COLD TEST GERMINATION OF HYBRID SEED CORN

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Gerard Neptune

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This is to certify that the

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COLD TEST GERMINATION
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COLD TEST GERMINATION OF HYBRID SEED CORN

By

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INTRODUCTION

Wherever corn is grown a good stand is essential for maximum yields. In the northern areas, particularly, obtaining a good stand of corn is often a problem. Cold, wet weather frequently occurs after planting. Under these conditions, seedling blights and rots are likely to develop and kill the seedling before or after emergence. Since the number of plants per acre has a very large effect on the yield of grain (17), it is important to understand the factors that influence stands of corn.

The purposes of this study were to determine:

(a) the extent of the difference in cold test germination among the various hybrids grown by Michigan farmers;

(b) the differences that might occur among different seed producers of the same hybrid; and

(c) the effect of age of seed on cold test germination.

REVIEW OF LITERATURE

Several factors affecting stands of corn under adverse conditions have been investigated. Various microorganisms have been shown to cause reduction in stands of corn under cold wet conditions (3, 7, 8, 9, 19). Low temperature and excessive soil moisture have been shown to be favorable for development of various pathogens which attack the seed and young seedling. Pythium sp. have been reported to be the principal pathogens involved (7, 8). Injury to germination and seedling vigor was found to be greater as the water content of the soil increased in cold weather (5). Germination was not greatly affected when soil at 30-40% of its water-holding capacity was inoculated with Pythium.

The amount and the type of seed coat injury have been shown to cause reductions in stands of corn (1, 2, 10, 11, 12, 14, 20, 21). Injury to the pericarp permits invasion by seed-borne and soil-borne organisms which cause kernel rot, seedling blight, and root rot. Significant correlations of field stands with cold test germination have been reported by Tatum and Zuber (21), and Pinnel (15).

Genetic differences in reaction to attack by seedling blight organisms have been reported (4, 6, 13, 15, 20). Genetic constitution of the seed was shown to affect cold test performance with wide differences existing among inbred lines and hybrids (15, 21). These differences were largely maternal; the pollen parent exerted relatively little influence on the cold test reaction of the seed.

Commercial processing was found to cause much damage to hybrid seed corn (22). Injury increased as processing progressed through successive stages. Hybrids were found to differ in their susceptibility to physical injury during processing, and, also, to differ in their potential ability to germinate.

Maturity of the seed and frost injury have been reported (18) as additional factors influencing stands in cold wet soil. In general, cold test stands improved as the seed matured. Arasan treated seed gave better stands than nontreated seed in all cases. While standard laboratory germination tests indicated no reduction in germination from frost, the frosted seed gave a lower cold test germination than unfrosted seed.

MATERIALS AND METHODS

Seeds of 118 corn hybrids entered in the 1950 Michigan Hybrid Corn Trials and seed of 120 hybrids entered in the 1951 trials were tested for their ability to germinate under cold, wet conditions. The seeds for the two trials were produced in 1949 and 1950, respectively. Samples, generally representative of seed offered for sale, were submitted by the various seed companies participating in the state yield trials. All seed samples had been treated with a seed disinfectant, but the same compound was not used on all of the samples.

The 1949 seed entered in the 1950 trials was tested during the period January 21 to February 15, 1951. The 1950 seed entered in the 1951 trials was tested during the period April 28 to May 23, 1951. In both tests, three replications of fifty seeds each, were planted in soil in flats. The soil was saturated with water and the flats placed in a walk-in cold chamber maintained at 45° F for twelve days. The flats were then moved to a warm room (70-80° F) in the greenhouse for thirteen days. Strong seedlings were counted at this time.

The seedlings were cut at ground level and the average green weight per seedling in grams was obtained.

Seeds of four Michigan Certified hybrids (Ohio M 15, Michigan 51 B, Michigan 11 A, and Michigan 36 B) produced by different seed growers in 1948, 1949, and 1950 were subjected to cold test germinations. The cold tests were conducted April 19 to May 17, 1951. There were six different growers involved and they are designated by letters. Five growers produced Ohio M 15 during the three-year period, four produced Michigan 51 B, three produced Michigan 11 A, and two produced Michigan 36 B. Samples of seed representative of that offered for sale were submitted by each grower. The large flat grade of seed was used in all cases.

EXPERIMENTAL RESULTS AND DISCUSSION

Cold test germination and average seedling green weight for the 1949 and 1950 seed of entries made in the Michigan Hybrid Corn Trials are presented in Table I, and the analyses of variance in Table II. For both years, there were significant differences among the hybrids for both characteristics.

Rag-doll germinations under standard laboratory conditions were conducted on all of the seed samples. The average germination was 98.5% and all samples were above 94%. Thus, all of the seed was capable of a high germination percentage under the ideal conditions of a standard germination test.

The range in cold test germination was 86.0 to 1.3% for the 1949 seed samples and 98.7 to 19.3% for the 1950 seed samples. The averages were 46.6 and 80.0% for the two years. The older seed (1949 crop) was generally lower in cold test than the new seed (1950 crop).

Differences among hybrids in germination cannot be attributed entirely to varietal differences since other factors such as abuse of the seed in processing, maturity, and frost injury (22, 18) may have affected the cold test performance.

TABLE I

AVERAGE COLD TEST GERMINATION AND GREEN WEIGHT PER SEEDLING FOR 1949 AND 1950 SEED SAMPLES ENTERED IN THE MICHIGAN HYBRID CORN TRIALS FOR 1950 AND 1951

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Pioneer	X 5822	82.7		1.0	
"	348	84.7		1.0	
"	382	68.7		1.0	
"	359	33.3		0.9	
"	339	78.0		1.2	
Pioneer	X 5562	56.7	88.7	1.1	0.9
"	X 7278	78.0	93.3	1.0	0.8
"	322	60.0	78.7	0.9	0.7
"	373	70.7	88.0	1.3	0.9
"	344	70.0	90.0	1.2	0.9
Pioneer	388	66.7	83.3	0.9	0.8
"	352	72.7	90.0	1.0	0.8
"	342 A	76.0	86.0	1.4	0.8
"	349	86.0	88.7	1.3	0.7
"	X 5643	66.0	87.3	0.9	0.9
Pioneer	377 A		76.7		0.8
"	396		90.7		1.0
"	314		82.7		0.6
"	X 7027		96.0		1.0
"	X 7036		96.0		1.0
"	X 7164		84.0		0.6
"	X 7164 MF		83.3		0.7
Average		71.3	87.3		

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Funks	G 30	22.0	88.0	0.8	0.9
"	G 16 A	55.3	87.3	0.9	0.9
"	G 6	26.7	75.3	0.9	0.7
"	G 28	38.0		1.0	
"	G I A	48.7		1.2	
Funks	G 11		82.0		0.9
"	G 18		86.0		0.8
"	G 68		88.7		0.8
"	G 188		78.0		0.9
Average		38.1	83.6		
Pfister	PAG 2675	76.7	78.7	1.0	0.7
"	PAG 7011	68.0	94.7	0.8	1.0
"	PAG 299	69.3	84.0	1.0	0.8
"	PAG 253	73.3	88.7	1.1	0.8
"	PAG 56	65.3	87.3	1.0	0.8
"	PAG 35	76.0	79.3	1.1	0.9
Pfister	PAG 61	74.7	90.0	1.1	0.8
"	PAG 2772		93.3		0.8
"	PAG 4196		96.7		0.8
"	PAG 4199		96.0		0.8
"	PAG 4560		83.3		0.8
"	PAG 7020		90.7		0.8
"	PAG 7026	50.7		1.4	
Average		69.2	88.6		

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Master	F 101 A	70.0	78.0	1.3	1.0
"	F 82	70.0	86.0	1.0	0.8
"	F 83	52.7	78.7	1.2	0.7
"	F 21	74.7	87.3	1.0	0.8
"	F 60	81.3	92.0	1.2	0.8
"	F 140		62.7		0.8
Average		69.7	80.8		
Haapala	120	4.0		0.3	
"	130	6.0		0.8	
"	270	29.3		0.6	
"	300	73.3		1.1	
"	352	40.0		1.2	
"	475	17.3		0.9	
Average		28.3			
Garno	448 A	59.3		1.0	
"	440	52.7		1.3	
"	451	37.3		0.8	
Average		49.8			
De Kalb	404 A	43.3	75.3	1.1	0.7
"	406	72.7	78.7	1.3	0.7
"	240	38.7	90.0	1.0	0.8
"	65	32.0	78.0	0.8	0.8
"	43	56.7	87.3	0.8	0.8

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
De Kalb	410	58.7		0.8	
"	50	47.3		1.0	
"	408		81.3		0.8
"	459		77.3		0.5
"	239		81.3		0.7
De Kalb	41		65.3		0.9
"	56		72.7		0.8
"	58		74.7		0.7
Average		49.9	78.4		
Jacques	1157 J	56.7		1.0	
"	1055 J	60.7	75.3	1.2	0.9
"	956 J	64.0	53.3	1.1	0.6
"	907	54.7	82.0	1.0	0.8
Jacques	1153 J		84.0		0.8
"	1107 J		86.7		0.8
"	1003 J		75.3		0.6
"	G 2		81.3		0.8
"	H 7		88.7		0.8
Average		59.0	78.3		
Wolverine	55	28.7		1.0	
"	83	18.0	80.0	1.1	0.9
"	60	40.7	62.0	0.8	0.9
"	77	75.3	90.7	1.3	0.8
"	58	53.3	78.7	1.1	0.6

TABLE I (Continued)

Hybrids	Germination (%)		Green Weight per Seedling (grams)	
	1949	1950	1949	1950
Wolverine 22	29.3	83.3	0.9	0.8
" 46	50.0	74.0	0.9	0.8
" 66	22.0	91.3	0.7	0.7
" 90		48.0		0.6
Average	39.7	76.0		
Kingscrost KT	72.0		1.1	
" KE 2	88.7		1.2	
" KE 1	71.3	90.7	0.9	0.7
" KA 4	22.7	88.0	1.0	0.7
" KS 2	58.0	80.7	0.9	0.8
" KS 6	62.0	78.7	1.2	0.9
" KL	77.3	84.7	1.2	0.8
Kingscrost KO 5		91.3		0.8
" KS 3		90.0		0.8
" KS 4		86.0		0.9
" KH 3		89.3		0.7
" KY 4		92.0		0.7
" KI		82.0		0.7
Average	64.6	86.7		
Michigan 11 A	24.0	90.0	0.9	0.9
" 24 B	49.3	83.3	0.8	0.8
" 36 B	27.3	78.0	0.9	0.8
" 51 B	43.3	84.0	1.3	0.8

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Michigan	20 D	72.7	95.3	1.1	0.9
"	29 D	52.0	88.7	1.1	0.9
"	250	58.7	98.0	1.0	0.9
"	350	69.3	95.3	1.2	0.8
"	480		98.7		0.8
Average		49.6	90.1		
Nosco	N 4	56.0		1.5	
"	N 6	36.0		1.4	
"	N 9	46.7		1.0	
"	N 12	17.3		1.2	
Average		39.0			
Minnesota	800	42.0		0.9	
Wisconsin	270	41.3		1.0	
United	U 17	47.3		1.3	
"	U 18	56.7		0.9	
"	U 26	39.3		0.7	
"	U 28		19.3		0.5
"	U 32-30		77.3		0.7
"	U 33		50.0		0.8
United	U 20	29.3	66.0	1.0	0.8
"	U 22	28.0	96.7	0.7	1.0
"	U 24	20.7	90.7	0.5	0.9
"	U 32	67.3	78.7	1.0	0.7
"	U 32 A	68.0	62.0	1.0	0.6
Average		44.6	67.6		

TABLE I (Continued)

Hybrids	Germination (%)		Green Weight per Seedling (grams)	
	1949	1950	1949	1950
Supercrost F 140	25.3		0.9	
" 85 A	1.3		0.1	
" 213	23.3	56.7	1.1	0.7
" F 112 A	8.0	67.3	0.9	0.7
" F 440		78.0		1.0
Average	14.4	67.3		
Schumaker B 15	5.3		0.4	
" B 16	37.3		0.8	
" B 20	23.3		0.5	
" B 28	42.0		0.9	
Average	27.0			
Farmcraft 29		64.7		0.8
" 39	14.0	79.3	0.7	1.0
" 40	4.7	82.7	0.4	0.8
" 47	18.7		0.5	
Average	12.5	75.6		
Aldrich A 60	44.0		1.2	
" A 61	72.7		1.1	
" 30		91.3		0.8
Average	58.3	91.3		

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Ohio	C 54	8.0		0.6	
"	W 64	39.3		1.0	
"	K 62	31.3	83.3	0.9	0.9
"	K 24	6.7	63.3	0.7	0.9
"	M 15	31.3	92.7	0.7	1.0
"	K 54		80.7		1.0
"	K 64		69.3		1.0
	Average	23.3	77.8		
Iowa	H 4417		48.7		0.8
"	H 4560		79.3		0.9
"	H 4308		72.7		0.9
"	H 4567		72.7		0.9
	Average		68.4		
Lowe		23.3		0.5	
"	32	62.0		1.0	
"	38	24.7		0.8	
"	52	39.3		1.0	
	Average	37.3			
Gries	201	4.7	31.3	0.8	0.5
"	420	6.0	48.0	0.6	0.9
"	606	4.0	54.7	0.4	0.8
	Average	4.9	44.7		

TABLE I (Continued)

Hybrids		Germination (%)		Green Weight per Seedling (grams)	
		1949	1950	1949	1950
Indiana	419 A	19.3	66.7	0.6	0.8
"	252 A	15.3	54.7	1.0	0.7
"	210 B		62.7		0.8
"	416 B	7.3		0.4	
Average		14.0	64.5		

The correlation coefficient (Table III) for hybrids common to both years was highly significant, 0.49, indicating that the same hybrids tended to be high in germination in both tests. Considering all samples from each seed company, some seed concerns averaged higher in cold tests (Table I).

These data emphasize that large differences in stands of corn may be expected under adverse conditions even though all of the seed was capable of high germination under standard laboratory conditions. State and federal seed laws require that germination tests be conducted under ideal conditions so that each seed is given maximum opportunity to germinate. Results of these tests are carried on the tags with the seed

TABLE II

ANALYSES OF VARIANCE FOR COLD TEST GERMINATION AND GREEN WEIGHT PER SEEDLING FOR 1949 AND 1950 SEED

Source	Degrees of Freedom	Mean Squares	
		Germination	Green Weight
		1949 Seed	
Total	353		
Replications	2		
Hybrids	117	1,676.7**	0.19**
Error	234	164.8	0.07
		1950 Seed	
Total	359		
Replications	2		
Hybrids	119	543.8**	0.03**
Error	238	54.9	0.01

** Significant at the 1% level of probability.

TABLE III

CORRELATION OF COLD GERMINATION AND SEEDLING VIGOR

	r	Degrees of Freedom
Vigor 1949 - Vigor 1950	0.20	64
Germination 1949 - Vigor 1949	0.06	116
Germination 1950 - Vigor 1950	0.56**	118
Germination 1949 - Germination 1950	0.49**	64

** Significant at the 1% level of probability.

as it is offered for sale. Ideal conditions of the standard laboratory germination test rarely prevail in the field.

In view of the large effect of stands of corn in relation to yields (17), it appears that information on cold test performance would be desirable information to include on the tag for the seed purchaser. The buyer would know what germination to expect under adverse weather conditions following planting. This practice would stimulate the seed corn industry to use more care in processing seed corn. Information on cold test performance is another factor that farmers should consider

in choosing a hybrid for their farm. In addition to choosing an adapted hybrid that possesses an inherent ability to germinate under cold wet conditions, farmers should purchase seed of this hybrid from concerns that are able to produce the seed in a manner that will enable the seed to maintain this ability after processing.

Germination and seedling vigor, as measured by average green weight per seedling, were not related in the test of the 1949 seed (Table III), while the two characteristics were highly significantly correlated in the test of the 1950 seed. There was no significant relationship in seedling vigor for the two tests.

Yield and maturity data from the 1950 Michigan Hybrid Corn Trials (16) were used to determine if any relationship existed with cold test germination and seedling vigor for the 1949 seed. The inconsistency of the correlations (Table IV) indicates that, in general, there was no definite relationship among these characteristics. Pinnel (15), also, reported no relationship between yielding ability of double-cross hybrids and stands in cold test trials.

TABLE IV

CORRELATIONS OF COLD GERMINATION AND SEEDLING VIGOR WITH YIELD AND MATURITY

Counties	Germination		Seedling Vigor		Degrees of Freedom
	Yield	Maturity	Yield	Maturity	
Monroe	0.05	0.07	0.0	0.10	48
Ingham	0.36	-0.01	0.84**	0.25	45
Kalamazoo	-0.07	-0.10	-0.86**	-0.30*	44
Saginaw	0.27	0.15	0.48**	0.37*	38
Oakland	0.18	0.10	0.08	-0.20	33
Newaygo	0.40*	-0.06	0.36*	0.17	28

* Significant at the 5% level of probability.

** Significant at the 1% level of probability.

Table V presents average cold test germinations for four Michigan Certified Hybrids produced by different seed growers in 1948, 1949, and 1950. Analyses of variance are given in Table VI.

Considering each hybrid individually, there were significant differences among the seed producers and there were significant differences due to age of seed. Seed producer F,

TABLE V

AVERAGE COLD TEST GERMINATION FOR FOUR MICHIGAN CERTIFIED HYBRIDS PRODUCED BY DIFFERENT GROWERS

Growers	1948	1949	1950	Av.	1948	1949	1950	Av.
	Ohio M 15				Michigan 51 B			
A	48.7	59.3	80.0	62.7				
B	19.3	44.0	77.3	46.9	32.0	62.7	72.7	55.8
C	46.7	46.7	64.0	52.4	28.7	29.3	57.3	38.4
D	18.0	38.0	61.0	39.1	49.3	59.3	69.3	59.3
E	42.7	66.7	89.3	66.2				
F					41.3	76.7	85.3	67.8
Average	35.1	50.9	74.4	53.4	37.8	57.0	71.2	55.3
	Michigan 11 A				Michigan 36 B			
C	51.3	52.0	62.0	55.1				
D	50.0	57.3	64.7	57.3	26.7	29.3	66.7	40.9
E					33.3	46.7	88.0	56.0
F	62.0	64.7	82.7	69.8				
Average	54.4	58.0	69.8	60.7	30.0	38.0	77.3	48.4

TABLE VI

ANALYSES OF VARIANCE FOR COLD TEST GERMINATION OF FOUR MICHIGAN CERTIFIED HYBRIDS

Source	Degrees of Freedom	Mean Square	Degrees of Freedom	Mean Square
	Ohio M 15		Michigan 51 B	
Total	44		35	
Years	2	5,373.8**	2	3,358.4**
Growers	4	1,119.9**	3	1,368.9**
Years x Gro.	8	193.6	6	240.6
Error	30	109.2	24	54.6
	Michigan 11 A		Michigan 36 B	
Total	26		17	
Years	2	576.4**	2	3,851.6**
Growers	2	562.4**	1	1,027.5**
Years x Gro.	4	35.6	2	86.2
Error	18	54.5	12	79.8

** Significant at the 1% level of probability.

who is a small seed grower with a limited amount of mechanical equipment, averaged significantly higher in cold test germinations for two hybrids than producers C and D, who are much larger growers with more mechanical equipment for processing seed. Size of operations and amount of mechanical equipment for processing seed are not necessarily indicative of ability to produce seed of highest quality. These results illustrate that a small seed producer can produce hybrid seed corn of high quality with a limited amount of mechanical processing equipment.

Results presented in Table V indicate the differences in germination that may occur with seed of the same hybrid produced by different growers. With new seed (1950 crop), there were 29.3, 28.0, 20.7, and 16.9% differences in cold test for Ohio M 15, Michigan 51 B, Michigan 11 A, and Michigan 36 B, respectively, when produced by different growers. All seed samples represented in Table V germinated 95% or better in rag-doll test under standard laboratory conditions.

One and two year old seed (1949 and 1948 seed) were significantly lower in cold test than new seed. The older the seed the lower the cold test. One year old seed germinated

23.5, 14.2, 11.8, and 39.3% less than new seed for the four hybrids, respectively (Table V). Two year old seed germinated 39.3, 33.4, 15.4, 47.3% less than new seed. Data in Table I also show that one year old seed gave generally lower cold test performance.

Carry-over seed corn that has a high germination in standard germination tests under ideal laboratory conditions has generally been assumed to be equal in quality to new seed. The results of this study show that the germination of old seed under adverse conditions is likely to be lower than that of new seed.

SUMMARY

Large differences in cold test germination were found to exist among samples of hybrid seed corn. All samples had a highly satisfactory germination under standard laboratory conditions. A low of 1.3% was found in 1949 seed and a low of 19.3% was found in 1950 seed. Hybrids that had a high cold test performance with 1949 seed tended to be high with 1950 seed.

Associations of cold test germination and seedling vigor were inconsistent so that it was not possible to reach a conclusion on the general extent of their relationship. The correlations of germination and seedling vigor with yield and maturity did not indicate that there was any consistent relationship among these characteristics.

Wide differences in cold test germination were present in samples of the same hybrid produced by different seed growers. A small seed producer with limited mechanical processing equipment was capable of producing seed with higher cold test performance than larger seed growers with a more highly mechanized process.

Cold test germinations for one and two year old seed were found to be lower than new seed. The older the seed the lower the cold test germination even though all seed was capable of very satisfactory germination under ideal laboratory conditions.

Cold test performance was recommended as desirable information to include on the tag.

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