of antagonistic and sustaining host species on the pathogen are not well understood. Also, new techniques need to be developed for rapid and accurate determination of both total and infective populations of the pathogen in the soil.

BRIEF SUMMARY OF RESEARCH ACTIVITIES - 1989:

1. Influence of oat residue and compaction on the severity of common pea root rot. (R. Allmaras, D. Davis, V. Fritz, F. Pfleger and C. Rosen)

Green peas, cv. Target, were sown in soil naturally infested with *Aphanomyces euteiches*, causal organism of common pea root rot at the Southern Experiment Station at Waseca, Minnesota during 1988 and 1989. There were four treatments, each replicated four times. Treatments consisted of soil which was compacted or non-compacted and a previous crop of peas followed by oats (green manure crop) or peas followed by fallow. Percent root rot severity was determined at peak bloom by using a 1 (0 - 10%) to 5 (76 - 100%) scale. Vine fresh weight was also determined at peak bloom Peas following oats as a green manure had significantly (P=0.05) greater vine weight and lower disease severity than peas following fallow. Compaction reduced vine weight and increased disease severity. The influence of oats on reducing disease severity and increasing vine weight was more pronounced when soil was non-compacted.

The following conclusions were drawn from these studies:

a. Soil compaction reduced pea growth beginning at the 2-3 node stage and continued through the peak bloom.

b. Oats appeared to suppress disease symptoms at the 3-5 node stage.

c. *Aphanomyces* root rot severity appeared to be enhanced in compacted vs. non-compacted soil.

d. Soil compaction increased water logging and decreased internal drainage.

e. Oats preceding peas significantly reduced root rot and increased vine weights and adjusted yields.

2. Evaluation of various techniques to enumerate oospores of *Aphanomyces euteiches* from infested soil. (D. Malvick and J. Percich)

Many questions remain unanswered concerning *Aphanomyces euteiches* ability to infect, increase, survive, and move in soil under various crop rotation systems and tillage practices. Also, the development of new techniques or the improvement of current methods for rapidly and accurately determining both total and infective populations of the pathogen is needed. Studies of pathogen ecology are underway at both the Saint Paul Campus and the Southern Minnesota Experiment Station. Methods of oospore enumeration currently being evaluated are the following:

A. Most Probable Number Technique (MPN).

Principle. This procedure provides a statistical estimate of the number of infectious propagules (oospores) in a soil sample; it is based on numbers of plants infected at various soil dilutions.

Preliminary results. The MPN has questionable sensitivity and reproducibility. Also, it is very laborious, and soils which have high clay and organic components create problems in producing accurate soil dilutions. However, the MPN technique may offer the possibility of an accurate and quick diagnosis of soil proneness to common root rot.

B. Rolled towel assay.

Principle. Soil is applied directly to roots of pea seedlings. Those soils containing higher populations of Aphanomyces euteiches will result in more seedling infection and faster symptom expressionthan soils with lower populations.

Problems. The rolled towel assay shares many of the same difficulties as the MPN technique, except, that the assay is simple and less time consuming.

C. Counting oospores via floatation and filtration.

Principle. Infested soil is blended into a slurry and placed in a dense solution of sucrose (or glycerol). The solution is centrifuged to remove most of the soil particles and the remaining supernatant is filtered to remove the oospores; then oospores trapped on the filters are counted.

Preliminary results. Large amounts of soil tend to be trapped on filters along with oospores. Various methods to separate oospores from soil components by floatation are being evaluated.

SOIL ECOLOGY WORKING GROUP RESEARCH ACTIVITIES FOR THE 1990 GROWING SEASON

The Soil Ecology Working Group is planning to continue its investigations into the ecology of *Aphanomyces euteiches* in 1990 by concentrating on the following areas:

1. Further evaluate the role(s) of oats as a green manure preceding peas on disease severity.

2. Study the effects of tillage practices on pea development, pathogen populations and disease severity.

3. Identify a method to accurately and rapidly determine oospore populations in soil.

4. Study oospore behavior on the roots of pea and other sustaining hosts.

EVALUATION OF PEA CULTIVARS AND BREEDING MATERIAL

Dave Davis, Vince Fritz, Frank Pfleger

University of Minnesota, Southern Experiment Station
Waseca, 1989

The attached tables summarize the results from the 1989 evaluations in the pea root rot nursery. Entries were planted on May 15 into moist soil at the rate of 100 seeds per 20-foot plot row. After emergence and stand establishment, the plots were sprinkle irrigated heavily and frequently to encourage infection and disease development. Irrigation was terminated beginning about one week prebloom. The degree of subsequent drought stress was dependent at least in part on the amount of root disease.

Data were taken on % stand, date of 50% bloom, estimated prime harvest date for canning/freezing and root rot score. In addition, a dry seed yield (grams) was obtained from the harvest of a 10-foot center length on the 4-row replicated plots.

Root rot evaluation was obtained by scoring the plants for foliar symptoms on both July 7 and July 13. Dr. John Kraft, Plant Pathologist, USDA, Prosser, WA, assisted in the root rot scoring. A 1 to 5 scoring system was used, where 0 = no damage; 1 = 1-25% damage (1-25% dead or showing symptoms); 2 = 26-50% damage; 3 = 51-75% damage; 4 = 76-100% damage; 5 = all dead.

In September, seeds of 12 of the best entries were planted in the greenhouse and some 400 crosses were made among these entries. This established a new (and higher) base population in the breeding program. Choice of entries for these hybridizations was based also on plant type (normal foliage; semi-leafless), earliness, pod type (normal, snap pod, snow pod), parentage, and the results of previous disease evaluation here and /or in other states. Some of the entries chosen were resistant to diseases other than common root rot, such as fusarium wilt, powdery mildew, and pea seedborne mosaic. Thus, the use of the chosen entries as parents gives us an opportunity to recombine different useful genes for disease resistance and useful plant and pod traits.

Seeds from these crosses were harvested in December and planted in the greenhouse in January. Harvest of seed from these hybrid plants in April will provide F_2 seed (the segregating generation) for planting back into the root rot nursery next May. Selection from the nursery next July will be based primarily on individual plants.

Pea Root Rot Evaluations
University of Minnesota, Southern Experiment Station
Waseca, 1989

Four-Row Replicated Entries

Three Reps

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
1	CS 9727-10	62	82	83	6/25	7/11	420	486	1254	2+	3+	1+	1+	3	3
2	CS 9811-7	88	91	86	6/25	7/11	666	928	1068	3+	2+	1+	4	2	2+
3	CS 9711-7-1	87	88	69	6/24	7/11	376	530	558	4	3+	3+	4+	3+	4
4	CS 9747-2	85	86	55	6/25	7/13	304	346	234	4	3+	4	4+	4	3
5	CS Argona	83	79	83	6/25	7/10	640	618	1046	2+	2+	1+	3+	2+	1+
6	CS 517-4	83	90	70	6/26	7/15	206	428	144	4	3+	4	4+	4	4+
7	CS 8440	86	78	86	6/26	7/14	130	464	690	4+	3+	3	4+	3	3+
8	CS 9798-3	82	81	66	6/27	7/12	834	208	240	2	4	4	1+	3+	4
9	CS 9823-12	89	88	81	6/26	7/10	988	382	968	1+	4	1+	1+	4	1+
10	CS 77224	84	83	90	6/29	7/13	596	720	976	3+	2+	2	3	3	2
11	CS 11154Bc4F_2	85	79	81	6/30	7/11	738	302	712	2+	3+	2+	3+	4+	3+
12	CS 7705-32	87	87	86	6/28	7/10	684	160	224	2+	5	4	3+	5	5
13	CS 9000	88	87	87	6/30	7/11	596	182	442	3	4+	3+	3	4+	4+
14	CS 10053-9	86	85	76	7/3	7/16	352	954	400	1+	1+	3	3	2	2+
15	CS 512-2	79	81	85	7/1	7/15	556	492	594	3	3+	2	3+	4+	3
16	Alaska M 163	80	85	80	6/19	7/5	94	486	492	2	4+	3+			
17	Early Sweet 41	90	88	83	6/19	7/5	164	432	644	2+	2	2+			

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
18	Canners 8221 EP	83	78	56	6/28	7/12	590	752	252	3	1+	3	3+	2+	3
19	Columbia	92	76	81	6/25	7/11	822	822	1048	1+	3	1	2	2	1+
20	Sunfire	87	88	89	6/28	7/11	1204	756	1108	1+	2+	2	1+	3	2+
21	Bounty	78	81	77	6/26	7/11	866	408	930	2	3	2	2+	3+	3
22	Nomad	90	93	84	7/1	7/13	1100	818	530	2	2	3	1+	2+	4
23	Span	90	87	80	6/21	7/9	834	558	864	2+	3	1+			
24	88MF 1231	56	42	58	7/1	7/14				2	2	2	2	3	
25	88MF 1231	55	61	61	6/30	7/14				1+	4	1+	2	4	
26	88MF 1231	70	65	58	7/1	7/14				1+	1+	2+	2+	2	
93	1150 E.S.	90	83	93	6/21	7/7	832	800	794	2+	1+	1+			
94	Sultan	87	87	92	6/29	7/12	838	650	782	2+	2+	2	3	3+	3
95	Payload	90	91	92	6/20	7/6	556	532	960	1+	2+	3			
	Single-Row Non-replicated Entries														
27	PI 166159	74			7/11					4			5		
28	MN 108	72			7/5					1			1+		
29	79-2022	87			6/30					1+			1+		
30	88-149	86			6/30					2			2+		
31	88-186	90			6/30					2+			3		
32	88-270	75			6/29					2			2+		
33	88-323	76			6/29					1+			2+		
34	88-325	86			6/24					1			1		

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
35	88-381	77			7/5					2+			4		
36	88-385	81			7/1					2+			2+		
37	88-408	67			6/30					3			4		
38	88-425	93			6/25					1+			3		
39	88-427	83			6/29					2+			3		
40	88-438	92			6/30					1+			2+		
41	88-466	92			7/1					1			2		
42	88-479	83			6/29					3			3		
43	88-552	81			6/30					2+			3		
44	88-570	84			6/30					3			3		
45	88-589	88			6/29					2			2+		
46	88-604	87			6/29					1+			1+		
47	88-606	81			7/1					1			1+		
48	88-607	86			7/3					2			2+		
49	88-612	95			6/28					2			3+		
50	88-616	94			6/30					3			4		
51	88-659	92			7/1					2+			3+		
52	88-660	74			6/30					2			3		
53	88-668	86			6/27					1			1+		
54	88-767	90			6/29					3+			4		
55	88-780	94			7/2					3			4		
56	88-763	83			6/29					2			3		

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
57	88-781	88			7/6					1			1+		
58	88-790	90			6/28					1+			2+		
59	88-793	85			6/27					1+			2		
60	88-799	88			6/28					3			3		
61	88-830	82			6/28					2+			2+		
62	88-1058	78			7/1					2+			3		
63	88-1073	87			7/1					1			1+		
64	88-1074	95			7/5					1			1+		
65	88-1135	91			6/28					2+			2+		

Single-Row Replicated Entries

Three Reps

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
66	GG 512	92	82	86	6/27					2+	2	1+	2+	1+	
67	GG 613	94	83	89	6/28					2	2	1+			
68	SN 5	82	88	80	7/1					4	3	3	4	3+	3
69	Vantage	84	79	82	6/27					1+	1+	2+	2	2	3
70	Mini	89	83	84	6/27					3	3	2	4	3+	3+
71	88-27	85	91	86	6/29					2+	2+	1+	3+	3	3+
72	88-63	93	93	92	6/27					2	2	2	3	4	2+
73	88-125	97	90	93	6/29					1	2+	2	1+	3	2
74	88-462	83	68	84	7/1					1+	2+	3	2+	4+	
75	88-522	82	85	94	6/29					2+	3+	1+	2+	4+	2+

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
76	88-620	91	87	91	6/26					3+	3+	4	3+	4	4+
77	88-621	87	89	86	6/25					3+	3	3	3+	3+	4+
78	88-628	89	83	81	7/1					1	3	2	1+	3	4
79	88-750	87	82	90	7/1					1+	3	3+	2	4	4
80	88-781	87	75	87	7/6					1	1	2	1+	3+	1+
81	88-782	76	73	76	7/5					2	2	3	3	3	4
82	88-829	86	84	89	6/30					3	2	3+	3+	3	3+
83	88-841	86	87	81	6/30					2+	2+	2+	3+	3	4
84	88-846	62	75	56	6/30					2+	2+	3	2+	4	3+
85	88-848	83	81	91	6/27					2	3	2	3+	3+	
86	88-890	63	61	62	6/30					3+	3	3	3+	3+	4
87	88-892	80	85	82	6/29					3+	2+	2	4	3	2+
88	88-920	96	92	91	6/29					3	1+	2	4	3	3
89	88-965	82	90	72	6/28					2	3+	2+	2	4+	3
90	88-982	86	60	78	6/30					1+	1	1	1	1	1
91	88-985	81	84	85	7/1					1+	1	1+	1+	1+	2
92	88-1046	84	88	90	6/30					2+	2+	2	3	2	4
Two Reps															
96	88-1059	82	81		6/30					1+	3		2	3	
97	88-1062	85	95		7/2					1+	2			2	
98	88-1077	83	86		6/29					2+	2+		2+	3	

89MF	Variety or Line Seed Source	Stand A	Stand B	Stand C	50% Bloom	Harvest Date	Dry Seed Yield (g) A	Dry Seed Yield (g) B	Dry Seed Yield (g) C	Root Rot Score 7/7 A	Root Rot Score 7/7 B	Root Rot Score 7/7 C	Root Rot Score 7/13 A	Root Rot Score 7/13 B	Root Rot Score 7/13 C
99	88-1078	90	88		6/29					1+	1+		3	3	
100	88-1138	79	78		6/30					4	4		4+	4+	

planted 5/15; 20' plot length; 100 seeds/20'; Command herbicide; harvest date is estimated date of prime maturity for canning/freezing.

root rot scale: 0 = no damage; 1 = 1.25% damage (1-25% plants dead or showing symptoms); 2 = 26-50% damage; 3 = 51-75% damage; 4 = 76-100% damage; 5 = all dead.

SELECTIVE WEED CONTROL IN CANNING PEAS

Leonard B. Hertz and Vincent Fritz

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University of Minnesota

This study was conducted to evaluate several combinations of herbicides for weed control in canning peas. 'Canners 9901' pea seed was planted May 16, 1989 into a clay loam soil, pH 6.4 and 6.5% organic matter at the Southern Experiment Station, Waseca, MN. The plots were 7 by 30 ft, arranged in a randomized complete block, each with four replications. All herbicides were applied with a bicycle mounted CO_2 pressure sprayer. A visual rating of weed control was made on June 20. Weed populations were light and consisted of foxtail spp. (72%), redroot pigweed (15%), common lambsquarter (7%) and velvetleaf (6%). Application dates, sprayer settings, environmental conditions, and plant size are listed below:

Date	May 16	June 6
Treatment	PPI	EPO
Sprayer		
gpa	20	20
psi	40	40
Air temperature (F)	58	62
Wind (mph)	5	7
Sky	cloudy	clear
Pea		
size (nodes)	--	2-4
Weeds		
height (inches)	--	0.5-2
infestation		
broadleaves	--	$2/ft^2$
foxtail spp.	--	$6/ft^2$

Results of this study are summarized in the accompanying table. Several herbicides performed well, including clomazone, imazethapyr, and bentazon. Bentazon plus 28%N or Dash produced slight crop injury. There were no differences in weed control or pea injury when clomazone was deep or shallow incorporated.

Table. Weed control, crop injury, and yield of peas (Hertz and Fritz).

Treatment	Rate	Time of appl.[y]	Weed control Grft	Colq	Vele	Oval[x]	Pea inj.[w]	Yield
(lb/A)			(%)					(T/A)
Clomazone	0.5	PPIS	94	95	99	92	0	1.6
Clomazone	0.5	PPID	92	94	100	92	0	1.8
Clomazone	1.0	PPIS	95	97	100	95	0	1.9
Clomazone	1.0	PPID	98	97	100	97	0	1.6
Clom + trif	0.5+0.5	PPI	99	99	100	98	0	1.5
Clom + trif	1.0+0.5	PPI	99	99	100	98	0	1.4
Imazethapyr	0.063	PPI	97	100	100	97	0	1.6
Imazethapyr	0.094	PPI	96	100	100	96	0	1.6
Imazethapyr + trifluralin	0.063 0.5	PPI PPI	97	100	100	97	0	1.6
Imazethapyr + pendimethalin	0.063 0.75	PPI PPI	97	100	100	97	0	1.7
Imazethapyr + clomazone	0.063 0.5	PPI PPI	94	100	100	94	0	1.8
Cinmethylin + trifluralin	1.5 0.5	PPI PPI	97	100	100	97	0	1.4
Trifluralin	0.75	PPI	96	99	99	97	0	1.6
Trifluralin + bent + 28%N[z]	0.5 0.5	PPI EPO	94	100	99	94	0	1.7
Trifluralin + bent + COC[z]	0.5 0.5	PPI EPO	97	100	100	97	1	1.4
Trifluralin + bent + Dash[z]	0.5 0.5	PPI EPO	97	100	100	97	0	1.5
Bentazone + FMC46360 +COC	0.5 0.05	EPO EPO	97	100	100	97	1	1.5
Bentazone + FMC46360 +COC	0.5 0.075	EPO EPO	94	97	100	94	2	1.6
Weeded			100	100	100	100	0	1.7
Untreated			0	0	0	0	0	1.8
LSD(0.05)			15	3	1	15		0.3

[z]Additives: 28%N = aqueous nitrogen solution with urea and ammonium nitrate, 1 gal/A; COC = crop oil concentrate, 1 qt/A; Dash = crop oil concentrate (BASF), 1 qt/A.
[y]Time of application: PPIS = shallow incorporation; PPID = deep incorporation; EPO = early postemergence.
[x]Oval = Overall weed control.
[w]Inj. = Injury: 0 = none; 10 = peas dead.

HEAT TOLERANCE IN BEANS

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Introduction

Beans may suffer from high temperature (HT) stress in any region of the United States. Growing optimally at 78/68°F D/N, beans can suffer from the adverse affects of HT at any point of the growing season in Minnesota and Wisconsin. HT stress may play a small role during certain developmental periods and a much greater one during others.

It has been established that the period of greatest HT damage is that period during and immediately preceding bloom. Symptoms of extreme HT stress (95/86°F) during this period include the dropping of buds, flowers and small pods. Less stressful temperatures (90/82°F) will reduce the number of seeds per pod and number of pods set. Many other factors such as root disease level, degree of drought stress, weather conditions preceding the HT period, etc. may influence the impact of HT. Split set of pods is perhaps the greatest damage experienced in snap bean production.

Evaluation of HT tolerance in beans at the University of Minnesota has concentrated primarily on the flowering and pre-flowering. Several selection criteria for HT tolerance are being examined for effectiveness and efficiency in breeding. The screening techniques being examined include the measurement of responses to HT of ethylene gas production rates from leaves, cell membrane thermostability, pollen viability, photosynthetic activity, transpirational control, and heat shock protein profiles.

Work on HT tolerance must be viewed as part of a larger system. The speed and size of gains made might depend on the importance of HT tolerance in the breeding program and on the resources dedicated to HT tolerance selection. Gains are also affected by factors such as the genetic variability in one's breeding populations and the effective utilization of experimental design. Our research may show that great and rapid gains may be realized through early selection with the above selection criteria. Conversely, selection during advanced field trials may remain the most effective method. HT tolerance also should be considered in light of its relationship to drought and cold tolerance. The ability of the plant to continue in its development under marginal conditions can be important to our understanding of any type of tolerance.

Cooperative work with Israel has been enlightening. Minnesota environments subject the bean to a wide range of temperatures. Growing conditions in Israel provide a nearly continuous HT stress in the late spring and early summer. These differences have led us to consider the concept of heat acclimation potential, which refers to the ability of a cultivar to adjust to HT as opposed to the basal level of HT tolerance expressed at the onset of HT conditions. If the maintenance of HT tolerance by a plant places a drain on its resources, acclimation potential may be very important. More study of this concept will provide additional understanding of HT tolerance.

Objectives

The objectives of the experimental data summarized in this report were to 1) study the inheritance of heat tolerance (ethylene production rate) in crosses between a heat-tolerant bean and a heat-sensitive bean (see Table 1), and 2) assess the range in heat tolerance in a group of bean varieties and types which we had reason to believe differed from one another in heat tolerance (see Table 2).

Procedure

Our earlier work showed that BBL 47 (Asgrow) and PI 271998 (a bean from Spain) differed in heat tolerance, with BBL 47 being much more sensitive. We made crosses between these 2 and then crossed the hybrid back to each of these 2 parents. Our objective was to see how the heat tolerance (ethylene production rate) was inherited.

The data in Table 1 were obtained from greenhouse grown plants of the 2 parents and the crosses, all grown at a temperature of 74°F day and 65°F night, approximately. At early bloom, but before pods had set, these plants were moved to a growth chamber for heat treatment. Leaf samples were collected after 48 hours of treatment. These samples were placed in rubber-capped, sealed glass vials and held in the lab for 2 hours at 70°F. At that time an air sample was withdrawn by syringe through the rubber caps. These samples were injected into a gas chromatograph to detect the ethylene gas produced by the leaf tissue.

In another experiment (Table 2) we grew plants of a group of varieties in the field. Following several hot days at the early flowering stage, we took leaf samples and treated them as described above.

Results

The data in Table 1 show that the 2 parents differed in rate of ethylene gas output from leaf tissue. The heat sensitive bean (BBL 47) has a higher rate (1.78 micro liters per gram of leaf tissue per hour) of ethylene production, indicating greater sensitivity to the heat treatment. This was 148% higher than in non-treated BBL 47. PI 271998, on the other hand, had a lower (1.13) rate and this rate was about the same (96%) as in the control.

The cross between the two parents was about the same (1.24) in ethylene production as the tolerant parent (1.13), indicating that heat tolerance may be inherited as a dominant trait.

The data in Table 2 show that there can be a wide range in ethylene output across a group of bean varieties, varying from a high of 2.52 from BBL 47 to a low of 0.62 from 85-CT-4986-3 in this particular experiment. Data on Heat Killing Time, obtained by a quite different procedure, as another indicator of degree of heat tolerance, agree fairly well with the ethylene data. That is, the lower the Heat Killing Time, the more heat sensitive the variety. Thus some of the varieties in Table 2 may be good sources of genes for heat tolerance.

These results indicate that bean heat tolerance, based on the way we estimated it, probably is an inherited trait that could be improved by plant breeding.

Table 1. **Rate of Ethylene Gas Production by Leaves of a Heat-Sensitive Bean (BBL 47) and a Heat-Tolerant Bean (PI 271998) and Their Offspring in Crosses After Heat Treatment at 95°F day and 86°F night for 48 hours.**

Breeding Generation	No. of Plants	Rate of Ethylene Production (ul/gr/hr)	% of Control
PI 271998	36	1.13b	96
BBL 47	36	1.78a	148
The Cross (The F_1)	36	1.24b	79
F_1 Crossed Back to PI 271998	108	1.14b	102
F_1 Crossed back to BBL 47	108	1.50ab	117

Controls consisted of 8 to 14 non-heat-stressed plants for each generation. Ethylene values followed by different letters have a 19 in 20 likelihood of being statistically different.

Table 2. Rate of Ethylene Gas Production by Leaves of Dry Bean and Snap Bean Varieties which Differ from One Another in Probable Heat Tolerance (plants were grown in field and leaves were sampled following several hot days)

Bean Type or Variety		Rate of Ethylene Production (ul/gr/hr)	Heat Killing Time (minutes)
BBL 47	snap bean	2.52a	60
UI 111	dry bean	2.45a	50
Strike	snap bean	1.71ab	95
Labrador	snap bean	1.59ab	97
Red Cloud	dry bean	1.48ab	--
GNUI 59	snap bean	1.39ab	110
PI 271998	snap bean	1.37ab	94
Tepary	dry bean	1.09b	--
Hebei No.1	snap bean	1.08b	80
G 4727 (Ancash 66)	dry bean	0.96b	100
85-CT-4986-3	dry bean	0.62b	90

Ethylene values followed by different letters have a 19 in 20 likelihood of being statistically different.

Heat killing Time was determined not by the ethylene test, but by the length of heat treatment required to cause 50% of the cellular contents to leak through damaged heat membranes, as measured by electrical conductivity.

PRELIMINARY STUDIES ON CAUSES OF POOR HUSKABILITY IN SWEET CORN

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Introduction

Reports of poor huskability surface periodically in the Industry. Causes probably can be related to 1) certain varieties or 2) to a high stress year, such as 1988, when ear/husk relationships are more likely to be abnormal, particularly if ears are not well filled. However, our impression is that beyond these two reasons there also are other reasons for poor huskability. Whatever the causes, poor huskability can result in reduced yield recovery and in a decrease in general efficiency and quality of pack. Some widely used hybrids, such as Jubilee, are marginal in ease of huskability. Many other hybrids are discarded in the testing stage because they are poor huskers.

Our objective was to find out why some varieties are poor huskers and why other varieties which generally are good huskers, on occasion cause difficulty in husking. Results from this work may assist the Industry in the following ways:

1. Processors may be better able to choose one variety over another for production. They also may be able to make certain management changes, such as in plant population, timing of harvest, etc.

2. Plant personnel may be able to modify post-harvest raw product handling practices to reduce the problem.

3. Sweet corn breeders may be able to better identify and eliminate poor huskers before sending them to the processing industry.

Materials and Methods

A non-butting husking table available at the Southern Experiment Station, Waseca, MN, was used. There have been two phases to the experimental work thus far. One was based on experimental plots under controlled conditions. The other was based on Jubilee samples drawn from the post-harvest holding slab at the Birds Eye plant in Waseca. In the first phase, 2 easy-husking, 2 intermediate-husking, and 2 difficult-to-husk hybrids used by the Industry were studied.

Phase 1: The following hybrids were used:

Poor Huskers	Intermediate Huskers	Easy Huskers
Jubilee	Commander	Exp. 62312
Shield Crest	Exp. 20-35	Exp. 20-216

The above 6 hybrids were grown in blocks in an non-irrigated replicated (4 reps) field trial planted on May 22 at Waseca, using six 30-inch rows 60 feet long as the experimental plot and a population of 22,000 plants per acre. Our goal was to harvest at 2 maturities (moistures)--about 78-80% and 73-75%. In each case, about 100 ears were harvested from each plot and run through the husker.

After dry husking, the ears were evaluated for degree of husk removed. The Husk Removal Classes into which these ears were classified are as follows:

1) unhusked
2) tip exposed due to the husking process
3) half husked
4) entirely husked

Hence, the ratings were subjective and thus based on judgement. But they were repeatable and not very confusing.

Phase 2: In Phase 2, Jubilee ears at about 72% moisture and with good tip cover were taken from the Birds Eye holding slab. These were divided into the following categories when we selected them from the pile:

1) long flags; no tip exposure
2) long flags; tip exposed
3) small (1 to 1 1/2 inch long) flags; no tip exposure
4) intermediate (2 to 3 1/2 inch long) flags; no tip exposure

Results

Phase 1. Harvest at the desired kernel moisture level was difficult due to the workload at the time from other experiments. Harvest of all 6 entries was made at a high moisture level, generally 76 to 80%. Of the 6, four were harvested also at a low moisture level, generally 69 to 74%.

Although the data have not been analyzed critically, the results do seem to correlate well with the known ease of huskability of the 6 hybrids. Differences in kernel moisture level within a hybrid did not seem to change huskability very much.

Averaged across replications and moisture levels, the huskability of the 6 was as follows:

Hybrid	% of Ears in Each Husk Removal Class 1	2	3	4	Total # of Ears	Ear Type
Jubilee	8.3	3.6	13.3	74.8	1103	large ears; short tip cover
Shield Crest	16.0	3.9	7.6	72.5	1100	
Commander	1.5	2.3	7.8	88.5	400	large ears; intermediate tip cover
Exp. 20-35	1.9	0.8	16.8	80.5	723	intermediate between Commander & Exp. 20316
Exp. 62312	0.3	0.8	2.8	96.3	400	fairly large ear; long tip cover
Exp. 20-216	1.4	0.8	12.8	85.1	800	small ear; long tip cover

To summarize, Jubilee and Shield Crest, the 2 poor huskers did not husk as well, with 74.8 and 72.5 of the ears fully husked, respectively. Differences among the other 4 were less clear, although Experimental Hybrid 62312 husked exceedingly well (96.3% in category #4).

These data tend to document that the hybrids do differ, but do not tell us why. Our work in 1990 will be directed more toward the reasons why these hybrids differ in huskability. The 6 hybrids were chosen for ear type and size differences but these differences did not provide recognizable clues to husking performance.

Phase 2. Huskability data on the Jubilee ears collected from the Birds Eye holding slab are as follows:

Ear Type	% of Ears in Each Husk Removal Class 1	2	3	4	Total # of Ears
Long flags, no tip exposed	20.6	0.9	12.4	66.1	218
Long flags; tip exposed	11.1	4.8	14.3	69.8	63
Small flag leaves	13.9	1.4	2.8	81.9	72
Intermediate flag leaves	12.4	2.2	10.9	74.5	137

The preliminary results from Phase 2 indicate to us that, based on this small sample, the different types of Jubilee ears pulled from the storage pile did not differ greatly in huskability. There was a tendency for ears with small flag leaves to husk better than those with larger (longer) flag leaves. We might have expected the opposite!

Regardless of ear type, Jubilee husked about the same in this experiment as it did in Phase 1, where we used a large sample (1103 ears). The differences among the 4 types of Jubilee ears used in Phase 2 could be due to random chance variation.

We will continue to work on the huskability problem in 1990.

DISPERSAL OF EUROPEAN CORN BORER LARVAE ON PLANTS OF RESISTANT AND SUSCEPTIBLE TYPES OF CORN

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The dispersal of newly hatched European corn borer (ECB) larvae affects the amount and location of the feeding damage. Larval dispersal may also affect the method or timing of chemical or biological measures used to control the insect. The objective of this work is to find out if ECB resistant and susceptible types of corn differ in 1) pattern of larval dispersal, and 2) degree of larval survival. At issue also is the question of whether larval behavior offers any insight into methods of improvement in breeding for resistance.

Resistance of Entries and Crosses

The entries used in this experiment were Maiz Amargo (MA), Antigua x San Juan (ASJ), Zapalote Chico (ZC) and Stowell's Evergreen (SE). Amargo is an exotic inbred. The next two are exotic populations. Stowell's Evergreen is an open pollinated sweet corn variety. These lines are reported to differ in their resistance to leaf feeding damage caused by the ECB. An experiment was conducted at St. Paul and at Becker, Minnesota to verify the level of resistance. All four entries and their crosses were planted in a replicated (10 reps of 5 plants each), completely randomized design and artifically infested. Data were taken on number and size of leaf lesions, on presence of silk, husk and shank damage, and on % of kernel and cob damaged. Only leaf feeding data are reported here. Other data, not yet fully analyzed, will be reported in the 1991 report.

The 4 entries were significantly different in mean index value, with the index taking into account both the number and size of the feeding lesions on the whole plant. The resistant lines, Amargo and Antigua x San Juan, had lower mean index values than the susceptible lines, Zapalote Chico and Stowell's Evergreen (Table 1).

Table 1. Student-Newman-Keuls mean separation of mean index values by entry.*

Entry	Mean index	SNK grouping
Parents		
SE	918	A
ZC	569	BC
ASJ	377	D
MA	157	E
Crosses		
ZC x SE	692	B
ASJ x SE	507	CD
ASJ x ZC	409	D
MA x SE	231	E
MA x ZC	198	E
MA x ASJ	165	E

*Mean index values not followed by the same letter under the SNK column have a 19 in 20 likelihood of truly being different. Stated another way, they have a 1 in 20 likelihood of differing by chance.

The evaluation of the crosses among these 4 entries showed that resistance is passed on to the progeny. The mean index values fall into three groups.

The most resistant crosses were progenies of Maiz Amargo. The intermediate crosses have Antigua x San Juan as the common parent. The cross of Zapalote Chico and Stowell's Evergreen was the most susceptible.

Dispersal of Larvae on Resistant and Susceptible Entries

In a concurrent experiment, at St. Paul only, the dispersal of ECB larvae, 1 and 5 days after infestation with egg masses, was determined on the 4 entries. For this study, dispersal was defined as the number and location of larvae on the whole plant. This set of values does not directly measure the movement of the larvae nor does it distinguish mortality from the action of leaving the plant by the insects. It merely tells us where the larvae are at the end of 1 day and at the end of 5 days. The number of eggs hatched from each egg mass was counted for comparison to the total larvae recovered.

The initial analysis was of total larvae per plant. Fewer larvae were found after 5 days than after 1 day (Table 2) which suggests that larvae continue to die or leave the plant during this period.

Table 2. Student-Newman-Keuls test of mean separation for total larvae by days from infestation.

Days from infestation	Mean larvae/plant	SNK grouping
1	11	A
5	5	B

The total number of larvae found on resistant entries was lower than that on susceptible entries (Table 3). The factors conferring resistance may be toxic or irritating to the larvae, increasing mortality or movement of the larvae off the plants.

Table 3. Student-Newman-Keuls test of mean separation for total larvae by entry.

Entry	Mean larvae/plant	SNK grouping
ZC	10	A
SE	9	A
ASJ	7	B
MA	6	B

A further analysis included the sites on the plant where larvae were found. There were 6 sites on each leaf of the plant; the inner, center and outer thirds of the upper and lower surfaces. The distribution pattern of the larvae, i.e. the percent found in each site, is also affected by entry and number of days from infestation.

Based on Table 1, the corn types we used differed in resistance. Table 2 shows that larval numbers drop over time, and in Table 3 we can see that this decrease depends on the variety. Our current work with the data is directed toward finding out if the larvae migrate differently on a resistant as compared to a susceptible type. More in next years' report!

EAR RESISTANCE TO THE EUROPEAN CORN BORER IN SWEET CORN: THE RESPONSE IN SINGLE CROSSES AND A PRELIMINARY STUDY OF THE CONTRIBUTION OF SILK CHANNEL LENGTH TO EAR RESISTANCE

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Breeding for Resistance

The University of Minnesota has been working for several years to develop sweet corn breeding material resistant to ear feeding by the European corn borer (ECB). The replicated tests in 1989 included 72 breeding lines. Most of them also had been tested in 1987 and 1988 and were advanced each year, while relatively susceptible lines were dropped.

To determine whether the resistance has practical value, testcross hybrids were made in the winter of 1988-89 and were added to the field tests of resistance in 1989. The testcrosses were made using some of the Minnesota lines on one side of the parentage and commercial inbreds on the other side.

At mid-silk the top ears of each of approximately 42 to 48 plants (divided into 6 to 8 replications) for each testcross and breeding line were infested at the tips with 40 to 50 freshly hatched larvae. Approximately 21 to 23 days after infestation, these ears were evaluated for damage according to the 9-point rating scale shown below Table 1.

Table 1 summarizes results from a typical subset of the lines and testcrosses, although evaluation was done somewhat later (25 to 27 days) after infestation. This subset was used also for other experiments and is convenient to use for a report at this time. Included in Table 1 were 6 Minnesota parent lines (# 96, 98, 101, 106, 132 and 169) and the testcross hybrids made with the 2 commercial inbreds (#s 16 and 18). Thus, the testcrosses are 96 x 16, 96 x 18 etc. Also the commercial hybrid 16 x 18 and Jubilee were tested as checks. Both checks were planted at several different times (J1, J2, J3, J4) so that some assessment of age (size) of ear could be made.

Except for #132, the 6 Minnesota breeding lines had some resistance in 1989, as in 1988. Ten of the 12 testcrosses appeared to have resistance, with the ears divided about 60 to 70% in resistance categories 1 through 4 and about 30 to 40% in susceptible categories 5 to 9. Jubilee was highly susceptible with about 60 to 70% of the ears in categories 5 to 9. The other commercial hybrid (16 x 18) was intermediate.

These results are typical of the larger sample. Some Minnesota lines continue to show resistance to ECB. There is transmission of this resistance to test hybrids but not in some cases. In 1990, many more test hybrids (made with other resistant Minnesota breeding lines) will be evaluated. Some of these also will be evaluated in processing company trials.

Table 1 gives the average score for each entry. Probably more important is the % of ears in each rating category. For practical purposes, the cut-off rating between resistant and susceptible is at about category 4. Our infestation loads (40-50 larvae at the ear tip) are very severe compared to the natural situation in commercial fields. One must keep in mind the performance as related to Jubilee.

Influence of Silk Channel Length on Resistance

Several factors may be involved in resistance. Although plants were infested at silking and evaluated after 25-30 days, the entries that flowered later showed less damage. This may have been due to the lower temperatures later in the season. The European corn borer is less active in cooler weather. It is not known if this effect is significant.

Another factor which may contribute to resistance is silk channel length. Silk channel length is quite variable in commercial hybrids, and may range from 0 inches (tip exposed) to as much as 4 inches in the same hybrid. The typical (average) silk channel length is usually 1 1/2 to 2 inches. Some of the Minnesota lines had silk channels that ranged from 3 to 5 1/2 inches. A long silk channel will be undesirable if it interferes with the husking operation or with pollination. If a long silk channel is responsible for the resistance in some of the Minnesota lines the material may not be useful in future breeding for ECB resistance.

A second study, designed to take a closer look at silk channel length as a contributing factor to ECB ear resistance, was conducted in 1989. Three resistant Minnesota lines were planted in the field along with Jubilee and a commercial inbred (#18) as checks. In half of the plots of the Minnesota lines the silk channels were cut to 2 inches (the length of Jubilee silk channels at the time) on the day before infestation. All other ears were trimmed slightly to eliminate differences due to cut tissue, but silk channel length was not significantly affected. Each ear was then infested with 45-50 live larvae on the silk at the tip.

The cutting appeared to affect the resistance somewhat in two of the Minnesota lines. It did not appear to affect the third line. All three Minnesota lines remained more resistant than the checks even after the silk channels had been cut (Table 2). While silk channel may contribute to ear feeding resistance in some Minnesota lines, it does not appear to be the sole factor.

More work needs to be done to determine the factors which contribute to ECB ear resistance in sweet corn. It is likely that factors which contribute to resistance in one line may not be important in another line. We need to be able to determine which factors are useful and incorporate them into breeding material which is useful to commercial breeders.

Table 1. Mean scores and distribution of ear damage in sweet corn parents, test crosses and checks following artificial infestation by European corn borer.

Entry	Mean Score	% in Category 1	2	3	4	5	6	7	8	9	% Resistant (1-4)	% Susceptible (5-9)
96	3.74	10	38	10	8	0	21	0	13	0	66	34
96x16	5.26	0	2	4	30	15	30	17	2	0	36	64
96x18	4.51	2	3	14	42	13	19	2	5	0	61	39
98	4.63	0	17	17	27	6	12	4	15	2	61	39
98x16	4.24	2	7	46	5	2	31	2	5	0	60	40
98x18	3.75	6	17	35	13	4	21	2	0	2	71	29
101	4.25	0	33	15	13	0	25	8	0	6	61	39
101x16	4.13	0	9	42	18	0	25	4	0	2	69	31
101x18	4.27	0	7	31	27	11	18	4	0	2	65	35
106	4.48	4	11	15	31	9	13	11	2	4	61	39
106x16	4.78	0	11	47	15	7	18	2	0	0	73	27
106x18	4.98	5	0	25	25	4	18	2	14	7	55	45
132	6.00	0	6	11	11	17	13	4	23	15	28	72
132x16	4.76	0	2	27	38	2	12	0	14	5	67	33
132x18	4.78	0	11	9	37	11	17	2	9	4	57	43
169	3.20	6	20	46	17	3	5	3	0	0	89	11
169x16	4.89	2	4	21	22	2	36	5	4	4	49	51
169x18	4.90	0	0	11	52	2	21	4	8	2	63	37
16	7.18	0	2	9	9	0	12	7	18	43	20	80
18	7.16	2	0	0	11	9	7	22	11	38	13	87
16x18-1	4.64	0	4	23	26	11	26	8	2	0	53	47
16x18-2	5.96	2	0	9	30	0	21	0	23	15	41	59
16x18-3	4.47	11	8	13	32	11	4	2	13	6	64	36
Total 16x18	5.02	4	4	15	29	7	17	4	13	7	52	48
J-1	6.40	0	0	0	21	17	10	15	29	8	21	79
J-2	6.16	0	0	5	25	9	22	7	14	18	30	70
J-3	5.06	4	2	6	38	15	12	6	13	4	50	50
J-4	5.50	0	0	16	17	33	0	17	0	17	33	67
Total J	5.85	2	1	4	27	14	14	10	18	10	34	66

Rating Scale:

1 = no damage to husks, silks or kernels
2 = silk and/or husk damage only
3 = up to 1% of kernels damaged at the ear tip only
4 = 1-5% of kernels damaged at the ear tip only
5 = 6-10% of kernels damaged at the ear tip only
6 = up to 5% of the kernels damaged at the ear tip and at the side or at the side only
7 = 6-10% of the kernels damaged at the ear tip and at the side or at the side only
8 = Cob tunneling from tip or shank
9 = more than 10% of the kernels damaged on the ear

Table 2. Influence of cutting silk channel length on amount of ear damage caused by European corn borer.

Entry	Mean Score	% in Category 1	2	3	4	5	6	7	8	9	% Resistant (1-4)	% Susceptible (5-9)
96 Normal	2.81	0	78	0	7	0	11	0	4	0	85	15
96 Cut	4.10	0	19	24	28	0	19	5	5	0	71	29
98 Normal	2.58	0	79	5	5	0	11	0	0	0	89	11
98 Cut	4.00	0	35	17	17	5	13	0	9	4	69	31
101 Normal	3.12	0	63	12	0	0	22	3	0	0	75	25
101 Cut	2.85	0	60	25	0	0	15	0	0	0	85	15
J Normal	4.82	4	5	14	32	13	14	0	14	5	55	45
18 Normal	7.25	0	0	0	0	0	25	50	0	25	0	100

The same rating scale was used in Tables 1 and 2.

RUST EPIDEMIOLOGY AND FUNGICIDE EVALUATION

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RUST EPIDEMIOLOGY

The effects of plant populations and planting dates on common corn rust severity and yields were evaluated. Foliar applications of Manzate resulted in reduced rust severity in corn planted after June 15. When averaged over all 4 planting dates (May 17, June 1, June 15, June 30), the highest plant population (27,000/A) seemed to encourage rust establishment as the leaves opposite and above the ear had more rust (11% of the leaf area infected) than the same leaf samples from 17,000 and 22,000 populations (5 and 8% of the leaf area infected, respectively) (fig. 1). In general, rust severity continued to worsen as planting date was progressively delayed from May 17 to June 30 (fig. 2).

Useable ear production (for corn on the cob freezing) was significantly affected by a population x fungicide treatment interaction. The use of Manzate to suppress rust was most effective in the 2 higher populations (22,000 and 27,000/A) (fig. 3). When averaged over all planting dates, it appears that sweet corn planted at 17,000/A would not benefit from fungicide treatments. The increased space between plants may suppress rust development by improved ventilation. The number of useable ears from fungicide treated plants increased by 1,906 and 3,703/A in 22,000 and 27,000 populations, respectively, when compared with untreated plants.

Cut corn recovery was significantly affected by a planting date x population interaction (fig. 4). Cut corn recovery increased linearly as plant population increased for the first 2 planting dates. However, after the June 1 planting, cut corn recovery generally declined as population increased. When averaged over all planting dates and populations, plots that received weekly treatments of Manzate once rust was present yielded 723 pounds/A more than untreated plots.

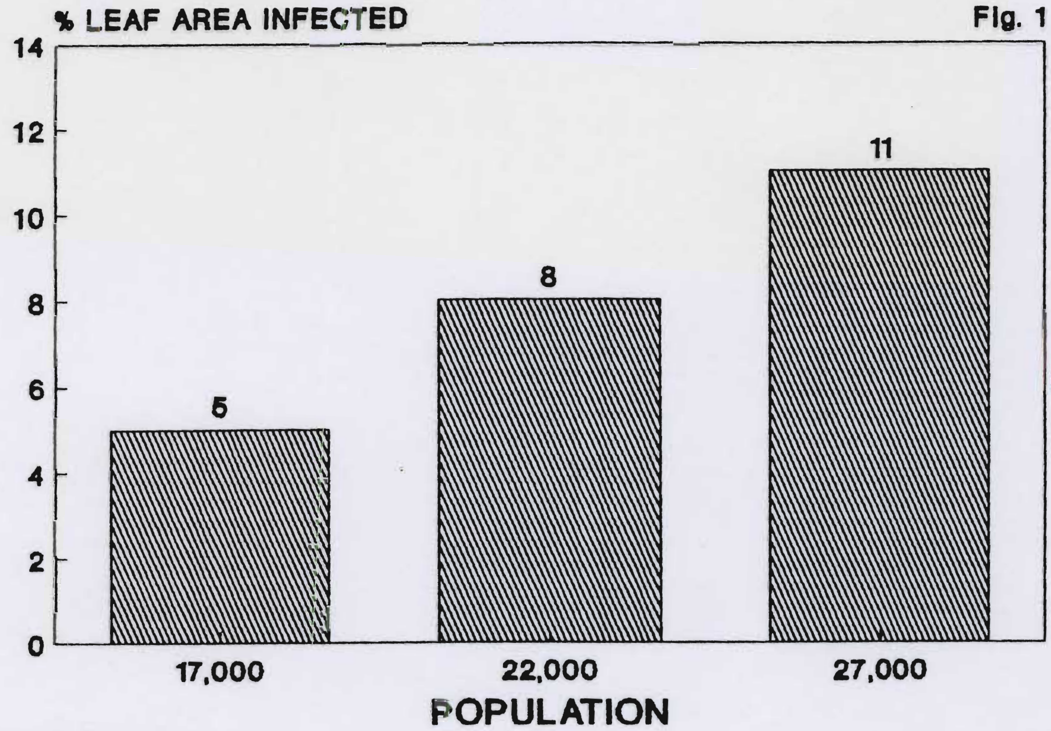
The study will continue in 1990 and one of the main objectives will be to improve the quality of disease severity measurements.

FUNGICIDE EVALUATION

Again this year, conventional contact (EBDC) fungicides were compared to systemic fungicides which represent the newer sterol inhibiting chemistry. The specific fungicides and the rates used are listed in table 1. The variety 'Jubilee' was used for the study. Maximum rust severity was determined to be 8.5% of the total flag leaf area in the control plot. Propiconazole at .11 lb. a.i./A (7 and 14 days) and diniconazole provided significant rust control (1 and 2% leaf area infected respectively) (fig. 5). The standard mancozeb treatments had an average 5% of the leaf area infected.

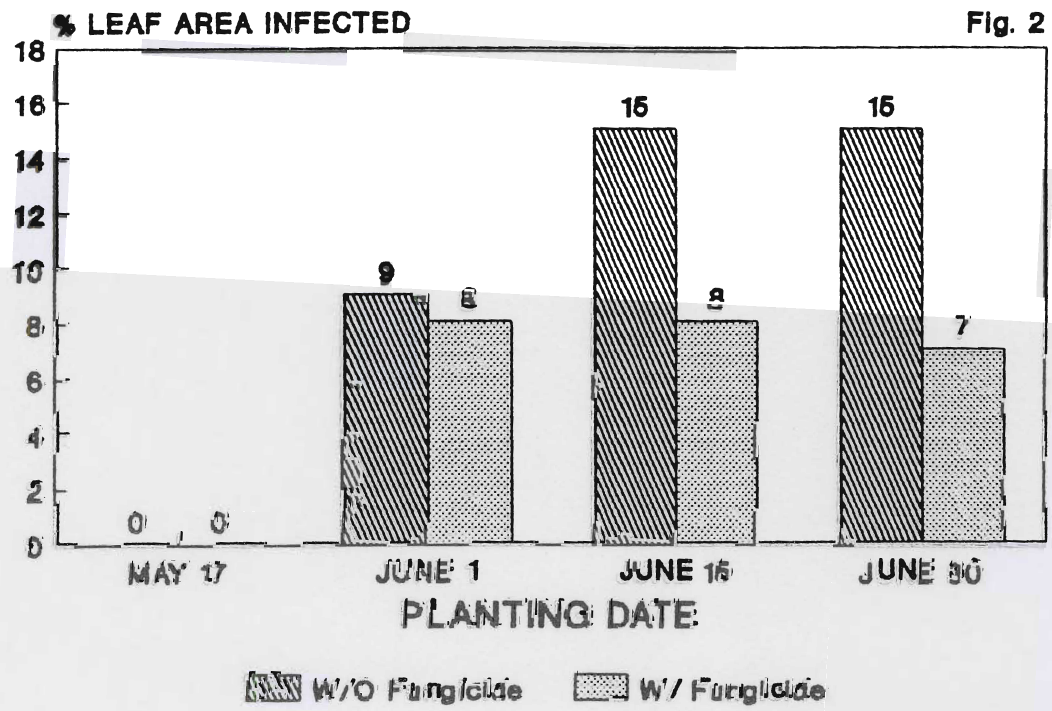
Corn treated with propiconazole (.11 lb. a.i. every 14 days) yielded 13% more cut corn than the control (fig. 6). In addition, propiconazole (.055 and .11 lb. a.i. every 7 and 14 days respectively) and diniconazole treatments yielded 40% more useable ears for corn on the cob freezing when compared with the control. It is uncertain how much of this increase in yield from plants treated with either propiconazole or diniconazole is wholly or in part attributable to a "grown regulator" effect, elicited by these fungicides, which has been observed before.

EFFECT OF POPULATION ON RUST

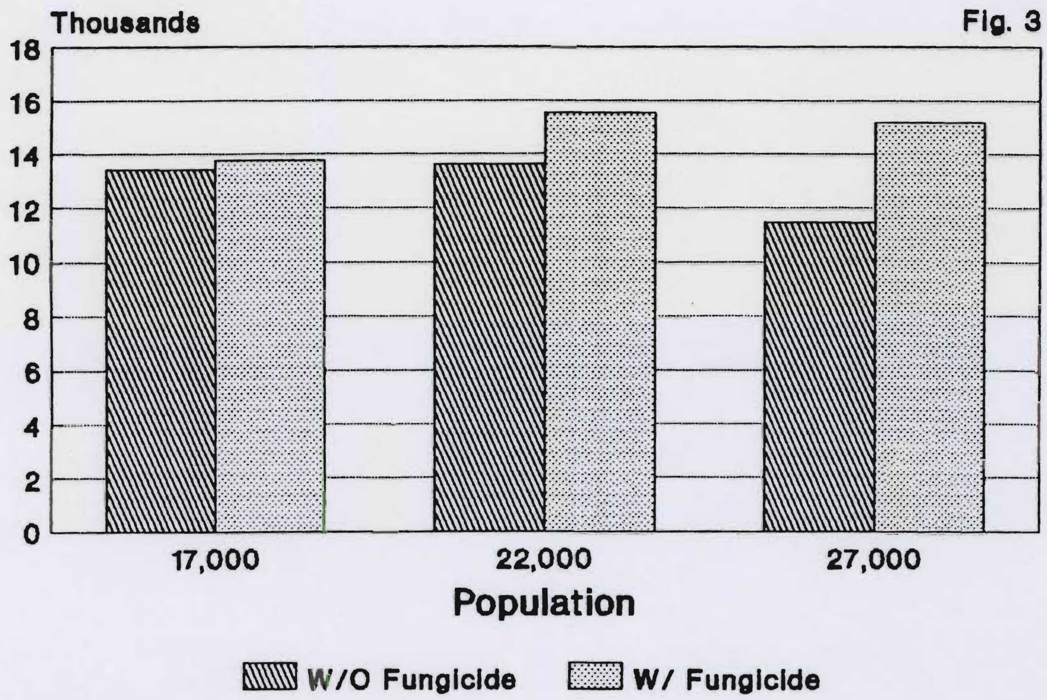


OPP./ABOVE EAR

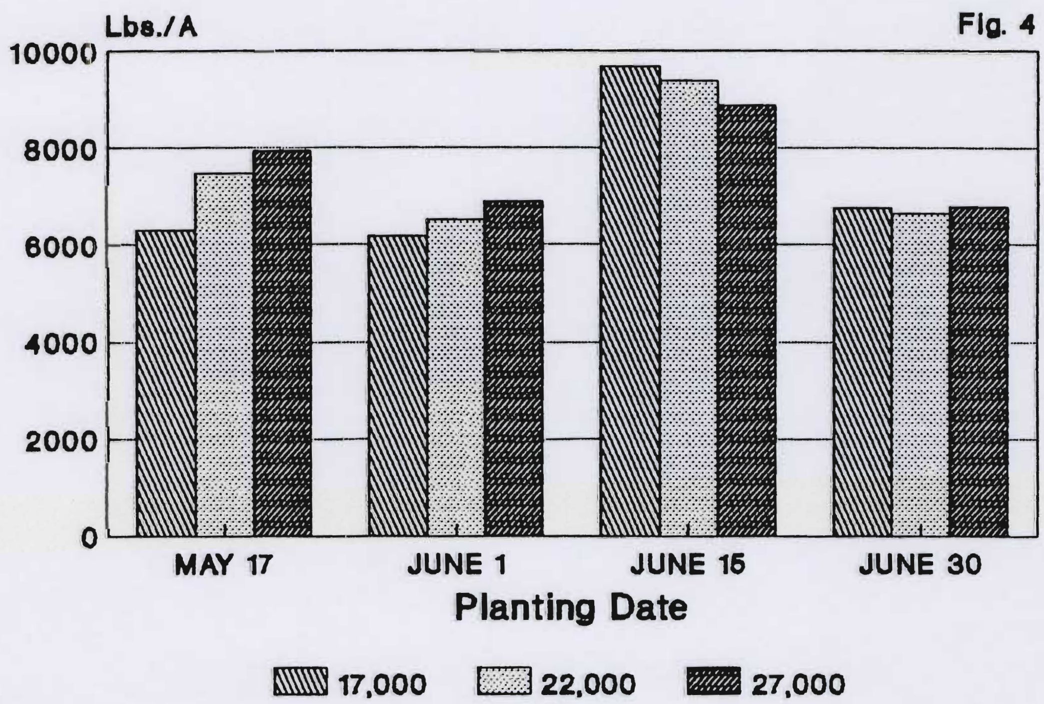
DATE X FUNGICIDE ON RUST



POP. X FUNG. ON USEABLE EARS



DATE X POP. ON CUT CORN

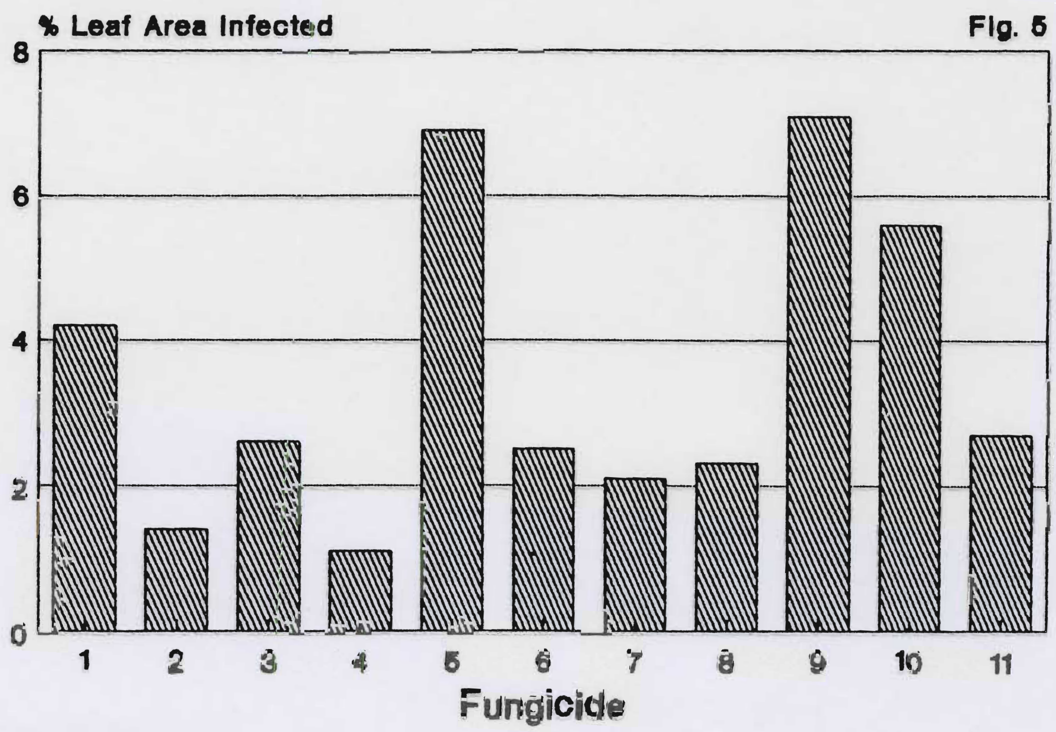


RUST FUNGICIDE TRIAL
1989 UPDATE

Table 1

	FUNGICIDE	RATE (LB.AI./A)	APP. INTERVAL (DAYS)
1	RH-7592 2F	.06+1qt. COC/A	10
2	TILT 3.6E	.11	14
3	DITHANE F45	1.6+1pt.B-1956/100 gal.	7
4	TILT 3.6E	.055	7
5	BAYLETON 50WP	.25	10
6	SYSTHANE 60DF	.12+1pt.B-1956/100 gal.	10
7	TILT 3.6E	.11	7
8	SPOTLESS 25WP	.10+6oz.X-77/100 gal.	10
9	MANZATE 80WP	1.2	7
10	NONTREATED	--	--
11	BRAVO 6F	.52	7

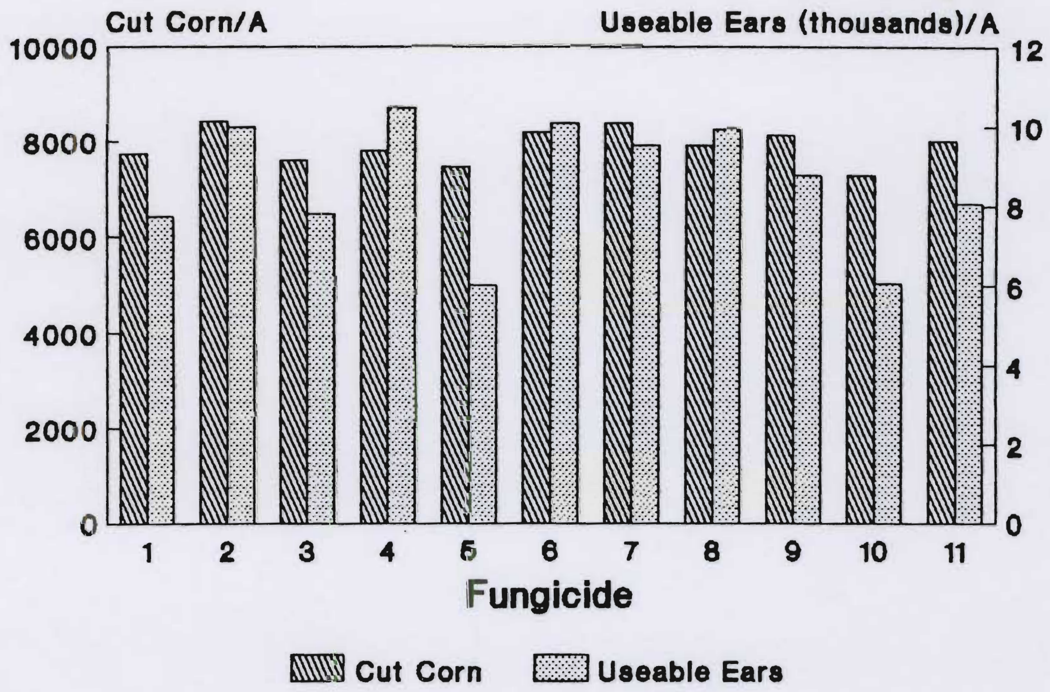
DEGREE OF RUST CONTROL



Opp./Above Ear

YIELD SUMMARY

Fig. 6



SWEET CORN BREEDING STOCKS DEVELOPED WITH HIGHER LEVELS OF PARTIAL RESISTANCE TO LEAF RUST

Dave Davis and Jim Groth

Departments of Horticultural Science and Plant Pathology

Introduction

We have made a strong case in recent years for more attention on the so-called partial resistance (small pustule, slow rusting, etc.) form of resistance to leaf rust in sweet corn. It has been our reasoning since the late 1970s that a backup form of resistance sooner or later will be needed for the strong resistance form now present in new hybrids, such as Arrestor.

Methods

In the early 1980s we began to test genetic sources of the partial form of resistance. This was followed by intercrossing several of these genetic sources and by selection of rust resistance plants in the progeny under high rust conditions in the field.

Results

Based on our evaluations in 1987 and 1989, we recognize that we now have some new types which are quite strong in resistance. In 1989, of 242 evaluated, 82 had good resistance. Most of our emphasis in 1990 will be placed on an elite group of 36 which have good resistance, plant type and kernel color.

We are ready to share seed of some of these with the commercial sweet corn breeders and can send out small samples of seed this spring. Meanwhile, we will be increasing seed further in 1990, and will be placing a small number of the new stocks in more exhaustive tests. These tests will emphasize the evaluation of late-planted material which will naturally come under more severe pressure (epidemic conditions) in early fall.

ANNUAL GRASS AND BROADLEAF WEED CONTROL IN SWEET CORN

Leonard B. Hertz and Vincent Fritz

Department of Horticultural Science
University of Minnesota

A study was conducted to evaluate several combinations of herbicides for weed control in sweet corn. 'Jubilee' sweet corn was planted May 17, 1989, in a clay loam soil, pH 6.4 and organic matter 6.5%, at the Southern Experiment Station, Waseca, MN. The plots were 10 by 30 ft with four rows spaced 30 inches apart and arranged in a randomized complete block with four replications. All herbicide applications were made with a CO_2 pressured bicycle sprayer equipped with 8002 nozzles, with the exception of the directed sprays, which were applied with a hand held CO_2 sprayer equipped with a three drop nozzle (8002E) boom with 30 inch spacings. Weed control and crop injury were rated on July 24. Weed populations were low and consisted of giant foxtail (67%), common ragweed (23%), redroot pigweed (4%), velvetleaf (3%), cocklebur (2%) and common lambsquarter (1%). Application dates, sprayer settings, environmental conditions, and plant sizes are listed below:

Date	May 17	June 9	June 22	June 28
Treatment	PRE	EPO	LPO	PDIR
Sprayer				
gpa	20	20	20	15
psi	40	40	40	28
Wind (mph)	10-15	5-10	5	0-5
Air temperature (F)	60	64	75	79
Sky	clear	cloudy	cloudy	clear
Sweet corn				
leaf no.	--	2-3	4-5	6
Giant foxtail				
leaf no.	--	--	--	7
height (inch)	--	1-2	4-6	<15
infestation	--	--	--	2/ft^2
Broadleaves				
height (inch)	--	0.5-1	4-6	8-13
infestation	___	--	--	<1/ft^2

Weed control, corn injury and yield are summarized in the accompanying table. All herbicides provided excellent control of broadleaf weeds. Combinations of bentazon and atrizine plus alachlor; clopyralid and 2,4-D plus alachlor; bromoxynil and atrazine plus alachlor gave poor control of foxtail spp. Mixtures oftridiphane plus atrazine or cyanazine have excellent overall weed control. Post-directed sprays of paraquat and glyphosate gave poor control of velvetleaf and slight injury to the sweet corn.

Table. Weed control in sweet corn (Hertz and Fritz).

Treatment	Rate	Time of appl.	Weed control					Corn inj[x]	Yield husk
			Colq	Rrpw	Vele	Gift	Oval[y]		
	(lb/A)		- - - - - - - - - % - - - - - - - - -						
(T/A) Alachlor +	2.0	PRE	95	100	100	60	60	0	4.3
clpy & 2,4-D	0.03+0.25	LPO							
Alachlor +	2.0	PRE	100	100	100	43	43	0	3.7
clpy & 2,4-D	0.06+0.50	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.2
clpy & 2,4-D	0.09+0.75	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra & bent + 28%N[z]	0.56+0.48	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra & bent + Dash[z]	0.56+0.48	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra & bent + COC[z]	0.56+0.48	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra & bent + 28%N	0.77+0.68	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra & bent + Dash	0.77+0.68	LPO							
Alachlor +	2.0	PRE	100	100	100	60	60	0	4.4
atra&bent+Dash+28%N	0.06+0.68	LPO							
Alachlor +	2.0	PRE	100	100	100	43	43	0	4.6
bromoxynil + atra	0.25+0.5	PRE							
Tridiphane +	0.5	EPO	100	100	98	90	90	0	4.8
atrazine + COC	2.0	EPO							
Tridiphane +	0.75	EPO	100	100	100	88	88	0	4.6
atrazine + COC	1.5	EPO							
Tridiphane +	0.75	EPO	100	100	100	95	95	0	5.1
atrazine + COC	2.0	EPO							
Tridiphane +	0.75	EPO	100	100	100	93	93	0	4.4
cyanazine	2.0	EPO							
Tridiphane +	0.75	EPO	100	100	100	95	93	0	3.6
cyan + atra	1.0+1.0	EPO							
Paraquat + X-77[z]	0.28	PDIR	100	100	75	68	65	0	4.7
Paraquat + X-77	0.37	PDIR	88	88	63	80	78	1	4.5
Paraquat + X-77	0.46	PDIR	100	100	63	85	85	1	4.6
Para + atra + X-77	0.28+0.25	PDIR	100	100	75	85	85	1	4.3
Para + atra + X-77	0.28+0.5	PDIR	100	100	63	88	83	2	4.7
Para + atra + X-77	0.28+1.0	PDIR	100	100	100	83	83	2	4.5
Glyphosate	0.18	PDIR	50	100	38	88	83	0	4.4
Glyphosate	0.36	PDIR	75	75	88	88	85	4	3.1
Glyphosate + COC	0.18	PDIR	63	100	88	78	78	0	4.6
Pendimethalin +	1.5	EPO	100	100	100	88	88	0	4.2
cyan + atra	1.5+1.5	EPO							
Pend + cyanazine	1.5+2.0	EPO	100	100	100	80	80	0	4.1
Hand weeded	--	--	100	100	100	100	100	0	5.3
Unweeded check	--	--	0	0	0	0	0	0	3.9
LSD (.05)			20	10	28	27	27		0.5

[z]Additives: COC = crop oil concentrate, 1 qt/A; Dash = crop oil concentrate (BASF), 1 qt/A; 28%N = aqueous nitrogen solution with urea and ammonium nitrate; X-77 = non-ionic surfactant, 1 qt/A.
[y]Oval = overall weed control.
[x]Inj. = injury: 0 = none; 10 = dead.

EVALUATION AND GENETIC SELECTION OF SEVERAL SPECIALTY TABLE LEGUMES

Dave Davis
Department of Horticultural Science

Research on new crops included emphasis on Pigeon Pea, Mung Bean and Southernpea; recognizing that there may be some potential of such crops for use as processed products. In addition, genetic selection of Lima Bean continued in 1989.

Most of the work was done at the Sand Plain Experimental Farm, Becker, MN. All experiments were conducted under irrigation at 30-inch row spacing. Broadcast of 300 lbs 8-10-30 was disked in pre-plant. Starter (165 lbs 8-10-30) was banded below seed depth 2 to 3 inches away from the row center at planting. One side-dressing of 30 lbs N/acre as ammonium nitrate was shanked in when plants were 4 to 6 inches high. Treflan (44 lb AI/ac.) and Amiben (1 lb AI/ac.) were used for weed control.

Lima Bean Selection

Individual plant selections were made in F_2 populations from crosses between small, green-seeded, small-plant-stature Minnesota lines and several commercial varieties. These will be evaluated in 1990 as F_3 families. The objective is small, vivid green seed on productive, sturdy, upright, disease resistant plant types.

Mung Bean Evaluation

An unreplicated test of 11 mung bean accessions from the Asian Vegetable Research and Development Center was made, with Texsprout as the check. Single-row 40-foot plots were used. The planting was installed 3 to 4 weeks later (June 17) than possible. Growth was lush, as in 1988, with the mature canopy at about 3 feet. In spite of the late start, 6 of the accessions matured. Yields were excellent, comparable to 1988 (see last year's report).

Evaluation of Pigeon Pea for Adaptability to Minnesota

An observational trial of 50 entries of pigeon pea (Cajanus cagan) was grown (in single-row 20-foot plots at 30-inch row spacing) to evaluate the adaptability of this subtropical legume to the Becker environment. With the exception of 3 of the entries grown in 1988, we are not aware that this crop has been grown heretofore in Minnesota. The Becker site was chosen because its sandy soil provides a fast start in the spring. Also, in 1988, we learned from Becker that the pigeon pea can perform very well on unirrigated, sandy loam. This crop should be explored further on dry land for both its forage and grain production.

The 3 entries evaluated in 1988 and 1989, and 36 of the new entries in 1989, were obtained from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in India. These entries are unusual in that genetically most of them are determinate in plant habit. This means that the central stem tops out in a flower cluster. Thus, these plants are shorter in stature and they flower and mature earlier than their normal, indeterminate counterparts. Nevertheless, many of the new entries flowered too late in 1989 to produce mature seed. These entries reached a height of 3 to 5 feet, while some of the earlier maturing entries did not exceed 24 inches.

Included in the 50 entries evaluated in 1989, were 14 which were derived from 1988 by collecting seed from earlier maturing individual plants from the 3 entries grown that year. These selections were less uniform in plant type and maturity in 1989 than expected. While we have expected that the pigeon pea will self pollinate, we have seen insects working the flowers. Thus, some degree of cross pollination may be occurring.

From the 1000 feet of row (20 feet x 50 entries), with 4 plants to the foot, we selected 207 earlier, more productive plants. These were selected from 20 of the 50 entries. The other 30 entries were too late to mature seed by early October.

The selected 207 will be examined in field plots again in 1990.

<u>Evaluation of Advanced Lines of Southernpea</u>

Thirty southernpea advanced breeding lines were evaluated for yield and for plant and seed traits in a replicated test. A second test was located at Rosemount. At Becker, an additional 41 were grown in an unreplicated test. All entries were grown in single-row 20-foot plots.

These entries include a wide variety of seed and pod types, with some small to moderate differences in plant type. The data from Becker for the replicated entries are summarized in Table 1.

Entries 1 (Minnesota 13) and 21 (California Blackeye #5) served as checks. California Blackeye #5, typical of most U.S. varieties in our region was very late, producing very few mature pods.

Of the 71 entries evaluated, 36 will be retested in 1990 and the best of these will constitute a germplasm collection of material adapted to this region. The best lines will be released as germplasm. Release of varieties will depend on whether or not the seed industry is willing to make a market in the crop.

Table 1. Average performance of southernpea advanced lines from three replications grown on irrigated sandy loam soil at Becker, MN in 1989.

Entry No.	Yield of 10-foot Net Plot (gms)	Pod Color	Seed Color*	Pod Length (in.)	No. pods per Cluster	Other
1	432	Light Brown	BlC	7	1-3	
2	256	Purple	BrC	7	1-2	
3	461	Tan	Cr		2-3	
4	430	Purple	RC		1-3	
5	258	Light Brown	Cr	4	1-2	viney
6	267	Brown	Gr	8	2	flat pod; viney
7	205	Brown	Gr	8	2-3	viney; flat pod
8	397	Brown	Gr	8		flat pod; viney
9	383	Brown	Gr	6	1-4	v. small seed
10	389	Brown	Cr	5	2-3	can repeat-hvt
11	434	Brown	Cr	6	2-4	exc. set
12	421	Light Tan	Cr	5	2-3	crowder type
13	427	Light Tan	Cr	7	2-3	crowder "
14	450	Beige	Br	8	1-2	crowder "
15	337	Tan	Br	6	1-2	crowder "
16	337	Light Brown	RC	6	1-2	crowder "
17	279	Brown	RC	6	1-2	smaller seed
18	394		RC			square seed
19	359	Brown	RC		1-2	larger seed
20	289	Tan	BlC	6	1-2	", flat seed
21	30		BE			too late
22	325	Brown	Gr		2-4	v. small seed
23	367	Purple	RC		1-3	larger seed
24	382	Light Brown	Cr	7		short kidney "
25	505	Beige	Bl	5	2-3	larger seed
26	471	Light Tan	Bl	4	2-3	larger seed
27	361	Brown	Cr	5	2-3	viney
28	359	Tan	Cr	5	2-3	viney
29	494	Light Brown	Br	6	1-2	crowder type
30	317	Tan Rose	Bu	9	1-2	larger seed

*Seed color types: BlC = Black Calico; BrC = Brown Calico; Cr= Cream; RC = Red Calico; Gr = Green; Br = Brown; BE = Blackeye; Bl = Black; Bu = Burgundy

PILOT PROCESSING AND FURTHER SELECTION OF WINTER SQUASH

Dave Davis and Vince Fritz
Department of Horticultural Science

With the objective of developing an improved canned pumpkin product, several research steps were undertaken in 1989. First, a pilot field of several acres of one U.of M. breeding line was grown and processed by Owatonna Canning Company. Fruit type and color seemed promising. Consistency data obtained with the Bostwick Consistometer on flow-rate of canned product were similar to data from Goldkeeper. Thus, consistency was not as good as in Dickenson and this U. of M. breeding line probably will not be retained.

Secondly, a seed increase of 3 other breeding lines was made in isolated 1/4 acre fields to enable further pilot processing in 1990.

Third, in field plots of 12 breeding lines, from 5 to 20 plants in each were self-pollinated to develop true breeding types for fruit size, shape, color, flesh color and other quality factors. Seed then were saved from about 80 of the resulting fruit (one per plant) after a cooking test. Some of these will be evaluated in field and cooking test in 1990 prior to pilot canning in 1991.

Annual Report
1989
Subcommittee on Genetics and Metabolism

Charles Boyer, Chairman

Project: NE-124 Genetics and Physiology of Sweet Corn Quality, Pest Resistance and Yield

PARTICIPATING STATIONS:

Florida AES	L. C. Hannah
	D. J. Cantliffe
Indiana AES	D. V. Glover
Pennsylvania AES	C. D. Boyer
	J. C. Shannon
Wisconsin AES	W. F. Tracy

I. SUMMARY OF WORK IN 1989:

Public and private sweet corn hybrids (26) were analyzed for carotenoids by HPLC. This group was selected from a larger group analyzed for color and provitamin A in 1988. The parental inbreds were also included in the analysis. Represented were the sugary, sugary-sugary-enhancer, and shrunken-2 genotypes. The range of relative total pigment was 5-fold and 7-fold among the hybrids and inbreds, respectively. The range of relative primary pigment -carotene was 24-fold and 69-fold among the hybrids and inbreds, respectively. The propensity among the hybrids to produce elevated levels of -carotene was consistent over years.

Genetic modification and breeding of 1) special-purpose corn starches with unique chemical, physical and functional properties for special food uses; and for 2) modified-hard endosperm quality protein maize for nutritional quality improvement was continued. Composite populations of several multiple genotypes are being developed. Analysis of isoamylase debranched starches and starch granule gelatinization have revealed that subtle changes in amylopectin fine structure can be correlated to specific thermal events.

The mechanism(s) involved in tissue culture stress induced variation is being studied. Tissue-culture-induced release of transposable elements has been reported. Methylation has been hypothesized to control their expression. Study was focused on regulation of the *Ac* transposable element *Ac bz-m2* by methylation with AraC or demethylation with 5AC. *Ac bz-m2* transposable element is highly mutable in maize plants from caffeine-treated seeds. High concentrations of AraC control this caffeine effect. *Ac bz-m2* is very highly mutable in maize plants from tissue cultured immature embryos. AraC at concentration reducing regenerability cannot control this tissue culture effect. AraC and 5AC appear no different than control in the inactivation of the *Ac* transposable element in tissue culture.

The first intron of the Shrunken-1 gene has been observed to increase the level of gene expression in chimeric genes 11- to 91-fold. Molecular characterization of the sh, sh2m bt2 and Sus genes have shown similarities and differences between related genes. Interestingly, the presence of mutant alleles at one locus has been shown to increase the steady-state levels of transcripts at the other loci.

A number of projects were continued to evaluate genetic components of seed quality, plant quality and table quality with traditional and non-sweet germplasm. Seedling vigor in shrunken-2 corn is being studied with non-concordant genotypes (mutant endosperm, normal embryo). It is tentatively concluded that poor vigor of the embryo is the result of its close association with the mutant endosperm during kernel development.

II. PROGRESS OF WORK AND ACCOMPLISHMENTS:

1. Kernel Composition. (Indiana, Pennsylvania)

a. Genetic modification of corn starches for food uses:

Genetic modification and breeding of special-purpose corn starches with unique chemical, physical, and functional properties for specific food uses is continuing at Purdue University and Penn State. Composite populations homozygous for several multiple gene combinations including du wx, ad du, and ae du wx are being developed (Pennsylvania). To evaluate the effect of mutant genotype starch gelatinization, a series of starches in the Ia5125 inbred line were studied by differential scanning calorimetry (DSC). To examine the effect of amylopectin structure on gelatinization behavior, those maize samples containing the wx gene were also studied by size exclusion HPLC after isoamylase debranching. Thermal analysis of starch gelatinization by DSC and the pattern of debranched chains by HPLC were then observed for four mutant genotypes (wx, ae wx, du wx, and ae du wx) from four inbred lines (Ia5125, Ia453, S3-61, and W64A). Within lines the DSC maximum temperature for the ae wx genotype was 8.6-15.9°C above other genotypes. Enthalpy was highest for the ae sx starches from the S3-61 and W64A lines. The generally bimodal HPLC chromatograms had a greater proportion of the total area in the high-MW peak for the ae wx starches. Furthermore, the higher MW shoulder of the low-MW peak became the dominant low-MW peak for the ae wx starches from the S3-61 and W64A lines. Either or both of these differences in amylopectin fine structure could explain the different thermal behavior of the ae wx starches during gelatinization. It appears that variation in the proportion of chains between and within the two major peaks, rather than displacement of the entire chain length distribution, may be responsible for the variation in amylopectin structure. Variation in these proportions may help explain differences in the physical properties of the starches.

b. Nutritional quality improvement.

Genetics and breeding for modified-hard endosperm quality protein maize for nutritional quality was continued. (Indiana)

c. Provitamin A values in sweet corn hybrids and inbred parents.

Carotenoids were analyzed by HPLC in 26 sweet corn hybrids, both public and private. The hybrids were a select group of interest for color and provitamin A from the 67 hybrids analyzed in 1988. Also, 22 inbred parental lines of the 26 hybrids were included in the analysis. Represented were the sugary, sugary-sugary enhancer and shrunken-2 genotypes. The range of relative total pigment was 5-fold (2348 to 448), the 7-fold (1720 to 233) among the hybrids and inbreds, respectively. The range of relative primary pigment -carotene was 24-fold (11.8 to 0.5) and 69-fold (28 to 0.4) among the hybrids and inbreds, respectively. In general, the propensity among hybrids to produce elevated levels of -carotene was consistent over years. (Indiana).

d. In vitro and in vivo digestion on high-amylose type starch granules.

In vitro and in vivo digestion of high-amylose type starch granules from sugary-2 (su2), amylose-extender (ae), dull (du) maize endosperms by salivary and pancreatic -amylase of rats were investigated. From results on in vitro starch granule digestion by both -amylases, a strong correlation between the starch-granule digestibility and the wave-length at the maximum absorbance (nm) of the absorption spectra of starch-iodine complexes was found. While digestibility of the starch granules, which were isolated from the stomach, small intestine, and cecum of rats fed on diets containing either normal, su2, or ae starch-granules, during passage through the mouth to the stomach of rats was calculated by using the regression equation obtained from the in vitro trials. Degradation values of 32-40, 47-68 and 7-15% were calculated for starch-granules from normal, su2 and ae endosperms, respectively. The relative order of digestibility of starch-granules in vivo was su normal ae, respectively, which agrees with the previous in vitro studies. (Indiana)

2. Kernel Metabolism (Florida, Pennsylvania)

Studies addressing metabolic pathways, enzymology and cellular compartmentation were continued. Investigations of the regulatory enzyme PFP reversible removes a P from F-1.6 focused on effector regulation. The effectors fructose-2, 6-bisphosphate and inorganic pyrophosphate (PPi) modulate the activity of this enzyme by causing the association and dissociation of the enzyme into a large or small form. Fructose -2, 6-bisphosphate causes the association of the enzyme into a large form; whereas, high concentrations of PPi cause the dissociation of the large form of the enzyme to a small conformation. (Pennsylvania) The proximal portion of a Sh2 cDNA clone has been expressed in E. coli. The fusion protein produced by this clone is being used to produce antibodies against glucose pyrophosphorylase. (Florida) A nonradioactive assay for starch branching enzyme has been developed. The assay measures the stimulation of inorganic phosphate production from glucose-1-phosphate as catalyzed by phosphorylase. (Florida, Pennsylvania) This assay is currently being used to purify endosperm branching enzymes for N-terminal sequence analysis.

3. Molecular Biology (Florida, Indiana)

a. Methylation of maize tissue cultures and seeds by AraC and 5AC on expression of the Ac bz-m2 transposable element under stress.

The mechanism(s) involved in tissue culture stress induced variation is being studied. Tissue culture-induced release of transposable elements has been reported. Methylation has been hypothesized to control transposable element expression. Study was focused on the regulation of the Ac transposable element (Ac bz-m2) by methylation with arabinofuranosylcytocine (AraC) or by demethylation with 5-azacytidine (5AC). Ac bz-m2 transposable element is highly mutable in maize plants from caffeine-treated seeds. High concentrations of AraC control this caffeine effect. Ac bz-m2 transposable element is very highly mutable in maize plants from tissue cultured immature embryos. AraC at concentrations reducing regenerability cannot control this tissue culture effect. AraC and 5AC appear no different than control in inactivation of the Ac transposable element in tissue culture. (Indiana)

b. Molecular characterization of the sh, sus, sh2 and bt2 genes.

Comparison of the sequences and structures of the two maize sucrose synthases revealed the following facts. Intron 15 of the Sh (shrunken) gene is missing in the second gene, Sus. There exists much sequence similarity between intron 15 and exon 16 of Sh. Thus it would appear likely that an internal duplication occurred in Sh or its progenitor that did not occur in the gene lineage that gave rise to Sus. Sh and Sus, however, appear to have arisen by a gene duplication event. Sequencing of the Sus counterpart from a distantly-related monocot showed that this gene also lacked intron 15. Comparison of the sequences of Sh and Sus showed that there exists much similarity between the genes in the exons but there is no similarity in the intron regions. This would clearly be the prediction if each of these genes is important to the maize plant. (Florida)

Probing the Northern blots of a series of spontaneous sh2 mutations revealed that four mutants appear to lack the most distal 500 nucleotides of the Sh2 mRNA. Analysis of DNA from these mutants clearly shows that the sequences are present in the genome. It would appear that these mutants contain altered splice signal needed for RNA processing. (Florida)

The bt2 gene of maize has been cloned through sequence similarity to a cDNA clone for ADP-glucose pyrophosphorylase from rice. Analysis of various mutants shows that mutants contain transcripts altered in size as well as in amount. (Florida)

By use of clones for Sh2 and for Bt2, it has been shown that sh2 mutants increase the steady-state level of Bt2 and that bt2 mutations increase the Sh2 steady state transcript levels. (Florida)

c. Increased gene expression by shrunken intron.

The first intron of the Sh locus of maize was incorporated into constructs containing the chloramphenicol acetyltransferase gene (CAT) coupled with the nopaline synthase 3' polyadenylation signal. Transcription was driven by the 35S promoter of the cauliflower mosaic virus (CaMV) or the Sh promoter of maize. Transient gene expression was monitored following electroporation into protoplasts of Panicum maximum (guineagrass). Pennisetum purpureum (napier grass), or maize. The 1028 base pair intron increased gene expression in cells of each species when transcription was driven with the 35S promoter. Eleven to 91-fold increases were observed. Expression levels observed in maize were two to eight times those observed in napier grass and guineagrass, respectively. The 35S promoter gave CAT activity 10 to 100 times that observed with the Sh promoter. Thus, the Sh first intron may prove quite useful in increasing expression of foreign genes in monocots and possibly other plants. (Florida)

d. Transposon tagging.

Transposon tagging is in progress to isolate mutable alleles of endosperm starch genes of interest (Indiana, Pennsylvania). Development of close linkage of transposable elements with the target locus of interest via translocation stocks is underway (Indiana). Test crosses involving a mutable su allele for identification of the transposable element system involved in the high mutability are being developed (Florida, Pennsylvania).

e. Endosperm DNA levels.

Developmental studies of the relationship of maize endosperm DNA amplification and kernel and yield characteristics are in progress. (Indiana)

4. Genetic/Breeding Studies (Florida, Wisconsin)

The cause of the poor vigor in sh2 corn was examined by the creation of seed containing a mutant endosperm and a wild type embryo. Crosses of the sweet corn Florida Stay Sweet as the female by a stock containing a translocated chromosome involving a B or supernumerary chromosome and the Sh2 region of chromosome 3 of maize generated seed of the non-concordant genotype mentioned above. Seed with mutant endosperm showed a germination rate of approximately 10% whereas the normal-appearing seed from the same families germinated at approximately 80%. Genotypes of the embryos were confirmed by test crosses of resultant ears. It is tentatively concluded that the primary lesion associated with the sh2 mutation lies in the endosperm and that the poor vigor of the embryo is the result of its close association with the mutant endosperm during kernel development. (Florida)

A number of projects on germplasm improvement and evaluation continue at Wisconsin. The effects of non-sweet germplasm on table quality and plant quality continue to be evaluated. The effects of different endosperm types on stalk and root quality and dry matter accumulation were also studied. Data were not analyzed at the time of this report. Recurrent selection programs for improvement of disease resistance, seed quality, and earliness are underway. Three populations have undergone 3 cycles of selection for improved rust resistance. The change due to selection was evaluated in 1989. The changes due to divergent selection for endosperm type were evaluated for a second time in 1989. In both cases data summaries were not available at the time of this report.

III. WORK PLANNED FOR NEXT YEAR:

All stations will continue investigations related to the ongoing projects described above.

IV. PUBLICATIONS:

a. Regional: None
b. State, Station: None
c. Journal Articles, Proceedings

Indiana

Glover, D. V. 1988. Corn protein and starch -- Genetics, breeding and value in foods and feeds. In: Proc. 41st Ann Corn Sorghum Res Conf. American Seed Trade Association, Washington, DC pp. 106-130.

Ninomiya, Y., K. Okuno, D. V. Glover and H. Fuwa. 1989. Some properties of starches of sugary-1 and brittle-1 maize (*Zea mays* L.). Starch/Starke 41:165/167.

Fujita, S., D. V. Glover, K. Okuno and H. Fuwa. 1989. *In vitro* and *in vivo* digestion of high amylose type starch granules. Starch/Starke 41:221-224.

National Research Council. 1989. Triticale: A promising addition to the world's bread cereals. National Academy Press, Washington, DC 105 p. (Panel Members: R. Bressani, W. L. Brown, D. V. Glover, A. R. Hallauer, V. A. Johnson, C. O. Qualset, and N. D. Vietmeyer)

Pennsylvania

Goldner, W. R. and C. D. Boyer. 1989. Starch granule-bound proteins and polypeptides: The influence of the *waxy* mutations. Starch/Starke 41:250-254.

Wisconsin/Illinois

Tracy, W. F. and J. A. Juvik. 1989. Pericarp thickness of a shrunken-2 population of maize selected for improved field emergence. Crop Science 29:72-74.

d. Abstracts and Newsletters

Indiana

Papenfuss, J. M. and D. V. Glover. 1989. Methylation of maize tissue cultures and seeds by AraC or 5AC on the expression of the Ac bz-m2 transposable element under stress. Agron. Abstr, ASA, Madison, WI p 178.

Inouchi, N., D. V. Glover and H. Fuwa. 1989. DSC Characteristics of starch granules and retrograded starches of single-, and double-, and triple-mutants and their normal counterpart in the inbred Oh43 maize (*Zea mays* L.) background. Abstr. In: Symposium on Food polymers, Agriculture and Food Division. NE Reg. Mtg. ACS, June 18-21.

Wisconsin

Chang, Y-M. and W. F. Tracy. 1989. Indirect effects of divergent selection for endosperm phenotype on seedling characters in sweet corn. Agron Abstr, ASA, Madison, WI p 77.

Treat, C. L. and W. F. Tracy. 1989. Stalk and root quality in dent corn by sweet corn crosses. Agron Abstr, ASA, Madison, WI p 103.

Gerdes, J. J. and W. F. Tracy. 1989. Diversity and relationships of historically important sweet corn inbred lines. Maize Genetics Newsletter. 63:93.

Tracy, W. F. and R. D. Hatfield. 1989. Effect of corngrass on cell wall components. Maize Genetics Newsletter. 63:93.

Tracy, W. F. 1989. Lindsey-Meyers blue sweet corn. Maize Genetics Newsletter. 63:93-94.

e. Theses: None

f. Manuscripts in Press

Florida

Vasil, V., M. Clancy, R. J. Ferl, I. K. Vasil, and L. C. Hannah. 1989. Increased gene expression by the first intron of maize Shrunken-1 locus in grass species. Plant Physiol 91:(in press)

Indiana

Henson, A. R., D. V. Glover and W. E. Nyquist. 1989. Evaluation of R-nj kernel color expression as a selection criterion in maize. Crop Science (in press).

Pennsylvania

Dang, P. L. and C. D. Boyer. Comparison of soluble starch synthases and branching enzymes from leaves and kernels of normal and amylose extender maize. Biochem, Genet 27:521-532. (in press)

Wisconsin

Tracy, W. F. and J. G. Coors. 1990. Agronomic performance of sugary-brawn2 maize: A potential additive for high protein silage production. Agron J 82:(in press).

ANNUAL REPORT
1989

Subcommittee on Diseases and Pests

PROJECT: NE-124 Genetics and Physiology of Sweet Corn Quality, Pest Resistance and Yield

COOPERATING AGENCIES AND PRINCIPAL LEADERS:

Delaware AES (Newark)	J. A. Hawk
Florida AES (Belle Glade)	E. A. Wolf
Georgia AES (Tifton)	N. W. Widstrom
Illinois AES (Urbana)	J. K. Pataky
Minnesota (Sunseeds - Farmington)	S. L. Grier
New York AES (Ithaca)	M. E. Smith
	T. A. Zitter
Pennsylvania AES (University Park)	J. E. Ayers

SUMMARY OF PRINCIPAL ACCOMPLISHMENTS

The NE-124 disease and insect nursery indicated that common rust was prevalent in many areas in 1989, particularly Minnesota and New York. Northern leaf blight was prevalent in Florida. Stewart's wilt was prevalent in Delaware, Illinois, and New York. Common smut was observed at many locations but incidence of ear and stalk galls was highest in Minnesota. European corn borer, corn ear worm, and sap beetles were prevalent at some locations. Alleles conveying resistance to rust were evaluated at all locations. Alleles ld, le, lf, lg, ll, 3c, and 5 conditioned resistance at several locations. A project to develop inbreds from Zapalote Chico which can serve as a source of corn earworm and European corn borer resistance has been on hold pending identification of modified sources which will grow better in New York. Results of projects on Stewart's and Goss's wilts, common smut, resistance to infection of kernels by <u>Fusarium</u> <u>moniliforme</u> were published.

1. PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS

a. Cooperative Disease and Insect Nursery

The sweet corn disease and insect nursery included 8 locations and 12 different plantings (Table 1). Common rust, northern leaf blight, Stewart's bacterial wilt, common smut, eyespot, southern leaf blight, and southern rust were reported (Tables 2, 3, 4, 5, and 7). European corn borer, corn earworm, sap beetles, flee beetles, and aphids also were reported (Tables 6 and 7). Rp alleles, ld, 13, lf, lg, ll, 3c, and 5 conveyed resistance to common rust at five or more of the 7 locations reporting reactions.

b. Illinois AES

Relationships between incidence and severity of Stewart's and Goss's bacterial wilts (caused by Erwinia stewartii and Clavibacter michiganense nebraskense) and yield of sweet corn were examined from factorial experiments with sweet corn hybrids, pathogens, and incidence of initial infection as main factors. Relationships were similar for the two diseases but were affected differently by host resistance. In resistant and moderately resistant hybrids, Miracle and Gold Cup, relationships between incidence and severity were linear. For a susceptible hybrid, Jubilee, the relationship was curvilinear with severity ranging from 25 to 65% (rating 4 to 6.5 on a 1 to 9 scale) at 100% incidence depending on the host growth stage at which plants were infected.

A strategy for managing common rust on sweet corn was prepared from results of various research projects concerned with yield reductions due to rust, resistance to rust, epidemiological
development of rust, and the use of fungicides
to control rust.

Techniques for inducing ear galls by inoculating plants with Ustilago maydis were evaluated in the field. Injection of a sporidial suspension between the leaf sheath and stalk at the sixth, seventh, and eigth nodes below the top of plants 0 to 8 days before tassel emergence produced ear galls repeatedly in greenhouse trials. These procedures usually resulted in tassel galls in 1989 field trials. Further work is being done.

Weak associations among 19 sweet corn hybrids were observed between yield of sweet corn and titer of maize dwarf mosaic virus (MDMV), between yield and symptoms of MDM, and between titer and symptoms. Three types of resistance of MDM were observed. Terminator and 87-5134 had resistance (similar to that of Pa 405) in which all plants remained asymptomatic and titer did not differ from uninoculated plants. Plants of Seneca 258 segregated for symptoms and titer. Titer of symptomatic plants was less than that of the most susceptible hybrid. Sundance and Wintergreen had partial resistance in which titer was less than in susceptible hybrids and symptoms were less severe. Yields were less severely affected by MDMV for all resistant hybrids.

Relationships among carbohydrate content of kernels, condition of silks after pollination, and the response of sweet corn inbred lines to infection of kernels by Fusarium moniliforme were studied. Quantity and concentration of kernel carbohydrates were not related to infection of kernels by F. moniliforme. Asymptomatic infection of kernels was less for inbreds with green-brown, actively growing silks than for inbreds with silks that and turned brown quickly after pollination. A principal factors analysis indicated that emergence was affected by a fructose/glucose factor and an infection factor.

The time at which sweet corn hybrids were evaluated for reactions to E. stewartii and the method of evaluation affected the degree to which Stewart's wilt ratings and relative maturity of hybrids were related. Correlations among ratings and maturity were highest when plants were evaluated after anthesis and ranged from -0.34 to -0.71. Thus, early-maturing hybrids were rated more susceptible at late ratings and late-maturing hybrids were rated more resistant at late ratings as compared to early ratings. As a group, early-maturing hybrids were more susceptible to E. stewartii and late maturing hybrids were more resistant, although resistant and susceptible hybrids were identified in all three classes of maturity.

Other projects included: i) 1989 sweet corn hybrid disease nursery, ii) maternal inheritance of resistance for F. moniliforme [with J. M. Headrick], iii) evaluation of inbred lines for reactions to northern leaf blight and Stewart's wilt [with A. C. Meyer and J. A. Juvik], iv) evaluation of the value of the Ht1 gene (in terms of yield) in genotypes with varying levels of general resistance to E. turcicum, v) techniques to enhance commercial production of cuitlacoche (i.e. corn smut, maize mushroom), vi) yield loss functions for northern leaf blight, vii) production of sh2 seed lots infected with combinations of F. moniliforme, F. graminearum, and Penicillium sp. [with P. R. Mosely], and viii) effects of planting date on development of Stewart's wilt on hybrids with varying levels of resistance [with J. A. Hawk].

c. New York AES

Development of Zapalote Chico lines. The s2 lines grown in last year's nursery, although some of them flowered early enough to pollinate, had terrible seed set and seed quality. Alternative sources of Zapalote Chico derived materials are being sought in an attempt to get material with better adaptation and performance in New York environments. This project is temporarily on hold until such sources are found.

2. USEFULNESS OF FINDINGS

a. Cooperative disease and insect nursery

Yearly monitoring of disease and insect incidence and severity provides essential information to sweet corn breeders, pathologists, entomologists, and extension workers. Both sudden and gradual long term changes in pest populations are evident from the accumulated data on these trials. For example, the last two year's data give an indication of the prevalence of sweet corn pests in New York under two extremely different seasons (hot and dry in 1988 vs. normal temperatures and wet in 1989), information which can be used to guide breeding priorities for the range of environments likely to be encountered in this area over year. The continuing high populations of flee beetles may indicate a need to pay more attention to Stewart's wilt in this area. These tests provide an effective "early warning" system to detect threatening trends in pest incidence or severity.

Data from the evaluation of rust differentials provides an indication of the rust alleles which can be usefully deployed in an area, and conversely, sheds light on the genetic nature of the population of P. sorghi in an area.

b. Illinois AES

The studies described provide useful information which will allow for a better understanding of the methods by which to best control diseases of sweet corn.

3. WORK PLANNED FOR NEXT YEAR

a. Cooperative disease and insect nursery

Evaluation of the disease and insect nurseries and the Rp alleles will be continued. Segregation in some of the differentials needs to be selected for to fix these alleles. Work is continuing to backcross the alleles which are most effective over broad area into adapted sweet corn germ plasm.

b. Illinois AES

Disease nurseries and other "maintenance" work will be continued with an increased emphasis on incorporating disease resistance into adapted sweet corn germ plasm to be released to commercial breeders. Epidemiological projects on northern leaf blight will be expanded to examine competition among isolates of E. turcicum in relation to disease development and spread. Emergence and seedling blight problems will receive additional efforts. Ongoing projects will be completed.

c. New York AES

The effort to identify adapted Zapalote Chico inbreds will be continued and any materials available will be screened to determine its level of resistance to European corn borer and corn earworm. Contingent on the availability of funds to support molecular work and pending indentification of usable Zapalote Chico inbred, crosses to initiate molecular analysis of the resistance in Zapalote Chico may be made.

4. PUBLICATIONS ISSUED DURING 1989

A. Regional

Pataky, J. K. and J. M. Headrick. 1988. Illinois sweet corn hybrid disease nursery - 1988. Pg. 100-107 in: Midwest Vegetable Variety Trial Report for 1988. Purdue Univ. Agr. Exp. Sta. Bulletin No. 551.

B. State and Station

Pataky, J. K. and J. M. Headrick. 1989. Management of common rust on sweet corn through the use of partial resistance and fungicides. Pg. 102-108 in: Proc. Illinois Agricultural Pesticides Conference, Jan. 3-5, 1989, Urbana, IL.

C. Journal Articles

Byrnes, K. J., J. K. Pataky, and D. G. White. 1989. Relationships between yield of three maize hybrids and severity of southern leaf blight caused by race 0 of *Bipolaris maydis*. Plant Disease 73:834-840.

Headrick, J. M. and J. K. Pataky. 1989. Resistance to kernel infection by *Fusarium moniloforme* in inbred lines of sweet corn and the effect of infection on emergence. Plant Disease 73:887-892.

Pataky, J. K. and J. M. Headrick. 1989. Management of common rust on sweet corn with resistance and fungicides. J. Prod. Agric. 2:362-369.

Suparyono, and J. K. Pataky. 1989. Influence of host resistance and growth stage at the time of inoculation on Stewart's wilt and Goss's wilt development and sweet corn hybrid yield. Plant Disease 73:339-345.

Suparyono, and J. K. Pataky. 1989. Relationships between incidence and severity of Stewart's and Goss's bacterial wilts and yield of sweet corn hybrids. Crop Protection 8:363-368.

Thakur, R. P., K. J. Leonard, and J. K. Pataky. 1989. Smut gall development in adult corn plants inoculated with *Ustilago maydis*. Plant Disease 73:921-925.

D. Newsletters, Abstract, Supplements

E. Theses

Headrick, J. M. 1989. Epidemiology of and resistance to kernel infection of sweet corn by *Fusarium moniliforme*. University of Illinois, Urbana-Champaign. 91 pp. (Ph.D. dissertation)

F. Manuscripts in Press

Headrick, J. M., J. K. Pataky, and J. A. Juvik. Relationships among carbohydrate content of kernels, condition of silks after pollination, and the response of sweet corn inbred lines to infection of kernels by Fusarium moniliforme. Phytopathology (accepted with revision).

Olson, A. J., J. K. Pataky, C. J. D'Arcy, and R. E. Ford. Effects of drought stress and infection by maize dwarf mosaic virus on sweet corn. Plant Disease (accepted 20 September 1989).

Pataky, J. K. Illinois sweet corn hybrid disease nursery - 1989. Midwest Vegetable Variety Trial Report for 1989. Purdue Univ. Agr. Exp. Sta. Bulletin (in press).

Pataky, J. K.., N. R. Pataky, and D. E. Fisher. Sorghum downy mildew on sweet corn in central Illinois. Plant Disease (accepted 7 November 1989).

Pataky, J. K., J. F. Murphy, and C. J. D'Arcy. Resistance to maize dwarf mosaic virus, severity of symptoms, titer of virus, and yield of sweet corn. Plant Disease (accepted 30 November 1989).

Pataky, J. K., Suparyone, J. A. Hawk, M. L. Gardiner, and M. H. Pauly. Associations between Stewart's wilt ratings and maturity of sweet corn hybrids. Plant Disease (submitted for review).

1989 NE 124 Subcommittee Report
Environmental Influences on Plant Growth,
Performance and Seed Quality.

Contributors: Florida AES, D.J. Cantliffe.
New York AES, R.W. Straub.
Wisconsin AES, W.F. Tracy.

Summary Florida AES, D.J. Cantliffe.

Super sweet corn (Zea mays L.) seed was treated with captan, thiram, captafol, metalaxyl, and imazalil in combination or alone to evaluate their effect on emergence and stand establishment. Seeds were treated by a standard batch seed dusting method, or during seed priming which allowed the seed to partially hydrate in the presence of the chemical solution. Three microbial treatments were also evaluated for their effects on stand establishment and early seedling growth using the priming technique. Seeds were sown on 4 planting dates in the Spring of 1988, on sandy soil in Gainesville. After the first planting, severely low temperatures occurred, however, 76% emergence was obtained with a captan, thiram, metalaxyl, and imazalil combination treatment compared to 56% for the control. Similar differences in stand were observed on the second planting while stands were similar regardless of treatment in the third and fourth planting where soil temperatures were warmer. Seed priming combined with seed treatment improved the rate of germination. The addition of the microbial treatments did not improve sweet corn stands.

New York AES, R.W. Straub.

Cerone™ growth regulator was further evaluated (0.25, 0.30 and 0.38 lb Al/acre) for effects on plant ht., % marketable ears and ear wt. All treatments significantly reduced plant ht. of 4 hybrids (Silver Queen, BiQueen, Tendertreat, and Calico Belle), did not affect ear wt., but caused significant 'cob extension beyond husk cover' in Tendertreat and Calico Belle. In a separate trial in which this variable was evaluated on 20 hybrids, Cerone applied late (early green tassel stage) caused this negative effect on all but 4 hybrids. Hurricane Hugo provided an excellent opportunity to evaluate the effects of reduced plant stature on lodging. Cerone treated plants of 5 hybrids had no lodging, whereas lodging of untreated plants ranged from 19 to 39%. It is apparent that a treatment timing x rate interaction exists for the 'cob extension' character and most hybrids will yield few marketable ears if Cerone is applied at anytime later than the 3" embryonic tassel stage of growth. So too, it is apparent that if used properly, Cerone may have a positive impact in the significant reduction of lodging of most hybrids, in addition to reducing tall hybrids to a more acceptable stature.

Wisconsin AES, W.F. Tracy.

The timing of greatest sensitivity to imbibitional chilling injury was examined in two shruken-2 and two sugary hybrids. For sh2 hybrids the decrease in percent germination as a result of chilling during hours 0-2 equalled that for chilling during the first 24 hours. Damage due to chilling during hours 2-4 and 4-6 was not significantly less than that due to hours 0-2. However chilling during hours 6-8 resulted in significantly less damage than did the previous 3 treatments. Indeed, the percent germination in hours 6-8 equalled that of the warm test. Chilling (5C) during the first 6 hours of imbibition resulted in large decreases in germination. The size of the decrease depends upon the hybrid and the endosperm type. For sh2 endosperm this damage was generally at an economically unacceptable level. Many factors following imbibition can lower germination, emergence, and final stand, but if sh2 seed is exposed to chilling conditions during early imbibition the maximum possible germination may be reduced by 15-50% depending upon the hybrid. In a separate experiment, three cold stress tests resulted in decreased germination relative to the warm test. Averaged over 4 hybrids the cold bath followed by 24 hours of cold air (5°C) resulted in the lowest germination but this response was not consistent over hybrids.

Progress of Work and Principle Accomplishments

Florida AES, D.J. Cantliffe.

These experiments were conducted to improve stands and ultimately yields of super sweet corn. Combinations of fungicide seed treatments were best to improve stands under conditions of low soil temperature. A combination of captan, thiram, metalaxy., and imazalil was more effective than the stand treatment of captan, thiram, metaxyl and captafol. Thus, imazalil seems to be an improved replacement for captafol, the latter of which has been withdrawn from use as a fungicide. Benefits from seed treatments were no longer apparent as environmental conditions improved, especially warmer soil temperatures, for germination of super sweet corns. Seed priming has been shown to be an effective method to improve rate and uniformity of stands of various crops sown under environmental stress. In the present experiment, seed priming of super sweet corn seed had little influence on stand parameters. This was again most likely related to the more or less optimum field conditions at the time of sowing in later March and early April and probably due to the high seed quality of the particular seed lot used. Yield was affected most by poor stands in the initial 4 March planting. As stands were optimized, yields were improved.

The use of growth promoting bacteria had no promotive effect on early plant growth or yields. There was a tendency towards reduced stands when seeds were primed with the bacteria and sown at high seed moisture content. Once the seeds were redried this observation was negated probably due to the death of the bacteria were continued to test the effects (plant ht., % marketable ears and ear wt.) of Cerone™

growth regulator on 4 hybrids, ie., Silver Queen, BiQueen, Tendertreat and Calico Belle. A single application of Cerone at 0.25, 0.30 and 0.38 lb Al/acre was made when the embryonic tassel was 3" . Similar to last year, all rates significantly reduced plant ht. without significant reduction in ear wt.; however, again similar to last year, all rates of Cerone applied to Tendertreat and Calico Belle caused cob extension beyond the husk cover. In a separate trial, Cerone applied to 20 hybrids (0.28 lb Al/acre) in the early green tassel stage caused excessive cob extension in all but 4 hybrids. This deleterious effect ranged from 0% (Silver Queen) to 96% (Sprite). Hurricane Hugo provided opportunity to evaluate the effects of Cerone on lodging. On 5 hybrids, ht. was reduced from 22-32% and resulted in 0% lodging; in untreated, 19-39% of the plants were lodged.

Wisconsin AES, W.F. Tracy.

Progress of work and principle accomplishments

The timing of imbibitional chilling injury in sh2 corn was further examined. In 1989 two experiments were performed; Experiment 1 - six 2 hour chilling treatments were imposed during the first 12 hrs of imbibition; Experiment 2-3 different types of chilling injury were imposed in the first 24 hrs. Experiment 1: seed of 2 sh2 hybrids and 2 sugary (su) hybrids were obtained. The hybrids were commercially available and treated with fungicide and insecticide. There were six treatments consisting of 2 hour periods of cold treatment at 2 hour intervals during the first 12 hours after the onset of imbibition, followed by 7 days at 25C. Treatment 1, 5 C 0-2 hours after the onset of imbibition; treatment 2, hours 2-4 5C; ....; treatment 6, hours 10-12 5C. Experiment 2: Seed of four hybrids, 2 sh2 and 2 su were exposed to four treatments. Treatment 1, consisted of rage dolls soaked in 25C water and then put into a 25C cabinet for 7 days; treatment 2, rag dolls soaked in OC water and then put into 25C cabinet for 7 days; treatment 3, 25C soak followed by 24 hours at 5C and then 6 days at 25C; and treatment 4, OC soak followed by 24 hours at 5C followed by 6 days at 25C. Experiment 1. The sh2 hybrids were strongly affected by the 2 hour cold treatments. No differences in the germination of the su hybrids were detected. For the sh2 hybrids the 0-2 h treatment averaged 65% germination (the same as the 24 h cold treatment). The 2-4 and 4-6 h treatments were not significantly different from 0-2 h. The 6-8 h treatment averaged 80% germination. The warm test germination for these two hybrids was 79%. Germination in the 10-12 h treatment declined significantly from the maximum for both types of hybrids. The reasons for significantly from the maximum for both types of hybrids. The reasons for this decline are unknown. Experiment 2. Hybrids and treatments had significant effects on germination. There was also a significant treatment x hybrid interaction. Hybrid A-sh2 had poorer germination than the other 3 hybrids and also showed a greater response to cold treatments. Hybrid B-sh2 averaged higher percent germination than hybrid B-su. The response to the cold stress treatments varied over hybrids and no treatment resulted in the poorest germination in all hybrids. When averaged over all hybrids all three stress treatments had significantly lower germination than did the warm test. The cold bath/warm air treatment had significantly higher germination than the cold bath/cold air treatment.

Usefulness of Findings

Florida AES, D.J. Cantliffe.

These experiments showed the profound effect that low soil temperature has on plant stands of super sweet corn. Seed treatments with a combination of fungicides can greatly improve plant stands under these conditions. Thus, a major factor to be considered to maximize yields whenever using super sweet corn is to control seed and soil borne pathogens. This is probably at least as important, and possibly more important, to optimizing emergence of sh2 sweet corns than seed vigor considerations.

New York AES, R.W. Straub.

Cerone is effective in reducing the height of extremely tall hybrids, and in entirely eliminating lodging. However, if Cerone is applied too late in the plant's growth, the effects on cob extension beyond the husk are severe for most hybrids. It is concluded that Cerone could be a valuable tool, in the reduction of lodging alone, but application timing is critical.

Wisconsin AES, W.F. Tracy

Knowing when sh2 seed is most sensitive to chilling injury may allow growers to avoid planting into adverse conditions. This information may also be useful in developing seed treatments that will decrease this sensitivity.

Work Planned for Next Year

Florida AES, D.J. Cantliffe.

A continuation of seed treatment and seed enhancement experiments to improve the usefulness of such for improving stands of super sweet corn.

Collaborative research with L.C. Hannah will focus on the 'genetic' effects of sh_2 on vigor. The results of this work will be reported next year.

New York AES, R.W. Straub.

The 'cob extension' effect of Cerone applications present a limitation to the usefulness of this treatment. The effects of various (rate and timing) treatments to a limited number of hybrids will be extensively investigated in file trials.

Wisconsin AES, W.F. Tracy.

Studies on imbibitional chilling injury will continue with emphasis on determining critical temperatures. The effect of seed fungicides on seed longevity will also be examined.

Publications issued during 1989

Cantliffe, D.J. and M. Bieniek. 1989. Improving plant stands for super sweet corn by seed treatment. Proc. Fla. State. Hort. Soc. 101: 1988: 372-376.

Schmidt, D.H. and W.F. Tracy, 1989. Duration of imbibition affects seed leachate conductivity in sweet corn. HortScience. 24:346-347.

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Tracy, W.F. 1989. Timing of imbibitional chilling in sh2 sweet corn. Agron Abst. 153.

Tracy W.F. 1989. Improving germination of super sweet corn. Midwest Food Processors Processing Crops Manual and Proceedings. 1:107-110.

NE124 Technical Committee Annual Report

1989

Subcommittee: Germplasm Resources

Prepared by: James L. Brewbaker, University of Hawaii

Summary of Principal Accomplishments:

New versions of bt inbred Hi38 were obtained from a 21-generation CRf conversion program improved for staygreen, fusarium tolerance, and many other plant and ear traits. The narrow backcross pedigree (1/128 WF9 x CI21E, 1/128 Hi27, remainder = inbred) has provided major genetic advance in 13 traits. High heritability was shown for staygreen in a diallel of bt inbreds, and little correlation shown with the kernel and seedling rot phases of Fusarium moniliforme. Monogenic inheritance was observed for stalk damage by Physoderma maydis, with resistance dominant.

A collaborative international program of tropical supersweet maize improvement was established. Trials were entitled the "Supersweet Worldwide Trials" (SWT). Maize breeders in Colombia, Mexico, Puerto Rico, Nigeria and Thailand initially agreed to participate in SWT90 trials and contribute OP composites and varieties important in the tropics. Invitations were forwarded to other potential collaborators.

Progress of Work and Principal Accomplishments:

Inbred development continued on brittle-1 background in tropical-adapted materials with major selection for tenderness, staygreen and disease resistance. Genetic improvement through recurrent selection occurred in 13 traits segregating in a major series of inbreds based on Hi38 (bt gene, derived from earlier su inbred AA8). The 21-generation pedigree was initiated in 1971 with crosses for conversion to C cytoplasm and Rf4 (from WF9 x CI21E) of Hi27 (Colombian-derived field corn), which was then crossed in 1972 to AA8. Present inbred constitution of Hi38 inbreds is ca. 1/256 WF9CRf, 1/256 CI21E, 1/64 Hi27 and 1/8 AA8su (of Golden Bantam x Cuban origin).

Improved bt Rf4 C sister-inbreds of Hi38 have been obtained for tenderness, high seed viability, staygreen, short glumes, low incidence of multiple ears, erect leaf, resistance to kernel rot (F. moniliforme), green inner silk, leaf-flecking, root lodging and tip-burning in this narrow pedigree. The AA8 su gene appeared linked to poor brace rooting and high susceptibility to stalkrot phase of F. Moniliforme. The Rf4 gene showed close linkage to green plant color (not green silk color) and staygreen. Resistance to Physoderma maydis stalk and husk blotch segregated as a Mendelian trait, with susceptibility recessive, in this background.

Staygreen (SG) segregated among these Rf4 conversions, and four parents were chosen for generation mean analyses from three crosses involving divergent parents. Plants were scored on 1-9 scale. F1s were intermediate to parents, as noted below:

	P1	F1	P2
Cross 23 x 35	3.4	5.6	6.6
Cross 31 x 35	3.4	4.3	8.7
Cross 31 x 44	4.8	5.8	8.7

F2 and BC crosses segregated rather simply. Heritability was high, ranging from .38 to .72 (narrow-sense) and .95-.97 (broad-sense), and estimated gene numbers were small (0.65 to 1.47). It is suggested that SG is controlled in this series by a single gene, with F1's intermediate to parents, i.e., SG partially dominant.

A collaborative international program of tropical supersweet maize improvement was established. High-sucrose genotypes alone will be entered in the trials. Trials were entitled the "Supersweet Worldwide Trials" (SWT), initiating with the SWT90 series. Maize breeders in Colombia, Mexico, Puerto Rico, Nigeria, Philippines and Thailand initially agreed to participate in the trials and contribute germplasm. Invitations were forwarded to other potential collaborators.

The SWT90 trials will involve OP composites and varieties that serve as basis for population improvement or commercialization in the tropics. Many of these are based on "Hawaiian Supersweet" cultivars of *sh2* or *bt* genotype. CIMMYT and IITA staff have agreed to collaborate in collection and dispersal of varieties that cannot be brought into the United States without the customary "act of Congress".

Usefulness of Findings:

Improved *bt* inbreds are released for evaluation in commercial hybrids in Hawaii and elsewhere in the tropics, where the Hawaiian Supersweet cultivars are increasingly well known. Improved resistance to early senescence ("staygreen") seems associated with improved fungal resistance important to maximize yields of sweet corns in the tropics.

Publications Issued During 1989:

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Brewbaker, J. L., M. L. Logrono and S. K. Kim. 1989. The MIR (Maize Inbred Resistance) trials; Performance of tropical-adapted maize inbreds. Hawaii Inst. Trop. Agric. Human Resources Research Rep. 000