

To the Graduate Council:

I am submitting herewith a thesis written by Daniel Bruce Smith entitled "The Effects of Reduced Tillage, Time of Fertilizer Application, and Plant Population Level on a Diverse Set of Corn (*Zea mays* L.) Genotypes." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

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THE EFFECTS OF REDUCED TILLAGE, TIME OF FERTILIZER
APPLICATION, AND PLANT POPULATION LEVEL ON A
DIVERSE SET OF CORN (ZEA MAYS L.) GENOTYPES

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ABSTRACT

A diverse set of corn (Zea mays, L.) genotypes was grown at the Plant Science Field Laboratory, Knoxville, Tennessee, and at the Plateau Experiment Station, Crossville, Tennessee, in 1980. The objective of the experiment was to evaluate the effects of various environmental conditions on agronomic performance. Environmental effects were location, time of nitrogen fertilizer application, and plant population level. Yield and ten other traits were measured on eight F_1 hybrids, five open-pollinated varieties, and three exotic varieties. Severe environmental conditions resulting from below normal rainfall occurred at both locations in 1980.

Open-pollinated and exotic varieties did not outperform hybrids with respect to yield under any combination of treatments. Hybrids were less responsive to environmental differences due to population level, fertility, or location than were varieties.

Significant location differences were found, with performance being better at Knoxville than at Crossville for most traits measured. Plant population level also had a significant effect on performance. Yields were highest at the intermediate population density of 43,000 plants per hectare. Stalk lodging increased, while prolificacy and tillering decreased, as population density increased from 25,000 to 61,000 plants per hectare. Variation in the timing of nitrogen fertilizer application had little effect on the traits studied. When the entries were divided into hybrids, open-pollinated varieties and

exotics, significant differences among these type groupings occurred for all independent variables.

There was no indication from the characteristics evaluated in this study that genetically heterogenous varieties would be preferred over hybrids in the set of environmental conditions considered. It would appear that, at least in the short term, germplasm selected for high yield using current cultural practices would be the preferred germplasm source for hybrid development under slightly modified cultural practices.



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LIST OF SYMBOLS

<u>Symbol or Abbreviation</u>	<u>Meaning</u>
F ₁	Fertilizer treatment where all fertilizer was applied pre-emergence
F ₂	Fertilizer where nitrogen fertilizer was applied one-half pre-emergence and one-half sidedress
P ₁	Plant population = 25,100-26,400 plants per hectare
P ₂	Plant population = 43,000-45,300 plants per hectare
P ₃	Plant population = 61,000-64,100 plants per hectare
BD	Percent bird damage
HL	Husk length (cm)
FILL	Grain fill (scale 1-5)
ENOPLT	Ear number per plant
TILLPLT	Tillers per plant
QUPHA	Quintals per hectare
FB	Days till 50% silking
MB	Days till 50% pollen shed
RANGEM	Pollen shed interval (days)
RANGEF	Silking interval (days)
ERECT	Percent of plants not stalk lodged
ERECTR	Percent of plants not root lodged
Mean PH	Average plant height (cm)
Mean EH	Average ear height (cm)
OP	Open-pollinated varieties
EXO	Exotic varieties

Symbol or
AbbreviationMeaning

HYB	Hybrid varieties
LOC	Location
FER	Fertility treatment
POP	Population treatment
REP	Replication
ENT	Entry

CHAPTER I

INTRODUCTION

Genotype x environment interactions are frequently observed in genetic studies (4) and plants selected for a specific trait in one environment may show different responses if evaluated in another environment (15). Since selection response is partially dependent on the selection environment, a variety selected for several generations under optimum growing conditions may perform poorly in a less suitable environment. The response to stress conditions by a variety selected under optimum growing conditions may be less favorable than the response by a variety selected in a stress environment (1). By selecting for desirable plant types under optimum growing conditions a bias may develop toward varieties performing well under optimum environmental conditions while varieties with a wide range of general adaptability may be passed over.

Russell and Teich (27) found that lines selected in high population environments are not necessarily the superior ones when grown at low populations. Lines selected at high populations have performed better at high populations than lines selected at low populations and grown in a high stand density environment.

While all plants within a hybrid variety have essentially the same genetic make-up, every plant within an open-pollinated variety is potentially a different genotype (3). Whereas all plants within a hybrid variety will be affected equally by a set of environmental conditions,

not all plants within an open-pollinated variety will react in a similar manner to the same environment. Therefore, if the environment elicits a negative response in a crop, the overall effect may be less for an open-pollinated variety which has many different genotypes than for a hybrid (16). This indicates that open-pollinated varieties possibly have a greater environmental buffer capacity and are overall more homeostatic with respect to growing conditions (10). If environmental stress conditions cause a reduction in yield for hybrids which is greater than the reduction for an open-pollinated variety, it may be profitable under these circumstances to grow the open-pollinated variety. It also might become feasible to use a low fertility environment to select new lines from the open-pollinated variety and develop hybrids that are similar to the variety in their response to fertility level.

Evidence which supports the favorable response of open-pollinated varieties over hybrids when grown under reduced cultural and fertilizer input conditions may be found in research done in Tanzania by Bolton and Scaife (8). It was shown that local open-pollinated varieties yielded better than African hybrids when grown under traditional cultural practices including no fertilizer, no insecticides and low plant populations. When cultural practices were altered by higher plant populations and addition of fertilizer, hybrids responded to a much greater degree than did local varieties. With unstable environmental conditions it was suggested that varieties with a wide genetic base, e.g., composite varieties, may be the most useful because such varieties may be improved to their most efficient level through recurrent selection. Other evidence supporting the use of open-pollinated varieties over

nonadapted hybrids in a less than optimum environment may be found in Tennessee variety yield data (24). In 1948, in a comparison of hybrids and varieties in Tennessee, the hybrids, which were developed in the Corn Belt, were frequently lower yielding than local open-pollinated varieties under testing conditions in Tennessee.

An ideal variety is one that has a high degree of phenotypic stability over many different sets of environmental conditions while maintaining desirable agronomic characteristics (10). Because hybrids traditionally have been developed to respond to high fertilizer and low weed competition environments, one might expect that with reduced fertilizer and weed control open-pollinated varieties would compete favorably with hybrids. The rate of plant improvement may be increased by examining older open-pollinated varieties as well as modern hybrids which have been selected under high fertility, low weed competition environments (16).

Components of the environment which may be manipulated easily include stand density, fertility level, and cultivation. By manipulating these components and studying the effects on agronomic characteristics maximum use of available resources may be achieved.

The objective of this study was to evaluate several diverse corn (Zea mays L.) types with respect to their response to cultural practices including reduced tillage, different stand density levels, and the interaction with different fertilizer applications. A comparison was made among open-pollinated, hybrid, and exotic varieties.

CHAPTER II

LITERATURE REVIEW

Plant Populations

Allen and Darrah (5) found that for two maize hybrids in Kenya there was a significant response to selection for increases in fertilizer nitrogen and plant population. Yield increases from additional nitrogen increments and higher populations were greater for each subsequent cycle of three cycles of selection.

Glenn and Daynard (17) have shown that plant to plant variability in height in maize is greater with increasing plant populations and that grain yield is adversely affected by variability in plant height.

Stringfield (33) has stated that corn yields per unit area, as a function of population, will increase linearly up to approximately 2000 plants per acre under adequate climatic conditions. At some point after this, yield will not increase at the same rate as population. This point may be described as the "minor crowding point." Yield will then increase at some diminishing rate until the point of "major crowding" is reached. At this point each additional increment of stand will reduce yield. The desirable population for producing maximum corn yield occurs somewhere between 1000 and 5000 fewer plants per acre than the population at which the "major crowding" point is reached even when climatic factors are not limiting. This is because lodging occurs at high populations.

Another description of plant yield-density relationships has been proposed by Holliday (20). The equation $Y=a+bx-cx^2$ describes the relationship between seed or grain yield and stand density, where Y = yield per unit area, x = plant population, and a , b , and c are regression constants. The equation $Y=ax/(1+abx)$ (a rectangular hyperbola) where a is apparent maximum yield per plant, x = plant population, and b is a regression constant, describes the relationship between biological yield and stand density. Maximum seed yield under nonlimiting environmental conditions will occur at approximately the point where biological yield levels off. In reality, environmental constraints do occur with increasing stand density under normal field growing conditions. Light becomes a limiting factor in the production of grain because interplant shading results in poor silk development. Water may also become a limiting factor to grain development, because at high plant populations the water supply may become exhausted before grain formation begins. Whereas in theory maximum seed yield occurs at about the point where biological yield levels off, in actuality environmental factors cause optimum stand density for grain production to be below this point. From this it may be seen that optimum stand density will vary depending upon whether corn is grown for silage or for grain. Corn for grain is usually planted in the 10-30,000 plants per acre range, while silage corn is planted at higher rates of 40,000 plants per acre and above.

Holliday (20) also noted that increased barrenness and smaller ears resulted from high plant populations and other stress conditions.

Stinson and Moss (32) have shown that high populations will cause more shading among plants resulting in more barren plants. Although

shade tolerant hybrids are available, a reduction in yield will occur in both tolerant and intolerant hybrids when planted at very high densities. The reduction in yield has been attributed to barrenness. Shade will reduce stalk diameter in both tolerant and intolerant hybrids, but not to such a degree as to cause significant stalk breakage. Plants grown in shade are generally taller than plants grown in full sunlight and this may contribute to lodging. They concluded that a hybrid tolerant to shade conditions resulting from high plant populations should have a short pollen to silk interval to assure that viable pollen and silks are available at the same time. Smaller tassels and high grain production per unit leaf area were other characteristics associated with population tolerant hybrids.

Dungan et al. (12) have shown that high plant populations generally cause plants to mature later than when they are grown at normal populations. They found that shelled kernels from 8, 12, 16, and 20 thousand plants per acre in northern Illinois contained 19.3, 20.2, 20.8, and 21.2% moisture at harvest respectively.

Alessi and Power (2) found in an experiment with dryland corn in Mandan, N.D., that there is an interaction between population and forage or grain yield. Grain yield was affected by population depending on when moisture stress occurred. It was shown that a lack of water during grain formation was the limiting factor. Drought conditions were shown to affect female more than male flowering in corn in an experiment by Herrero and Johnson (19).

Stickler (31) in Kansas and Duvick (13) in Iowa found fewer barren plants at lower plant populations than at high populations.

Josephson (21) has shown that prolific hybrids are better able to compensate for poor stands. He found that increasing plant densities caused the number of ears per 100 plants to decrease. Prolific hybrids revert to single-eared plants under higher plant densities which is an advantage under high planting rates. Collins et al. (9) have also found that two-eared hybrids yield more consistently across changing plant densities and that two-eared type hybrids out-yield single-eared types at low plant densities.

Josephson (21) contended that "fertility and moisture conditions are too variable in the South to hazard growing high populations of plants." He found that a prolific variety had higher yields than a single-eared variety at 9,170 and 18,341 plants per acre. This was attributed to the fact that single-eared varieties adjust to adverse environmental conditions by changes in ear size or barrenness. While grain weight per ear decreased with increased populations in a single-eared variety, it remained relatively constant in a prolific variety.

Fertility

Lang et al. (22) have shown that grain yields will increase with increasing soil productivity at levels of stand density from 8-24,000 plants per acre. When the "major crowding" point is reached, regardless of soil productivity, yields will decline. Soil productivity may be described in terms of such factors as available water holding capacity, fertility, structure, texture, degree of slope, and moisture supplying capacity.

Dungan et al. (12) have found that fewer tillers per plant will be formed on soils of high productivity as population density increases.

Low productivity soil will produce plants with less tillering than will high productivity soils. If tillers are excessive in number, optimum plant density probably has not been reached. They also reported that the capacity of an individual corn plant to produce an ear of given weight will vary under different stand densities. On highly productive soil, while yield will increase with the population to the "maximum crowding" point, they reported that the weight of each ear per plant declined. The authors concluded that while yield of corn will increase linearly with population in uncrowded conditions, fertility becomes a more limiting factor at high populations.

Tillage

A reduction in tillage practices in corn has been the focus of interest for many researchers. Andrew et al. (6,7) grew corn at different population levels and fertility levels with minimum tillage. They found that corn produced from reduced tillage practices yielded comparable with corn produced with conventional tillage methods.

Raghaven et al. (26) and Cook (11) cited the advantage of less soil compaction with less tillage. Larson (23) reported advantages of reduced water runoff and less erosion with reduced tillage.

In addition to comparable yields of corn produced via reduced tillage versus conventional methods, there are economic advantages to reduced tillage methods. Cook (11) points out that much less mechanical labor is required for reduced tillage than for conventional tillage. This results in less fuel consumption and reduced depreciation on machinery.

CHAPTER III

MATERIALS AND METHODS

Entries Included in the Experiment

Genotypes for this study were chosen to represent an array of germplasm available to corn breeders. A total of fourteen open-pollinated, synthetic, and hybrid seed sources were grown at the Plant Science Field Laboratory at Knoxville and at the Plateau Agricultural Experiment Station near Crossville. A fifteenth entry was not common to both locations.

Open-pollinated varieties in the experiment included: 'Jarvis,' 'Jellicorse,' and 'Neal Paymaster.' Two synthetic varieties, 'SGP,' a mixture of southern germplasm sources, and 'TLLE-9,' a synthetic selected on the basis of low ear placement, were used. Three varieties which have been termed exotic were evaluated in the experiment. These were: 'Zapalote Chico,' a Mexican variety with small ears and very tight husks, 'Cow Corn,' a prolific variety producing several very small ears, so called because the ears resemble nubbins which are useful as cattle feed and 'Huffman,' a variety producing few but very large ears. Eight hybrids were included in the experiment. Those developed at The University of Tennessee were 'T7100,' 'T5009,' 'T111xT115,' '75:1683x75:1684' (a cross with Teosinte incorporated early in its development), and 'T505,' a doublecross hybrid which was evaluated only at Crossville. Two commercial hybrids included were 'Pioneer 3147' and

'DeKalb XL390B.' A single cross from North Carolina, 'NCJR10 x NCIR10,' was evaluated only at Knoxville.

Cultural Practices

At Knoxville the experimental site had been planted in soybeans in 1979 and was plowed in the fall after harvest. Fertilizer (6-12-12) was applied and disced in on April 10, 1980, at a rate of 1073.0 kg/ha. The experiment was hand planted on April 23. Atrex, at a rate of 1.7 kg/ha, was applied on April 24. Ammonium nitrate was applied at a rate of 212.4 kg/ha as a band between rows to half of the area on April 24 and to the other half on June 6. The total nitrogen applied to the field was 144 kg/ha. At Knoxville the experimental plot consisted of two rows, 2.7 m long with 1.0 m spacing between rows and 0.9 m alleys between plots.

Three different seeding rates were used. The low rate was 24 seeds per plot subsequently thinned on June 5 to 14 plants per plot resulting in a plant population of 25,100 plants per ha. The intermediate population was seeded at 40 seeds per plot and thinned on June 5 to 24 plants per plot, resulting in a plant population of 43,100 plants per ha. The high population was seeded at a rate of 54 seeds per plot and thinned on June 5 to 34 plants per plot resulting in a plant population of 61,000 plants per ha.

After conventional seedbed preparation, at Crossville 165 kg/ha of urea was broadcast and disced in on May 7. Atrex was applied at a rate of 1.7 kg/ha on May 8. The experiment was hand planted on May 14. Using a hand distributor, 165 kg/ha of urea was applied as a band between

rows on May 28 on one-half the experiment, and on the other half on June 13. The total nitrogen applied on the field was 151.5 kg/ha.

At Crossville the experimental plot consisted of two rows, 2.7 m long with 0.90 m spacing between rows and 0.90 m alleys between plots.

The lowest of the three seeding rates at Crossville was 24 seeds per plot thinned on June 13 to 14 plants per plot resulting in a plant population of 26,400 plants per ha. The intermediate population was seeded at a rate of 40 seeds per plot, thinned to 24 plants per plot resulting in a plant population of 45,300 plants per ha. The high seeding rate was 54 seeds per plot, thinned to 34 plants per plot resulting in a plant population of 64,100 plants per ha.

At both Knoxville and Crossville border rows were planted to insure fair competition among plants. No cultivation or weed control was practiced other than pre-emergence herbicide at planting.

Experimental Design

A modified randomized complete block design was used for the experiment. To facilitate application of the fertilizer, the experiment was blocked into two sections with respect to fertilizer treatments. One section was fertilized at planting and the other sidedressed at a later date. To facilitate planting and to insure equal competition between plants, plant populations were arranged in a split plot across both fertility treatments. The experiment was replicated four times at each location. Plant populations were randomized within each replication. Entries were randomized within each population in each fertility treatment.

Collection of Data

Several agronomic characters for each entry were measured during the course of the experiment. The method of measurement for each of these was as follows:

Yield. All ears were hand harvested on September 25 at Knoxville and on October 14 at Crossville. Field weights were recorded to the nearest tenth of a pound. At Knoxville moisture samples were taken from each plot. At Crossville time permitted moisture samples to be taken from only two replications. An average of these two replications was computed for each entry and used as the percent moisture for the other two replications. Field weights were expressed as bushels per acre and converted to quintals per hectare on a 15.5% moisture basis.

Tillers per plant. Tillers were counted for each plot and divided by the number of plants per plot.

Anthesis date. This date was when 50% of the plants in a plot shed pollen on the center spike of the tassel.

Silking date. This date was when 50% of the plants in a plot had visible silks.

Ear number per plant. Total ears per plot was divided by the number of plants per plot.

Ear height. This was measured to the nearest tenth of a foot from the ground to the first ear-bearing node for six plants per plot, from which an average was obtained. Appropriate metric conversions were made later.

Plant height. This was measured to the nearest tenth of a foot from the ground to the tip of the center spike of the tassel for six

plants per plot, from which an average was obtained. Appropriate metric conversions were made later.

Bird damage. This was a subjective measurement based on the percent grain per plot assumed to be destroyed by birds.

Root and stalk lodging. Root lodging was computed on the basis of the number of plants fallen over at the root. Stalk lodging was computed as the number of plants per plot broken below the ear.

Grain fill. This was a subjective measurement on a scale from 1 to 5 with 1 being nearly complete grain fill.

Husk length. This was computed on a per plot basis as the length of the husk in cm over the tip of the ear.

Data were not collected at Crossville for the variables husk length, bird damage, anthesis date, and silking date.

Statistical Analyses

Conversions were made to the appropriate metric units. All calculations were made using the Statistical Analysis System 79 (SAS79) on the IBM 360165 computer at The University of Tennessee Computer Center. All tests of significance were made using the .05 probability level.

The treatments of population level and fertility were considered to be fixed effects while replications, locations, and entries were considered to be random.

Means were computed for each dependent variable at each location, fertility, and plant population in all combinations for each entry.

The form of the analysis of variance is shown in Appendix Table A-1 with expected mean squares. Analyses were computed for each location separately and combined over locations.

In each analysis, interactions and main effects were tested using the appropriate pooled error term as described by Snedecor and Cochran (29) and Steele and Torrie (30).

Because of a possible fertility gradient across the field, and based on the experimental design, the fixed effect of fertility and the fertility x population interaction were not tested for significance. For the fixed effect of population, an error term was synthesized according to expected mean squares and complex F tests were carried out according to the following formulas as proposed by Satherthwaite (28).

$$\text{Degrees of freedom numerator} = \frac{\text{ms}^2}{\frac{\text{ms}}{\text{df}}}$$

$$\text{Degrees of freedom denominator} = \frac{(\text{ms}_1 + \text{ms}_2 + \text{mse})^2}{[(\text{ms}_1)^2 + (\text{ms}_2)^2 + (\text{mse})^2]}$$

$$F = \frac{\text{ms}}{\text{ms}_1 + \text{ms}_2 - \text{mse}}$$

Where ms = mean square of effect to be tested

ms₁, and ms₂ = mean squares of main effect interactions

mse = mean square of the error term.

Duncan's Multiple Range tests at the .05 level of probability were used to separate population and entry means for the appropriate significant dependent variables (30).

CHAPTER IV

RESULTS AND DISCUSSION

Analysis of Yield

The average yield of all entries at both locations was 33.9 q/ha with a range from 10.4 (Zapalote Chico) to 52.8 (Pioneer 3147) q/ha (Table 1). One might have expected, based on the review of literature, to see an open-pollinated variety perform better than some hybrids for some combination of treatments, but the highest yielding open-pollinated variety, Jellicorse (33.1 q/ha), did not yield as well as the lowest yielding hybrid, DeKalb XL390B (43.3 q/ha).

Environmental conditions during the critical grain filling period resulted in stress at both locations (Table 2). Comparison of hybrid yields in this study with performance in more favorable years, indicated that yields were depressed approximately 50% for the group of hybrids. No comparisons of variety yields could be made since they had not been evaluated in recent years. The yield depression for hybrids was not great enough that their yield performance was below any open-pollinated or exotic variety in spite of the greater environmental buffering capacity of open-pollinated varieties. Means of all entries may be found in Table 1 and all treatment means for yield may be found in Appendix Tables A-2 and A-3. The highest yielding hybrid was Pioneer 3147 (52.8 q/ha). The highest yielding open-pollinated variety was Jellicorse (33.1 q/ha). The highest yielding exotic was Cow Corn (23.7 q/ha).

Table 1. Mean* yield over all fertility and population levels for corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
----- q/ha -----			
<u>Hybrids</u>			
NCJR10xNCIR10	51.4 a	-	-
Pioneer 3147	60.7 a	45.0 a	52.8 a
T111xT115	55.9 a	42.1 ab	49.0 a
T7100	58.6 a	36.3 abcd	47.5 a
75:1683x75:1684	55.3 a	36.1 abcd	45.7 a
T5009	58.0 a	32.6 bcde	45.3 a
DeKalb XL390B	56.3 a	30.9 cdef	43.3 a
T505	-	37.8 abc	-
<u>Open-pollinated varieties</u>			
Jellicorse	39.3 b	26.8 def	33.1 b
SGP	37.4 b	24.5 ef	31.0 bc
Neal Paymaster	36.6 b	20.8 f	28.7 bc
TLLE-9	24.0 cd	18.7 f	21.3 c
Jarvis	24.7 cd	18.0 f	21.3 c
<u>Exotic varieties</u>			
Cow Corn	30.1 bc	17.2 f	23.6 bc
Huffman	19.1 cd	3.5 g	11.3 d
Zapalote Chico	13.4 d	7.3 g	10.4 d
Low population	39.0 b	30.0 a	34.5 a
Medium population	43.4 a	27.4 a	35.4 a
High population	41.5 ab	22.2 b	31.9 b

*Means followed by a common letter do not differ at the 5% level of significance based on the Duncan's Multiple Range Test. Only means within a column may be compared.

Table 2. Precipitation amount and frequency for Knoxville and Crossville, Tennessee, in 1980, and the normal average for the months April through September.

	April		May		June		July		August		September	
	Knox	Cross	Knox	Cross	Knox	Cross	Knox	Cross	Knox	Cross	Knox	Cross
Frequency (no.) ^a	11	12	10	13	4	6	10	6	8	6	8	10
Amount (in.)	3.58	3.87	3.87	4.41	1.22	1.15	3.83	2.94	4.91	2.54	2.17	0.92
Average Frequency (no.) ^b	11	9	11	8	11	8	12	8	10	7	9	6
Average Amount (in.) ^b	3.61	5.50	3.28	4.70	3.63	4.73	4.70	5.10	3.24	3.38	2.78	3.99

^aNumber of days of .01 inch or more rainfall.

^bAverage of past 20 years.

A significant location effect was found for the dependent variable yield. The analysis of variance may be found in Appendix Tables A-4, A-5, and A-6 for the Knoxville, Crossville, and combined locations, respectively. The location effect was greatest for the open-pollinated variety Huffman, which had a reduction in yield of 81.5% from Knoxville (19.1 q/ha) to Crossville (3.5). The hybrid with the greatest reduction in yield from Knoxville to Crossville was DeKalb XL390B which yielded 56.2 q/ha at Knoxville and 30.9 at Crossville, a 45% decrease. Of the open-pollinated varieties, Neal Paymaster had the greatest reduction in yield from Knoxville to Crossville. Its yield was reduced 43%, or from 36.6 q/ha to 20.8. No entry yielded better at Crossville than at Knoxville. This may be explained by the harsher environment existing at Crossville in terms of more severe drought conditions (Table 2).

There was no significant fertilizer x location interaction for the experiment. At Knoxville the sidedress treatment had a mean yield of 43.7 q/ha and the pre-emergence treatment 38.9. At Crossville the sidedress mean yield was 27.6 q/ha and the pre-emergence 25.4. Fertilizer treatment means may be found in Appendix Tables A-2 and A-3.

While it can be said that generally the sidedress fertilizer treatment caused a positive yield response, certain anomalies did exist. Huffman and T7100 yielded better overall when the fertilizer was all applied pre-emergence.

A significant plant population effect was observed for yield. The intermediate population had the highest yield response, 35.5 q/ha, the low population ranked next with 34.5 followed by the high plant

population, 31.9 (Table 1). The middle and low populations probably did better than the high population because of greater environmental stress in the highest stand density due to more interplant competition. This stress was multiplied by the existing drought condition as well as some weediness due to reduced tillage. It should be noted, however, that the drought conditions were such that weeds were not a highly significant factor in the experiment.

A significant location x population interaction was found for yield. Whereas at Knoxville the highest yield occurred at the middle population, followed by the high and low populations respectively, at Crossville the highest yield occurred at the lowest population, followed by the middle and high populations, respectively (Table 1). The higher yields at the lower populations at Crossville can be explained again by the greater environmental stress occurring at this location.

There was no significant location x population x fertility effect in the analysis over locations. At Crossville the highest yield occurred at the low population for both fertility treatments. At Knoxville the highest yield for both fertility treatments occurred at the middle population. The point of "major crowding" (33) was reached at a lower population at Crossville than at Knoxville.

Following the major effect of location, the greatest variation in yield was attributed to differences among entries. Variability within the exotic group was the greatest followed by open-pollinated and hybrids, respectively (Table A-6, Appendix). Hybrids, open-pollinated varieties, and exotic entries were significantly different as groups with respect to yield. There was a significant location x entry interaction

for yield. The location x exotic and location x open-pollinated interactions were significant while the location x hybrid interaction was not. This indicates a greater environmental stability in the yield of hybrids, although one might have expected, on the basis of reports in the literature, that open-pollinated varieties would be more environmentally stable (16).

There were no significant effects due to fertilizer treatment x entry or population x entry interactions in the combined analysis for yield. Also, there were no significant three-way or four-way interactions for yield.

Analysis of Yield at Knoxville

At Knoxville there was a significant population effect on yield. The greatest yield occurred at the intermediate population (43.4 q/ha) followed by the high (41.5) and the low (39.0) populations (Table 1, p. 16). While most entries followed the pattern of yielding highest at the intermediate population, some exceptions did occur. Zapalote Chico yielded better at the highest population as did Pioneer 3147. It is interesting to note that these are the lowest and highest yielding entries, respectively. Entries 75:1683 x 75:1684 and NCJR10 x NCIR10 performed best at the lowest population although both of these entries were somewhat yield stable over all three populations (Table A-2).

A significant entry effect on yield existed at Knoxville. The range was from 13.4 q/ha (Zapalote Chico) to 60.7 (Pioneer 3147). Significant differences among the three groups existed in yield with hybrids yielding best (57.0 q/ha) followed by open-pollinated (32.3) and exotic (20.9) varieties (Table 1).

No significant yield differences were observed for the fertility x entry interactions at Knoxville although a significant effect was found within the exotics where Huffman yielded comparatively more at the sidedress treatment than the other two exotics (Table A-2).

No significant population x entry yield interactions were observed for the experiment at Knoxville although again a significant interaction effect was found within the exotics where Huffman performed best at the intermediate population and Zapalote Chico and Cow Corn yielded best at the high population.

The entry x population x fertility interaction was not significant at Knoxville for yield.

Analysis of Yield at Crossville

At Crossville there was a significant yield response to population. The highest yield occurred at the lowest population (30.0 q/ha) followed by the middle (27.4) and the high (22.2) populations. Significant differences occurred in the population x exotic and population x hybrid interactions, but not in the population x open-pollinated variety interaction. The most stable entry at Crossville was Zapalote Chico which yielded approximately seven q/ha regardless of population level (Table A-3).

No entry did best at the highest population—again reflecting the harsh environmental conditions at Crossville relative to Knoxville. The only entry which performed better at the high population than at the middle was T111 x T115. Jarvis, Paymaster, Cow Corn, and T505 were entries yielding better at the middle than the low population (Table A-3).

Yields of hybrids and open-pollinated varieties decreased with increasing plant populations at Crossville. Exotics yielded slightly higher at the intermediate than at the low population and yielded least at the high population (Table 3).

Significant differences among entries occurred with respect to yield. The range was from 3.5 q/ha (Huffman) to 45.0 q/ha (Pioneer 3147).

Significant differences in yield occurred among hybrids, open-pollinated varieties, and exotics and within each of the type subgroups. The highest yielding hybrid was Pioneer 3147, 45.0 q/ha (Table 1, p. 16). The highest yielding open-pollinated variety was Jellicorse (26.8 q/ha) and the highest yielding exotic was Cow Corn (17.2). There was a significant fertility x entry interaction at Crossville. Some entries responded best to the pre-emergence fertility treatments (e.g., Paymaster and T5009) and others to the sidedress treatment (e.g., Jarvis and Pioneer 3147 (Table A-3).

Analysis of Ear Height

The average ear height for the experiment was 103 cm. The range of ear heights was from 74 cm for TLLE-9 to 124 for Huffman (Table 4). The low ear height of TLLE-9 is to be expected since it is a synthetic selected for low ear height. The mean ear height for hybrids was 104 cm, for open-pollinated varieties, 101 and for exotics, 113.

There were significant location and fertility x location effects on mean ear height. Plots which were sidedressed averaged 6 cm higher ear heights than those fertilized pre-emergence (Tables A-7 and A-8, Appendix).

Table 3. Mean yields of hybrids, open-pollinated varieties, and exotics grown at Crossville in 1980 for three plant population levels.

Types	Plant Population Density		
	Low	Medium	High
	----- q/ha -----		
Hybrids	41.7	37.7	31.7
Open-pollinated	25.2	22.8	17.0
Exotics	9.8	10.0	8.0

Table 4. Mean* ear height over all fertility and population levels for corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
	----- cm -----		
<u>Hybrids</u>			
NCJR10xNCIR10	110 bc	-	-
Pioneer 3147	92 efgh	99 ab	90 c
T111xT115	89 gh	101 ab	90 c
T7100	100 def	99 ab	100 bc
75:1683x75:1684	113 b	113 a	116 ab
T5009	104 cde	108 ab	106 bc
DeKalb XL390B	100 def	99 ab	100 bc
T505	-	105 ab	-
<u>Open-pollinated varieties</u>			
Jellicorse	96 efgh	110 a	103 bc
SGP	105 bcd	105 ab	106 bc
Neal Paymaster	112 bc	105 ab	109 abc
TLLE-9	60 h	89 b	74 d
Jarvis	98 defg	108 ab	103 bc
<u>Exotic varieties</u>			
Cow Corn	124 a	105 ab	116 ab
Huffman	130 a	117 a	125 a
Zapalote Chico	90 fgh	102 ab	97 c
Low population	101 a	105 a	103 a
Medium population	102 a	105 a	103 a
High population	101 a	105 a	103 a

*Means followed by a common letter do not differ at the 5% level of significance based on the Duncan's Multiple Range Test. Only means within a column may be compared.

There was no significant population effect on mean ear height. Ear height differed significantly among the entries, among hybrids, among open-pollinated varieties, among exotics and among types.

There were significant location x entry and population x entry interactions for ear height. Genotypes did not rank the same in ear height at Knoxville and Crossville, nor did changes in population density affect all genotypes in the same manner. Although these entry interactions were significant, no pattern in response could be detected when entries were grouped into hybrid, variety, or exotic categories (Table 4).

Analysis of Ear Height at Knoxville

The only factor significantly affecting ear height at Knoxville was genotype. Significant effects within hybrids, open-pollinated varieties, exotics, and among these types were found. The height of the ear ranged from 60 cm (TLLE-9) to 130 (Huffman) (Table 4).

Analysis of Ear Height at Crossville

The genotype was also the main factor affecting ear height at Crossville. The mean ear height ranged from 89 cm (TLLE-9) to 117 cm (Huffman). The range was less than at Knoxville with the lowest ear height higher, and the highest, lower than at Knoxville (Table 4).

Although there was no overall population effect on average ear height, the interaction of entry and population was significant (Table A-5). Hybrid ear height was not affected by population, but there were significant differences within open-pollinated and exotic varieties in mean ear heights at the three different population density

levels. It is interesting to note that TLLE-9 which has been selected for low ear height had a mean ear height of 107 cm at the low population and 84 cm at the high population. Huffman responded in an opposite manner with an average height of 107 cm at the low population and 125 at the high (Table A-8).

Analysis of Plant Height

The average plant height for the experiment was 215 cm, with a range from 188 cm for Zapalote Chico to 227 for Huffman (Table 5). The mean plant height at Knoxville (207 cm) was significantly different from that at Crossville (222) (Tables A-24 and A-25, Appendix).

Population had no significant effect on plant height (Table 5). This is in contrast to the findings of Stinson and Moss (32) who found higher plant populations produced taller plants.

Entries differed significantly with regard to mean plant height. A significant interaction between entry and location also existed. No entry was taller at Crossville than at Knoxville. The greatest difference in plant height over the two locations was 27 cm, DeKalb XL390B, while Zapalote Chico differed by only 4 cm (Table 5).

There was a significant population x entry interaction. This was probably due for the most part to the exotics and particularly to Zapalote Chico which was the tallest entry at the low population, but was shorter than the other entries at the middle and high populations. Huffman, another variety classified as exotic was the only other entry which responded to population. It varied by 6 cm over the three stand densities (Table 6).

Table 5. Mean* plant height over all fertility and population levels for corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
----- cm -----			
<u>Hybrids</u>			
NCJR10xNCIR10	248 a	-	-
Pioneer 3147	215 de	206 ab	209 abc
T111xT115	211 de	206 ab	206 bc
T7100	237 abc	212 ab	225 ab
75:1683x75:1684	227 bcd	211 ab	219 abc
T5009	230 abcd	211 ab	219 abc
DeKalb XL390B	227 bcd	201 ab	212 abc
T505	-	-	-
<u>Open-pollinated varieties</u>			
Jellicorse	222 bcd	212 ab	215 abc
SGP	229 bcd	207 ab	219 abc
Neal Paymaster	237 abc	211 ab	225 ab
TLLE-9	198 ef	208 ab	203 cd
Jarvis	219 cd	213 a	215 abc
<u>Exotic varieties</u>			
Cow Corn	211 de	196 ab	203 cd
Huffman	241 ab	215 a	228 a
Zapalote Chico	186 f	190 b	188 d
Low population	224 a	213 a	215 a
Medium population	225 a	207 a	215 a
High population	219 a	202 a	209 a

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

Table 6. Mean plant height for corn entries grown at three plant population levels at Knoxville and Crossville in 1980.

Entry	Population					
	Low		Medium		High	
	Knoxville	Crossville	Knoxville	Crossville	Knoxville	Crossville
----- cm -----						
Hybrids						
NCJR10xNCIR10	216	---	200	---	202	---
Pioneer 3147	215	216	203	219	201	211
TL11xT115	205	247	214	249	212	249
T7100	218	240	214	236	205	235
75:1683x75:1684	208	209	217	213	207	213
T5009	215	228	220	224	201	228
DeKalb XL390B	208	227	198	226	195	227
T505	---	232	---	232	---	225
Open-pollinated varieties						
Jellicorse	221	223	208	229	207	216
SGP	204	233	213	233	204	221
Neal Paymaster	211	243	216	241	207	228
TLLE-9	221	195	202	202	201	197
Jarvis	213	217	221	227	205	212
Exotic varieties						
Cow Corn	203	220	194	216	191	197
Huffman	216	245	217	242	211	238
Zapalote Chico	224	190	172	184	174	184

The population x location x entry interaction was also significant. Zapalote Chico varied greatly in plant height with increasing populations at Crossville but not at Knoxville. The variation in plant height for Neal Paymaster over the three stand densities was greater at Knoxville than at Crossville (Table 6).

Analysis of Plant Height at Knoxville

No significant effects on plant height due to population density existed at Knoxville. However, the tallest plants were in the middle population and the shortest were in the high (Table 5). Again this is in contrast to the findings of Stinson and Moss (32).

Significant effects due to entry existed for plant height. Entry NCJR10 x NCIR10 had the tallest plants (248 cm) and Zapalote Chico the shortest (186).

There were no significant interactions influencing mean plant height at Knoxville.

Analysis of Plant Height at Crossville

Plant height response at Crossville was similar to that observed at Knoxville. Huffman again was tallest (215 cm) and Zapalote Chico the shortest (190) (Table 5).

Although the effect of population on plant height was not significant at Crossville, unlike at Knoxville the tallest plants were found at the low populations rather than the intermediate (Table 6).

A significant population x entry interaction existed at Crossville. Zapalote Chico had an average plant height of 190 cm at the low population and 184 at the high population whereas 75:1683 x 75:1684

had an average plant height of 209 cm at the low population and 213 at the high.

Analysis of Root Lodging

Because there was essentially no root lodging at Crossville the discussion of the variable response of root lodging must be confined to the Knoxville location.

Root lodging was computed as the percent of plants not root lodged at maturity. The only independent variable which had an effect on root lodging was entry. The range of erect plants at maturity was from 91% (Jellicorse) to 100% (TLLE-9, Pioneer 3147, 75:1683 x 75:1684, DeKalb XL390B). Root lodging in Jellicorse was significantly greater than in those genotypes having 99% or more upright plants (Table 7).

The dry season could account for the relatively small amount of root lodging, especially at Crossville. High incidences of root lodging often occur when rainfall is accompanied or followed by strong winds. Saturated soil allows roots to be more easily pulled loose under windy conditions, and root lodging may result. Since there was a deficit of rainfall during the 1980 growing season, root lodging occurred at a low frequency.

Analysis of Stalk Lodging

Stalk lodging was expressed as a percent of plants not stalk lodged at maturity. The mean number of erect plants for the experiment was 84.5%. A significant location effect occurred with 82% erect plants at Crossville and 87% at Knoxville (Table 7). Because of the

Table 7. Mean* percent of plants not root lodged for corn entries grown at Knoxville in 1980, plants not stalk lodged for corn entries grown at Crossville and Knoxville in 1980, and means of three plant populations averaged over all entries.

Treatment	Plants not root lodged		Plants not stalk lodged		Two Location Mean
	Knoxville		Knoxville	Crossville	
----- % -----					
Hybrids					
NCJR10xNCIR10				-	-
Pioneer 3147	96 ab		87 abcd	93 a	88 abc
T111xT115	100 a		83 bcd	69 e	76 cd
T7100	96 ab		83 bcd	91 ab	93 a
75:1683x75:1684	93 b		95 ab	83 abc	89 ab
T5009	100 a		95 ab	74 cde	77 bcd
DeKalb XL390B	99 a		80 d	90 ab	88 abc
T505	100 a		85 abcd	81 bcd	-
	-		-		
Open-pollinated varieties					
Jelllicorse	91 b		80 d	71 de	76 cd
SGP	95 ab		87 abcd	82 abcd	85 abc
Neal Paymaster	95 ab		83 bcd	85 abc	84 abcd
TLLE-9	100 a		96 a	92 ab	94 a
Jarvis	95 ab		90 abcd	85 abc	87 abc
Exotic varieties					
Cow Corn	93 b		80 d	66 e	73 d
Huffman	97 ab		90 abcd	83 abc	87 abc
Zapalote Chico	98 ab		90 abcd	85 abc	87 abc
Low population	96 a		92 a	86 a	89 a
Medium population	96 a		86 b	80 b	83 b
High population	97 a		83 b	80 b	81 b

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

more severe environmental conditions at Crossville, the plants were generally smaller with smaller diameter stalks. This may have contributed to the relatively greater amount of stalk lodging at this location.

A significant fertility x location interaction was observed for the experiment. Whereas there was no difference in the amount of stalk lodging at either the sidedress or pre-emergence fertilizer application treatments at Crossville, at Knoxville there was less stalk breakage with the fertilizer being applied pre-emergence (89% erect plants) as compared to the sidedress treatment (85% erect plants) (Tables A-9 and A-10, Appendix).

Population density had an effect on stalk lodging. More stalk breakage occurred at the higher populations than at the lower (Table 7). This agrees with the findings of Stringfield (33).

Stalk lodging was significantly different among entries. The range was from 73% (Cow Corn) to 94% (TLLE-9) plants erect (Table 7). Significant differences occurred among types with exotics having the greatest amount of stalk lodging. Stalk lodging was also significantly variable within each group of genotypes (Table A-6).

A significant location x entry effect on stalk lodging occurred. Most entries had more stalk lodging at Crossville, but Paymaster, DeKalb XL390B, and Pioneer 3147 had more stalk breakage at Knoxville (Table 7).

There were no significant fertility x entry, population x entry, or higher order interaction effects on stalk lodging.

Hybrids, open-pollinated varieties, and exotics all had more stalk lodging at the highest populations, however, the effects were more dramatic in the hybrids than in the other two groups (Table 7).

Analysis of Stalk Lodging at Knoxville

Stalk lodging at Knoxville ranged from 80% erect plants (Cow Corn) to 96% erect plants (TLLE-9) (Table 7).

Increasing population caused more stalk breakage, with the low population having 92%, the medium having 86%, and the high, 83% erect plants (Table 7).

Entries varied significantly in the amount of stalk lodging. There were no significant differences among types of entries in the experiment, but significant variation did occur within each group (Table 7).

A significant population x entry effect on stalk lodging occurred at Knoxville. Some entries had more stalk lodging at the middle population and some at the high (Table 8).

Significant population x hybrid effects were observed, but the interactions of population with open-pollinated varieties and exotics were not significant (Table A-4). This could be due to the more uniform plant type of hybrids. The stalk diameters of open-pollinated varieties would naturally be more variable and less susceptible to population effects.

Analysis of Stalk Lodging at Crossville

Generally more stalk lodging occurred at Crossville than at Knoxville. The range was from 66% erect plants for Cow Corn to 93% erect plants for Pioneer 3147 (Table 7).

As in Knoxville, significant population effects on stalk breakage occurred. The low population had 86% erect plants at maturity and the high population 80%.

Table 8. Mean percent of plants not stalk lodged for corn entries grown at three population levels at Knoxville in 1980.

	Plant Population Density		
	Low	Medium	High
	----- % -----		
<u>Hybrids</u>			
NCJR10xNCIR10	89	88	84
Pioneer 3147	96	84	69
T111xT115	94	84	73
T7100	96	94	96
75:1683x75:1684	96	94	93
T5009	88	80	71
DeKalb XL390B	97	89	69
<u>Open-pollinated varieties</u>			
Jellicorse	86	76	79
SGP	86	87	87
Neal Paymaster	86	78	85
TLLE-9	95	96	98
Jarvis	92	88	91
<u>Exotic varieties</u>			
Cow Corn	80	76	83
Huffman	95	92	83
Zapalote Chico	95	89	86

Significant differences among entries, among hybrids, among open-pollinated varieties and among exotics were found. Exotics had more stalk breakage than hybrids or open-pollinated varieties, 78, 83, and 83%, respectively.

A significant fertility x entry interaction occurred at Crossville. Although the mean number of stalk lodged plants was the same for both fertility treatments, some entries lodged more as a result of the side-dressed treatment and others due to the pre-emergence treatment (Table A-10, Appendix).

There were no significant population x entry or higher order interaction effects on stalk lodging at Crossville. DeKalb XL390B lodged more at the middle population than at the low or high. T111 x T115 had the most dramatic response as it dropped from 86% plants erect at the low population to 71% at the middle and 56% at the high. Huffman had practically no response to changes in population density (Table A-10).

Analysis of Grain Fill

Mean grain fill ratings for entries grown at Knoxville and Crossville may be found in Table 9.

Based on the scale of subjective measurement from 1-5 there were no significant differences in grain fill. The range was from 2.4-3.0. Fill was generally better at Crossville than at Knoxville although an effect of entry x location was significant where some varieties did better at one location and others at the other.

Table 9. Mean* grain fill rating** of corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
----- scale 1-5 -----			
<u>Hybrids</u>			
NCJR10xNCIR10	2.3 cde	-	-
Pioneer 3147	2.5 cde	2.8 abcd	2.6 a
T111xT115	2.1 e	2.7 abcd	2.4 a
T7100	2.5 cde	2.4 abcd	2.4 a
75:1683x75:1684	2.3 de	2.8 ab	2.5 a
T5009	2.2 e	2.8 abcd	2.5 a
DeKalb XL390B	2.8 bcde	2.3 abcd	2.6 a
T505	-	2.6 abcd	-
<u>Open-pollinated varieties</u>			
Jellicorse	3.1 abc	2.2 cde	2.7 a
SGP	3.0 bcd	2.5 abcd	2.7 a
Neal Paymaster	3.2 abc	2.2 de	2.7 a
TLLE-9	3.7 a	2.3 bcd	3.0 a
Jarvis	2.9 bcd	2.4 abcd	2.7 a
<u>Exotic varieties</u>			
Cow Corn	2.2 e	2.9 a	2.5 a
Huffman	3.2 abc	1.7 e	2.4 a
Zapalote Chico	3.3 ab	2.2 de	2.7 a
Low population	2.6 a	2.7 a	2.7 a
Medium population	2.8 b	2.4 b	2.6 b
High population	2.9 b	2.2 b	2.6 b

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

**Rating scale 1-5, where 1 = complete grain fill.

Analysis of Grain Fill at Knoxville

A significant response to population level was observed at Knoxville. Fill was better at the low than at the intermediate and high plant populations. This concurs with Holliday's (20) principle of poor silk development due to interplant shading at high plant population.

Entries differed significantly with respect to grain fill. The range was from 2.1 to 3.7 on a scale of 1-5. The best grain fill was with T111 x T115 and the worst was TLLE-9 (Table 9).

Significant variation occurred within hybrids, within open-pollinated varieties, and within exotics. Hybrids had better fill than either exotics or open-pollinated varieties.

Analysis of Grain Fill at Crossville

The range of grain fill ratings at Crossville was from 1.7 (Huffman) to 2.9 (Cow Corn) (Table 9). Significant entry effects on grain fill existed as well as significant differences within hybrids, open-pollinated varieties, and exotics. Poorer fill occurred in hybrids than in exotics or open-pollinated varieties.

Population level had a significant effect on grain fill at Crossville. The best grain fill rating at Crossville was at the high population and the worst at the low population which was exactly opposite the effect at Knoxville (Table 9).

A significant fertility x type effect was observed at Crossville. Most open-pollinated varieties had better grain fill at the sidedress treatment while exotics and hybrids had better fill with the pre-emergence fertilizer treatment (Table A-12, Appendix).

Analysis of Tillers per Plant

In contrast to many of the other characters studied there was not a significant effect of location on the production of tillers. The number of tillers per plant varied significantly among entries with a range of from .02 for Zapalote Chico to .22 for Huffman (Table 10).

The interaction of fertility and location was significant. Whereas at Knoxville the number of tillers per plant decreased from .11 with all fertilizer at pre-emergence to .07 with a sidedress treatment, an opposite effect was found at Crossville where there were fewer tillers per plant with the pre-emergence fertility treatment, .05, than with the sidedress treatment .14 (Tables A-13 and A-14, Appendix). An explanation of this difference may be that stress conditions occurred at an earlier stage in plant development at Crossville (which was planted later) than at Knoxville where the environmental stress due to drought was experienced after the formation of most of the tillers.

Population level had a significant effect on the number of tillers per plant (Table 10). As one would expect, plots with fewer plants produced more tillers because of less interplant competition.

The location x population x fertility interaction was significant. Whereas at Knoxville the most dramatic drop in tillers per plant occurred as population increased at the pre-emergence fertility treatment, at Crossville the largest drop occurred with the sidedress treatment (Tables A-13 and A-14).

There were significant entry, hybrid, open-pollinated variety, and exotic effects on tillers per plant. The interactions of these variables with location were also significant. At Crossville there was

Table 10. Mean* number of tillers per plant for corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
	----- no. -----		
<u>Hybrids</u>			
NCJR10xNCIR10	0.22 a	-	-
Pioneer 3147	0.00 c	0.03 c	0.02 c
T111xT115	0.02 c	0.03 c	0.03 bc
T7100	0.03 c	0.05 bc	0.03 bc
75:1683x75:1684	0.12 abc	0.23 a	0.18 ab
T5009	0.05 c	0.07 abc	0.05 bc
DeKalb XL390B	0.04 c	0.04 c	0.03 bc
T505	-	-	-
<u>Open-pollinated varieties</u>			
Jellicorse	0.11 abc	0.06 abc	0.08 abc
SGP	0.21 ab	0.10 abc	0.15 abc
Neal Paymaster	0.07 bc	0.07 bc	0.07 bc
TLLE-9	0.20 ab	0.12 abc	0.16 abc
Jarvis	0.09 abc	0.11 abc	0.10 abc
<u>Exotic varieties</u>			
Cow Corn	0.02 c	0.08 abc	0.04 bc
Huffman	0.22 ab	0.21 ab	0.22 a
Zapalote Chico	0.02 c	0.01 c	0.02 c
Low population	0.21 a	0.19 a	0.17 a
Medium population	0.05 b	0.07 ab	0.16 a
High population	0.03 b	0.02 b	0.02 b

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

very little difference among any of the entry types with respect to tillers per plant. At Knoxville the open-pollinated varieties averaged approximately twice as many tillers per plant as the hybrids or exotics (Table 10).

The interactions of population with entry, type, hybrid, open-pollinated varieties, and exotics were all significant. All entries whether taken as a whole or as subgroups responded with less tillering as population increased. The differences among entries, types, and entries within subgroups were ones of degree. Some entries dropped more drastically between the highest and successively lower plant populations than others (Tables A-13 and A-14).

Analysis of Tillers per Plant at Knoxville

The mean number of tillers per plant was .09 (Table 10), with a significant population effect. The greatest drop in number of tillers per plant was between the low and middle population where the number of tillers dropped from .21 to .05. Between the medium and high the decrease in number of tillers per plant was only from .05 to .03.

The effect of fertility x population was not significant at Knoxville. For both fertility treatments the drop in tillers per plant with increasing stand density was approximately the same (Table A-13).

The significant difference in the number of tillers per plant produced by the different entries is evidenced by the range where Huffman produced .22 tillers per plant and Pioneer 3147 produced none.

The entries were significantly different in their response to population levels. As in the overall analysis, at Knoxville the

differences in entry response to population were ones of degree. As plant population increased the number of tillers decreased in all entries.

The greatest tiller production at Knoxville was by NCJR10 x NCIR10 at the low population where .55 tillers per plant were produced. Other high tillering entries were Huffman (.46), SGP (.44) and TLLE-9 (.40) (Table 10).

A significant difference in type occurred with respect to the number of tillers produced. Open-pollinated varieties produced more tillers than hybrids or exotics (Table 10). An explanation might be that inbred parents and hybrids may have been selected for low tiller production since tillers on female parents are undesirable in seed production.

The drop in tillers per plant with increasing populations was greater for open-pollinated varieties than for hybrids, but the number of tillers produced by open-pollinated varieties at the medium and low populations was still higher than the hybrids at these population densities.

Analysis of Tillers per Plant at Crossville

The average number of tillers per plant produced at Crossville was .10 (Table 10), and the effect of population on tiller production was similar to that at Knoxville.

The entry x population x fertility interaction was significant at Crossville. Most entries had greater reductions in tillering with increasing plant populations for the sidedress fertility treatment, but

some were reduced more than others. T505 went from .21 tillers per plant at the low population to .05 at the medium population with the pre-emergence fertility treatment and from .95 to .06 at the low and medium population levels, respectively, with the sidedress treatment. TLLE-9 increased from .04 to .07 in tillers per plant from the low to medium population at the pre-emergence fertility treatment, and a decrease of from .45 to .11 with the sidedress treatment (Table A-14).

The greater stress conditions at Crossville early in the season may have inhibited tiller production to the point where response to fertilizer applied pre-emergence was not evident. At Knoxville the growing conditions were such that plants could make use of fertilizer applied pre-emergence and tillering response to population levels was evident.

Analysis of Ear Number per Plant

The mean ear number per plant at Knoxville, Crossville and the two locations combined are presented in Table 11 for each entry, along with the means of the three plant population levels.

Prolific corn varieties when exposed to environmental stress conditions tend to have less barrenness than single-eared genotypes. For this reason the relative ranking with respect to ear number per plant was studied.

The range of prolificacy was from 0.3 ears per plant for Huffman to 1.6 ears per plant for Cow Corn. Huffman produced the largest ears of any entry and Cow Corn the smallest.

Significant differences in ear production occurred between locations. With relatively less environmental stress at Knoxville, the

Table 11. Mean* ear number per plant for corn entries grown at Knoxville and Crossville in 1980, and means of three plant populations averaged over all entries.

Entry	Location		Two Location Mean
	Knoxville	Crossville	
	----- no. -----		
<u>Hybrids</u>			
NCJR10xNCIR10	1.3 bc	-	-
Pioneer 3147	1.1 de	0.8 de	0.9 cd
T111xT115	1.5 b	1.1 bc	1.3 b
T7100	1.0 ef	0.7 ef	0.8 de
75:1683x75:1684	1.3 bc	1.2 ab	1.3 b
T5009	1.2 cd	0.9 cd	1.1 c
DeKalb XL390B	1.1 d	0.7 ef	0.9 cde
T505	-	0.9 bcd	-
<u>Open-pollinated varieties</u>			
Jellicorse	1.0 ef	0.8 de	0.9 cde
SGP	0.9 efg	0.6 ef	0.8 def
Neal Paymaster	1.0 ef	0.7 ef	0.8 def
TLLE-9	0.7 gh	0.6 ef	0.7 ef
Jarvis	0.7 gh	0.5 f	0.6 f
<u>Exotic varieties</u>			
Cow Corn	1.9 a	1.4 a	1.6 a
Huffman	0.5 h	0.1 g	0.3 g
Zapalote Chico	0.9 fg	0.6 ef	0.7 def
Low population	1.3 a	1.1 a	1.2 a
Medium population	1.0 b	0.7 b	0.9 ab
High population	0.8 b	0.5 c	0.7 b

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

average ear number produced per plant was 1.1. Crossville produced an average of 0.8 ears per plant.

One would expect that with increasing plant population the production of ears would be reduced due to interplant competition for available nutrients and sunlight (13,20). This in fact was the case. The low population had an average ear production of 1.2 ears per plant, the medium 0.9 and the high 0.7. The difference between the low and high plant populations was significant at the .05 level.

Significant differences in ear production occurred among entries and among types. Significant differences also occurred within each subgroup of entries. Hybrids averaged 1.1 ears per plant, open-pollinated varieties 0.37, and exotics 0.9 (Table 11). The greatest variation by far in ear production was within the exotics. The least variation was within open-pollinated varieties (Table A-6).

The location x entry interaction was significant. No entry produced more ears at Crossville than at Knoxville, although the reduction in prolificacy varied among entries. Hybrid entries did not vary significantly between locations.

The fertility x entry interaction for ears per plant was not significant, nor was the fertility x location x entry interaction. Slight differences in entry response to fertility and location treatments did occur (Tables A-15 and A-16, Appendix). At Knoxville, entries generally produced slightly fewer ears with the pre-emergence fertility treatment. At Crossville most entries did not change. The differences were very slight between locations and fertility treatments and nonsignificant.

The population x entry and the population x entry x location interactions were significant for ear production. The open-pollinated varieties did not vary significantly in their prolificacy with increasing stand densities. Exotics had the greatest response to increasing population. While Huffman showed no effect with increasing population, Zapalote Chico produced slightly fewer ears per plant with successive population increases and Cow Corn prolificacy was reduced greatly with increasing stand density (Tables A-15 and A-16). Since generally fewer ears per plant were produced by all entries at Crossville, the reduction in prolificacy with increasing plant populations was not as large as at Knoxville.

Analysis of Ear Number per Plant at Knoxville

As in the overall analysis, the most prolific entry was Cow Corn and the least prolific entry was Huffman. Cow Corn produced 1.9 ears per plant and Huffman 0.5 (Table 11).

A significant response to population level was observed at Knoxville. The numbers of ears per plant produced at the low, medium and high populations were 1.3, 1.0 and 0.8, respectively. The ear production at the low population was significantly different from that at the two higher populations.

Entries varied significantly in ear production per plant. Differences also occurred among types. Hybrids were the most prolific group with an average of 1.2 ears per plant. Exotics and open-pollinated varieties had 1.1 and 0.9 ears per plant, respectively (Table 11). The greatest variation occurred among exotics. The population x entry

interaction was significant for ear number per plant. All entries produced fewer ears per plant with increasing plant populations (Table A-15). Some entries were reduced in ear number less dramatically than others. Open-pollinated varieties did not vary significantly in prolificacy with increasing population levels (Table A-15).

Analysis of Ear Number per Plant at Crossville

As at Knoxville, the most prolific variety at Crossville was Cow Corn (1.4 ears per plant) and the least prolific Huffman (0.1 ears per plant) (Table 11).

The response to plant population level with respect to ear production was significant. The low, medium, and high populations elicited responses significantly different from each other. The low population had an average ear production of 1.1, the medium 0.7, and high 0.5 (Table 11).

Differences among entries, types and within hybrids, open-pollinated varieties and exotics were significant. Hybrids were most prolific followed by exotics and open-pollinated varieties, 0.9, 0.7, and 0.6, respectively. Entry T111 x T115 was the most prolific hybrid (1.1 ears per plant), and Jellicorse was the most prolific open-pollinated variety (0.8 ears per plant) (Table 11).

There was no significant difference observed in response to fertility treatments.

A significant population x entry interaction was observed but only the population x exotic interaction was significant of the subgroups. Differences in the degree of reduction in prolificacy existed over all

entries (Table A-16). The amount of prolificacy reduction with increasing plant population was about the same within hybrids and open-pollinated varieties. Yet the hybrids were generally less barren due to the greater number of ears they produced per plant.

The entry x population x fertility response with respect to ear number produced was not significant. Among entries, the amount of prolificacy reduction with increasing population was approximately the same with both the pre-emergence and sidedress fertilizer application (Table A-16).

Analysis of Days to 50% Pollen Shed (Anthesis) at Knoxville

Fifty percent male flowering occurred between 72 and 87 days after planting for the entries evaluated. Zapalote Chico reached 50% pollen shed earliest at 72 days and Huffman flowered latest at 87 days (Table 12).

Population level had a significant effect on anthesis. The higher the stand density, the later anthesis occurred. This is consistent with the findings of Dungan et al. (12). The mean number of days to anthesis at the low population was 75 as compared to 76 and 77 days at the medium and high populations, respectively.

Significant differences in days to anthesis occurred among entries, among types and within each subgroup. Open-pollinated varieties reached anthesis in an average of 75 days, hybrids in 76 days and exotics in 79 days. All entries reached anthesis between 74 and 78 days after planting except two exotic varieties, Huffman (87 days) and Zapalote Chico (72 days (Table 12).

Table 12. Mean* number of days until 50% pollen shed, days until 50% silking, days in the pollen shed interval, and days in the silking interval for corn entries grown at Knoxville in 1980, and means of three plant populations averaged over all entries.

Entry	50% Pollen Shed	50% Silking	Pollen Shed Interval	Silking Interval
----- days -----				
<u>Hybrids</u>				
NCJR10xNCIR10	77 cd	81 bc	6.2 cd	4.5 abcde
Pioneer 3147	76 cde	79 cdef	4.9 d	3.6 bcde
T111xT115	75 de	78 ef	5.1 d	2.7 e
T7100	76 cde	79 cdef	4.9 d	3.7 bcde
75:1683x75:1684	78 b	80 bcde	4.7 d	3.3 cde
T5009	76 cde	78 ef	5.1 d	2.9 de
DeKalb XL390B	77 cd	78 ef	6.3 cd	4.0 bcde
<u>Open-pollinated varieties</u>				
<u>Jellicorse</u>				
SGP	74 e	79 cdef	8.2 bc	4.8 abcde
Neal Paymaster	75 de	79 cdef	9.4 ab	5.6 abc
TLLE-9	76 cde	81 bc	8.3 bc	5.5 abc
Jarvis	75 de	81 bc	7.9 bc	6.0 ab
	77 cd	82 b	8.5 abc	5.3 abcd
<u>Exotic varieties</u>				
Cow Corn	77 cd	80 bcde	6.8 cd	4.7 abcde
Huffman	87 a	94 a	10.7 a	7.0 a
Zapalote Chico	72 f	74 g	9.8 ab	4.0 bcde
<u>Population</u>				
Low population	77 a	79 a	6.6 a	3.8 a
Medium population	76 b	80 b	7.1 ab	4.7 ab
High population	75 c	81 c	7.7 b	5.0 b

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test. Only means within a column may be compared.

The only other significant treatment effects on anthesis were the population interactions with open-pollinated varieties and exotics. Zapalote Chico flowered later at the middle population than at the low or high while the other exotics flowered progressively later with population density increases (Table A-18, Appendix). Among the open-pollinated varieties, differences between the low and medium populations occurred in Paymaster, TLLE-9, and SGP, but not in Jarvis or Jellicorse (Table A-18).

Analysis of Days to 50% Silking at Knoxville

Days to 50% silking ranged from 74 to 94 days after planting. Zapalote Chico reached 50% silking first, and Huffman, last (Table 12).

Population level had a significant effect on days to silking. The greater the stand density, the later the plants reached 50% silking. The low plant population plots reached 50% silking in 79 days, the medium in 80 days, and the high population in 81 days (Table 12).

Significant differences occurred among entries, among types and within each subgroup. Hybrids silked first in an average of 79 days, open-pollinated varieties next in 80 and the exotics last in 83. The late average days to silking in exotics can be explained by Huffman being much later (94 days) than any other entry.

The population x entry and population x type interactions were significant with respect to silking date. Differences among entries with respect to their response to population level may be described as ones of degree as every entry flowered later with the higher stand densities (Table A-17, Appendix). There was a difference of three days

between the low and high population silking dates in the open-pollinated varieties and two days in hybrids and exotics (Table A-17). The fertility x treatment interactions were not significant for days to 50% silking.

Analysis of the Silking Interval at Knoxville

The number of days from first silk appearance until 50% silking ranged from 3 to 7. Huffman took longer to reach 50% silk after the appearance of the first silks. Entries T111 x T115, 75:1683 x 75:1684, and T5009 all took three days to reach 50% silk stage (Table 12).

Significant differences occurred in the silking interval among entries, among types and within hybrids and exotics. Hybrids had a silking interval of four days, open-pollinated and exotic varieties had a five-day interval (Table 12).

The only other significant treatment effects on silking interval were the fertility x entry interaction and fertility x exotic interaction. Among the exotics, Cow Corn silked two days longer with the pre-emergence fertilizer application and Huffman silked two days longer with the sidedress treatment (Table A-17). This could be because Cow Corn matured earlier than Huffman and the effects of the sidedress fertilizer were not as pronounced.

Analysis of the Pollen Shed Interval at Knoxville

The time from first pollen shed until all plants in a plot were shedding pollen ranged from 4.7 to 10.7 days. Entry 75:1683 x 75:1684 had the shortest pollen shed interval and Huffman the longest (Table 12).

The effect of population level on the pollen shed interval was significant. The pollen shed interval increased as the population level increased. However, the difference was approximately one day between the two extreme stand densities.

Significant differences among entries, among types, and within hybrids and exotics were observed. There were no differences among open-pollinated varieties or hybrids. Hybrids, open-pollinated varieties, and exotics had average pollen shed intervals of 5, 8, and 9 days, respectively.

Analysis of Percent Bird Damage at Knoxville

Although it could be purely random, birds did damage some entries more than others (Table 13). A correlation between bird damage and husk length was not significant ($r = -.23$). Long husks did not seem to deter birds except in the extreme case of Zapalote Chico which sustained practically no bird damage due to its unusually tight husks. Huffman also received little bird damage. This could be because Huffman produces so few ears that birds are attracted to more productive varieties. In fact two of the most productive entries, Pioneer 3147 and DeKalb XL390B, sustained the most bird damage.

Other than the significant differences among entries and among types, where hybrids received the most damage, only population level affected the amount of bird damage significantly (Table 13). The more dense the stand, the more damage from birds to the ears. This could be because the denser stand provides more cover for the feeding birds.

Table 13. Mean* percent bird damage and mean husk length for corn entries grown at Knoxville in 1980, and means of three plant populations averaged over all entries.

Entry	Bird Damage	Husk Length
	%	cm
<u>Hybrid</u>		
NCJR10xNCIR10	4.4 ab	3.0 bc
Pioneer 3147	5.0 a	1.8 c
T111xT115	4.6 ab	3.8 bc
T7100	3.9 abc	4.1 bc
75:1683x75:1684	3.4 abc	4.1 bc
T5009	4.2 ab	3.0 bc
DeKalb XL390B	4.8 ab	3.3 bc
<u>Open-pollinated varieties</u>		
Jellicorse	4.5 ab	3.5 bc
SGP	4.4 ab	4.3 bc
Neal Paymaster	3.6 abc	4.3 bc
TLLE-9	3.8 abc	5.6 ab
Jarvis	3.1 abc	4.1 bc
<u>Exotic varieties</u>		
Cow Corn	1.5 bc	6.9 a
Huffman	0.8 c	4.1 bc
Zapalote Chico	0.8 c	7.1 a
Low population	3.1 a	4.3 a
Medium population	3.6 ab	4.1 a
High population	3.9 b	4.3 a

*Means followed by a common letter do not differ at the 5% level of significance based on Duncan's Multiple Range Test.

Analysis of Husk Length at Knoxville

Husk length, an important characteristic for protection of the ear from insect, weather, and possibly bird damage, ranged from 1.8 cm in Pioneer 3147 to 7.1 in Zapalote Chico (Table 13).

The only significant treatment effect on husk length was entry. This indicates the high degree of genetic control of this morphological trait. Husk length varied significantly between types. Exotics had an average husk length of 6.1 cm, open-pollinated varieties 4.2 and hybrids 3.3.

CHAPTER V

SUMMARY

The objective of this study was to determine the effects of population levels and interactions with fertilizer application on corn genotypes grown under reduced tillage conditions. Measurements taken to determine these effects were yield, ear height, plant height, root lodging, stalk lodging, grain fill, tillers per plant, ear number per plant, anthesis dates, silking dates, bird damage, and husk length.

Experiments were conducted at Knoxville and Crossville and analyses performed on each location separately and combined. Entries were selected to be diverse and, as one would expect, significant differences for all dependent variables were found among the entries.

Even though the drought conditions compounded environmental stress, open-pollinated varieties of several different genotypes did not out-perform hybrids in yield for any of the population or fertilizer treatments.

Individual entries had certain desirable agronomic or morphological characteristics. Huffman produced few but very large ears. Zapalote Chico had extremely tight and long husks over the tip of the ear providing for efficient earworm and bird damage protection. Zapalote was the earliest and Huffman the latest maturing variety. Cow Corn was the most prolific. It is obvious that the selected exotic varieties were extreme for several traits. In fact, with the exception of root and

stalk lodging, exotic varieties exhibited more variation for every variable than either hybrids or open-pollinated varieties.

The most variable responses were obtained for tillers per plant and yield. The least variable response was for root lodging. Very little root lodging occurred generally in the experiment.

In general, open-pollinated varieties produced fewer ears than hybrids, 0.8 versus 1.2, respectively. The open-pollinated varieties which produced the most ears yielded less than the hybrid which produced the least number of ears. Also, the highest yielding open-pollinated variety yielded less than the lowest yielding hybrid. Yield differences among hybrids were not significant, but were within open-pollinated varieties and exotics. Since entries were planted later and flowered later at Crossville than at Knoxville, they were exposed to more severe conditions during the critical flowering-to-kernel filling period.

The stress conditions were generally greater at Crossville, where a more severe drought existed. Environmental stress increased as the growing season progressed. Overall, the drought prevented many weeds from infesting the plots. Therefore, the ability of the different entries to compete with weeds could not be discerned.

No evaluation of the tillering contribution to yield could be made because no significant amount of tillers bore ears, possibly due to environmental stress. Few tillers were produced with any treatment although significantly more were produced at the low population. Tillering would only be desirable if the tillers bore ears and did not compete

with the main stalk and potentially productive neighboring plants for light and nutrients.

Since many independent variables contributing to bird damage, i.e., habits of birds and weather effects, could not be assessed, only a preliminary report could be made on the treatment effects on bird damage and no conclusive statement should be made.

A general range of flowering dates was reported for all the entries. Different environmental conditions could change the results to some extent. The effect of population density on anthesis and silking was significant, and similar to that reported in the literature (12). Higher populations had longer intervals of both pollen shed and silking.

Except for ear and plant height, root lodging and husk length, all dependent variables were significantly affected by population level. This could indicate a relatively higher degree of genetic and lower degree of environmental or genotype x environment effect for plant height, ear height and husk length.

The interaction of entry x location was significant for all dependent variables. Hybrids were generally more stable over locations than open-pollinated varieties or exotics which is contrary to some previous reports in the literature (10).

As a group, hybrids reacted similarly to changes in population levels except for the variables stalk lodging, tillering, and ear number. These were the variables most affected by changes in population density. Open-pollinated varieties differed from hybrids in their reaction to stand density in that the population x open-pollinated interaction for ear number was not significant and the response to the population x

open-pollinated interaction for ear height was significant.

Open-pollinated varieties generally had small reductions in their production of ears with increasing populations whereas hybrids had ear number reductions with increasing population densities that varied from slight to moderate. However, the amount of barrenness was less than that of open-pollinated varieties and exotics. The significant population x open-pollinated variety interaction for ear height may be explained by the relatively greater variation occurring among open-pollinated varieties for ear height.

Overall, the stability and lesser reduction in agronomic traits that one would expect for open-pollinated varieties relative to hybrids when environmental stress conditions occur was not expressed to the degree where open-pollinated varieties become more attractive. In spite of the wider genetic base and the theoretical greater buffering capacity of open-pollinated varieties, they seemed to be affected about as greatly as hybrids by the stress conditions. The reduction for hybrids was not great enough to make open-pollinated varieties look attractive economically even under stress conditions.

Current commercial corn hybrids have been selected for high yield under a variety of testing conditions. In this experiment hybrids maintained a yield advantage under several combinations of cultural practices. Although the original focus of the experiment was to test different corn genotypes under environmental stress conditions mainly due to weed competition, very few weeds grew in the experimental plots, probably due to limited rainfall. If one extends the term stress to include anything which interferes with optimum growing conditions the results due to

weediness or drought stress may be similar. Using the term environmental stress in this broad sense, some conclusions might be drawn from research conducted under this particular set of environmental stress conditions and possibly extended to describe the response of corn genotypes to less than optimum growing conditions.

One of the objectives of this research was to determine what germplasm might be most productive if limited resources caused a change in the high input corn production practices used in the U.S. Based on the results of this study, it would appear that germplasm selected for high yield using current practices would also be highest yielding under other cultural practices. A major change in production systems might not require a return to relatively unimproved sources of germplasm. Material selected for high yield under current conditions may be shifted to a breeding program using an altered set of production practices and still maintain an advantage over unimproved germplasm sources.

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APPENDIX

APPENDIX

Table A-1. Form of the analysis of variance for one location.

Source of Variation	Expected Mean Squares
REP	$\sigma^2_E + FP\sigma^2_{RV} + FPV\sigma^2_R$
FER (α)	$\sigma^2_{E+R} + \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{PFV} + P \frac{F}{f-1} \sigma^2_{RFV} + RP \frac{F}{f-1} \sigma^2_{FV} + V \frac{P}{p-1} \sigma^2_{RPF} + \frac{RV\Sigma(\alpha\beta)^2}{(p-1)} + \frac{RVP\Sigma\alpha^2}{f-1}$
REPxFER	$\sigma^2_E + PV \frac{F}{f-1} \sigma^2_{RF}$
POP (β)	$\sigma^2_{E+R} + \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{PFV} + F \frac{P}{p-1} \sigma^2_{PVT} + V \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{RPF} + RV\Sigma(\alpha\beta)^2 (p-1)(f-1) + FV \frac{P}{p-1} \sigma^2_{RP} + \frac{RV\Sigma\beta^2}{p-1}$
REPxPOP	$\sigma^2_{E+FY} + \frac{P}{p-1} \sigma^2_{RP}$
POPxFER	$\sigma^2_{E+R} + \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{PFV} + V \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{RPF} + RV \frac{\Sigma(\alpha\beta)^2}{(p-1)(f-1)}$
REPxPOPxFER	$\sigma^2_{E+V} + \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{RPF}$
ENTRY (γ)	$\sigma^2_{E+FP\alpha^2} + RV + RFP\alpha^2_V$
REPxENTRY	$\sigma^2_E + FP\sigma^2_{RY}$
POPxENTRY	$\sigma^2_{E+FR} + \frac{P}{p-1} \sigma^2_{PV}$
REPxPOPxENTRY	$\sigma^2_E + F \frac{P}{p-1} \sigma^2_{RPV}$
FERxENTRY	$\sigma^2_{E+RP} + \frac{F}{f-1} \sigma^2_{FV}$
REPxFERxENTRY	$\sigma^2_E + P \frac{F}{f-1} \sigma^2_{RFV}$
POPxFERxENTRY	$\sigma^2_{E+R} + \frac{P}{p-1} \frac{F}{f-1} \sigma^2_{PFV}$
REPxPOPxFERxENTRY	σ^2_E

α = Fixed effect of fertility.

β = Fixed effect of plant population level.

γ = Random effect of entry.

Table A-2. Mean yield for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	P ₂	Mean	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃		
----- q/ha -----																	
Hybrids																	
NCJR10xNCIR10	51.4	52.1	50.5	51.7	50.5	47.1	47.6	48.4	54.2	53.8	55.7	54.6					54.6
Pioneer 3147	60.7	52.7	59.6	70.0	57.5	58.5	68.7	61.6	47.9	60.7	71.3	59.9					59.9
T111xT115	55.9	53.0	58.9	55.7	50.0	59.8	57.4	55.7	56.1	58.0	54.0	56.0					56.0
T7100	58.6	51.3	66.7	57.7	54.7	59.0	62.0	58.6	47.8	74.5	53.4	58.6					58.6
75:1683x75:1684	55.3	56.2	55.6	54.1	56.9	48.5	47.3	50.9	55.6	62.7	61.0	59.8					59.8
T5009	58.0	58.9	57.8	57.5	57.6	54.8	54.1	55.5	60.2	60.8	60.8	60.6					60.6
DeKalb XL390B	56.3	52.5	59.5	56.8	47.9	56.0	49.6	51.2	57.1	63.1	63.9	61.3					61.3
Open-pollinated varieties																	
Jellicorse	39.3	34.7	41.5	41.7	30.8	37.7	34.2	34.2	38.5	45.4	49.2	44.4					44.4
SGP	37.4	33.9	40.2	38.0	31.5	35.8	36.5	34.6	36.3	44.5	39.5	40.1					40.1
Neal Paymaster	36.6	36.3	38.6	35.1	36.2	34.0	30.4	33.5	36.3	43.1	39.8	39.7					39.7
TLLE-9	24.0	23.1	26.9	22.1	19.0	24.5	17.7	20.4	26.4	29.3	26.5	27.4					27.4
Jarvis	24.7	24.4	28.4	21.1	22.0	23.8	18.4	21.4	26.8	33.0	23.9	27.9					27.9
Exotic varieties																	
Cow Corn	30.1	26.3	30.1	33.8	27.6	29.9	32.0	29.8	25.1	30.3	35.6	30.3					30.3
Huffman	19.1	20.1	23.4	13.7	12.5	21.9	12.6	15.7	27.6	24.3	14.8	22.4					22.4
Zapalote Chico	13.4	12.7	13.5	14.1	11.3	13.0	12.1	12.1	14.0	14.0	16.0	14.7					14.7
Mean	41.3	39.0	43.4	41.5	37.7	40.3	38.7	38.9	40.2	46.5	44.4	43.7					43.7

Table A-3. Mean yield for corn entries grown at two fertility and three plant population levels at Crossfield in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	Mean	P ₁	P ₂	Mean	Mean	P ₃	Mean	P ₁	P ₂	P ₃			
----- q/ha -----																	
<u>Hybrids</u>																	
T505	37.8	39.4	43.0	31.1	44.7	38.5	26.6	36.6	34.0	47.5	35.6	39.0					
Pioneer 3147	45.0	52.3	46.3	36.4	46.9	36.7	31.7	38.4	57.7	55.9	41.1	51.6					
T111xT115	42.1	43.4	40.0	42.8	44.5	37.0	37.0	39.5	42.3	43.1	48.6	44.7					
T7100	36.3	46.6	35.9	26.4	44.6	35.5	21.0	33.7	48.6	36.4	31.8	39.0					
75:1683x75:1684	36.1	40.3	36.6	31.4	39.6	35.9	28.9	34.8	41.0	37.4	33.8	37.3					
T5009	32.6	38.8	31.0	28.1	35.4	38.8	29.2	34.5	42.2	23.2	27.1	30.8					
DeKalb XL390B	30.9	33.3	32.5	27.0	32.5	27.0	24.4	28.0	34.0	38.1	29.6	33.9					
<u>Open-pollinated varieties</u>																	
Jellicorse	26.8	28.9	27.9	23.8	24.6	29.0	25.2	26.2	33.1	26.8	22.4	27.4					
SGP	24.5	30.9	22.7	20.0	31.2	21.0	18.2	23.4	30.6	24.4	21.9	25.6					
Neal Paymaster	20.8	23.0	23.6	15.9	24.9	28.3	15.5	22.9	21.1	18.9	16.2	18.7					
TLLE-9	18.7	23.9	18.9	13.2	25.4	16.2	13.7	18.4	22.4	21.5	12.6	18.9					
Jarvis	18.0	19.9	21.4	12.7	16.0	18.9	12.4	15.8	23.7	23.9	12.9	20.2					
<u>Exotic varieties</u>																	
Cow Corn	17.2	16.2	20.3	15.1	16.3	20.3	14.9	17.2	16.1	20.3	15.3	17.2					
Huffman	3.5	5.6	3.0	2.0	6.6	3.2	2.9	4.2	4.7	2.7	1.1	2.8					
Zapalote Chico	7.3	7.7	7.4	6.8	7.3	7.1	7.3	7.3	8.2	7.7	6.3	7.4					

Table A-4. Partial listing of the analysis of variance for the 1980 Knoxville data.

Source of Variation	df	QUPHA	TILLPLT	RANGEF	RANGEN	ENOPLT	FB	MB	MEANCH	MEANPH	BD	ERECTR	ERECT	FILL	HL
Mean Squares															
REP	3	845.54*	0.031	7.749 ^{ns}	7.20 ^{ns}	0.113*	13.76*	19.46*	0.846*	1.660*	8.13 ^{ns}	0.002 ^{ns}	0.041*	0.935 ^{ns}	0.278 ^{ns}
FER	1	3361.57	0.145	3.21	14.80	0.159	3.60	23.00	1.736	14.890	5.14	0.037	0.208	0.300	3.600
E (A) REPxFER	3	397.13*	0.0002 ^{ns}	5.29 ^{ns}	10.75*	0.048 ^{ns}	11.93*	9.23*	0.507*	0.499*	10.10 ^{ns}	0.002 ^{ns}	0.030*	0.024 ^{ns}	0.689 ^{ns}
POP	2	969.35*	1.148*	48.67*	30.34*	8.00*	166.08*	60.22*	0.037 ^{ns}	0.470 ^{ns}	23.05*	0.003 ^{ns}	0.222*	3.309*	0.264 ^{ns}
FERxPOP	2	66.10	0.006	2.14	5.43	0.018	2.36	0.49 ^{ns}	0.109	0.385	7.10	0.008	0.012	0.294	0.456
E (A) REPxPOP	6	632.97	0.035	3.13	3.73	0.033	1.44	2.86	0.113	0.329	21.98	0.003	0.018	0.461	0.296
REPxFERxPOP	12	10345.68*	0.150*	34.54*	94.48*	2.86*	438.50*	263.94*	7.159*	7.107*	46.48*	0.071*	0.077*	5.939*	7.338*
ENT	14	64290.87*	0.174*	146.67*	518.84*	20.02*	383.59*	246.00*	10.685*	6.395*	284.40*	0.374*	0.003 ^{ns}	23.541*	30.737*
TYPE	6	335.58 ^{ns}	0.123*	9.19*	9.81*	0.933*	31.28*	25.71*	1.993*	3.988*	7.17*	0.017*	0.086*	1.370*	2.610*
HYB	4	2171.53*	0.095*	4.52 ^{ns}	8.08 ^{ns}	0.525*	38.53*	15.54*	10.847*	5.705*	7.83 ^{ns}	0.027*	0.096*	2.600*	1.940*
OP	2	2799.09*	0.317*	58.50*	96.85*	11.462*	2515.01*	1493.37*	11.755*	19.980*	3.79 ^{ns}	0.018*	0.086*	8.722*	8.919*
EXO	14	153.32 ^{ns}	0.014 ^{ns}	5.81*	3.65 ^{ns}	0.035 ^{ns}	2.23 ^{ns}	0.88 ^{ns}	0.063 ^{ns}	0.154 ^{ns}	5.01 ^{ns}	0.003 ^{ns}	0.013 ^{ns}	0.204 ^{ns}	0.198 ^{ns}
FERxENT	2	250.93 ^{ns}	0.041*	1.01 ^{ns}	2.54 ^{ns}	0.082*	5.15*	0.40 ^{ns}	0.023 ^{ns}	0.194 ^{ns}	2.12 ^{ns}	0.001 ^{ns}	0.007 ^{ns}	0.481 ^{ns}	0.163 ^{ns}
FERxTYPE	6	204.03 ^{ns}	0.007 ^{ns}	1.12 ^{ns}	2.22 ^{ns}	0.013 ^{ns}	2.31*	1.07 ^{ns}	0.027 ^{ns}	0.112 ^{ns}	6.84 ^{ns}	0.004 ^{ns}	0.014 ^{ns}	0.240 ^{ns}	0.140 ^{ns}
FERxHYB	4	55.70 ^{ns}	0.0008 ^{ns}	8.90 ^{ns}	4.26 ^{ns}	0.018 ^{ns}	1.55 ^{ns}	0.85 ^{ns}	0.055 ^{ns}	0.170 ^{ns}	4.71 ^{ns}	0.003 ^{ns}	0.013*	0.025 ^{ns}	0.330 ^{ns}
FERxOP	2	98.82*	0.020*	18.50*	7.83 ^{ns}	0.088 ^{ns}	0.431 ^{ns}	0.85 ^{ns}	0.227 ^{ns}	0.208 ^{ns}	3.01 ^{ns}	0.002 ^{ns}	0.016 ^{ns}	0.177 ^{ns}	0.143 ^{ns}
FERxEXP	28	160.38 ^{ns}	0.066*	2.10 ^{ns}	3.57 ^{ns}	0.235*	2.71*	2.10 ^{ns}	0.073 ^{ns}	0.175 ^{ns}	5.31 ^{ns}	0.002 ^{ns}	0.026*	0.310 ^{ns}	0.470 ^{ns}
POPxENT	4	19.76 ^{ns}	0.060*	6.84 ^{ns}	2.97 ^{ns}	0.312*	8.74*	2.45 ^{ns}	0.052 ^{ns}	0.513 ^{ns}	10.61 ^{ns}	0.001 ^{ns}	0.058*	0.790*	0.465 ^{ns}
POPxTYPE	12	257.00 ^{ns}	0.082*	0.78 ^{ns}	2.71 ^{ns}	0.158*	1.72 ^{ns}	1.44 ^{ns}	0.051 ^{ns}	0.067 ^{ns}	3.37 ^{ns}	0.001 ^{ns}	0.031*	0.190 ^{ns}	0.350 ^{ns}
POPxHYB	8	57.72 ^{ns}	0.023 ^{ns}	1.79 ^{ns}	2.54 ^{ns}	0.023 ^{ns}	2.05 ^{ns}	2.09*	0.054 ^{ns}	0.123 ^{ns}	6.61 ^{ns}	0.000 ^{ns}	0.006 ^{ns}	0.320 ^{ns}	0.749 ^{ns}
POPxOP	4	216.76*	0.110*	1.94 ^{ns}	8.81 ^{ns}	0.813*	0.973 ^{ns}	3.75*	0.198 ^{ns}	0.265 ^{ns}	3.23 ^{ns}	0.005 ^{ns}	0.019 ^{ns}	0.170 ^{ns}	0.277 ^{ns}
POPxEXO	28	98.67 ^{ns}	0.004 ^{ns}	1.06 ^{ns}	1.86 ^{ns}	0.022 ^{ns}	1.72 ^{ns}	0.68 ^{ns}	0.041 ^{ns}	0.121 ^{ns}	5.11 ^{ns}	0.001 ^{ns}	0.008 ^{ns}	0.162 ^{ns}	0.335 ^{ns}
ENTxPOPxFER	252	141.14	0.012	3.36	3.40	0.024	2.02	1.40	0.051	0.240	6.11	0.003	0.008	0.298	0.637
TOTAL	359	24.80	98.12	42.44	25.28	13.89	1.48	1.33	7.84	5.12	70.40	5.61	11.09	17.79	41.16
C.V. (%)															

*Significant at the 5% level.

^{ns} Nonsignificant.

Table A-5. Partial listing of the analysis of variance for the 1980 Crossville data.

Source	df	TILLPLT	ENOPLT	MEANPH	MEANEH	ERECT	QUPHA	FILL
----- Mean Squares -----								
REP	3	0.060*	0.070 ^{ns}	0.514 ^{ns}	0.202 ^{ns}	0.035*	133.93 ^{ns}	0.197 ^{ns}
FER	1	0.762 ^{ns}	0.018	8.763 ^{ns}	6.263 ^{ns}	0.000	740.42	0.017 ^{ns}
(EA) REPxFER	3	0.023 ^{ns}	0.137*	0.527 ^{ns}	0.127 ^{ns}	0.014 ^{ns}	642.18*	0.095 ^{ns}
POP	2	0.944*	9.335*	4.471*	0.000 ^{ns}	0.131*	3095.72*	7.275*
FERxPOP	2	0.253	0.021	0.241	0.113	0.017	43.90	0.136 ^{ns}
(EB) REPxPOP	12	0.021	0.023	0.265	0.062	0.016	135.54	0.556
REPxFERxPOP	14	0.124*	2.190*	1.247*	1.152*	0.168*	5878.93*	2.377*
ENT								
TYPE	2	0.008 ^{ns}	2.942*	2.571*	0.685*	0.072	35200.36*	4.752*
HYB	6	0.193*	0.878*	0.482*	0.788*	0.193*	956.21*	0.940*
OP	4	0.015 ^{ns}	0.260*	0.176 ^{ns}	1.700*	0.133*	568.69*	0.388*
EXO	2	0.251*	0.234*	4.330*	1.615*	0.259*	1946.14*	8.291*
FERxENT	14	0.043*	0.023 ^{ns}	0.407 ^{ns}	0.138 ^{ns}	0.027*	179.32*	0.526 ^{ns}
FERxTYPE	2	0.017*	0.022 ^{ns}	0.627*	0.059 ^{ns}	0.000 ^{ns}	313.00*	0.888*
FERxHYB	6	0.047*	0.026 ^{ns}	0.222 ^{ns}	0.095 ^{ns}	0.033*	246.68*	0.377*
FERxOP	4	0.018 ^{ns}	0.030 ^{ns}	0.036 ^{ns}	0.032 ^{ns}	0.023*	97.28 ^{ns}	0.283*
FERxEXO	2	0.107*	0.001 ^{ns}	1.484*	0.558*	0.044*	7.64 ^{ns}	1.097 ^{ns}
POPxENT	28	0.068*	0.103*	0.670*	0.501*	0.014 ^{ns}	140.22*	0.199 ^{ns}
POPxTYPE	4	0.004 ^{ns}	0.061 ^{ns}	0.891*	0.118 ^{ns}	0.011 ^{ns}	236.66*	0.720*
POPxHYB	12	0.118*	0.056 ^{ns}	0.327 ^{ns}	0.153 ^{ns}	0.021 ^{ns}	190.64*	0.127 ^{ns}
POPxOP	8	0.014 ^{ns}	0.010 ^{ns}	0.404 ^{ns}	0.865*	0.010 ^{ns}	64.01 ^{ns}	0.139 ^{ns}
POPxEXO	4	0.045*	0.472*	2.035*	1.200*	0.004 ^{ns}	44.94*	0.104 ^{ns}
ENTxPOPxFER	28	0.039*	0.026 ^{ns}	0.211 ^{ns}	0.327 ^{ns}	0.008 ^{ns}	110.87*	0.324
ERROR	252	0.016	0.034	0.289	0.255	0.007	95.15	0.180
TOTAL	359							
C.V. (%)		129.72	23.60	7.62	13.19	12.51	23.16	16.14

*Significant at the 5% level.

^{ns}Nonsignificant.

Table A-6. Partial listing of the analysis of variance of the 1980 data for the combined Knoxville and Crossville locations.

Source	df	QUPHA	MEANEH	MEANPH	ERECTR	ERECT	FILL	TILLPLT	ENOPLT
----- Mean Squares -----									
LOC	1	60699.92*	2.699*	33.395*	0.213*	0.436*	19.648*	0.000 ^{ns}	14.604*
REP	3	444.17*	0.251 ^{ns}	1.003*	0.002 ^{ns}	0.022*	0.262 ^{ns}	0.015 ^{ns}	0.115*
E(A) REPxLOC	3	421.55*	0.919*	5.808*	0.002 ^{ns}	0.050*	1.043 ^{ns}	0.073*	0.034 ^{ns}
FER	1	3391.97 ^{ns}	7.187	22.413	0.019	0.085	0.149	0.077	0.139 ^{ns}
FERxLOC	1	394.95 ^{ns}	0.697*	0.272 ^{ns}	0.019*	0.119*	0.081 ^{ns}	0.577*	0.041 ^{ns}
E(B) REPxFER	6	993.83	0.342	0.607	0.001	0.005	0.050	0.010	0.022
REPxFERxLOC	2	1149.55*	0.018 ^{ns}	4.870 ^{ns}	0.002 ^{ns}	0.345*	0.405 ^{ns}	1.410*	16.094*
POP	2	2696.10*	0.041 ^{ns}	0.865 ^{ns}	0.001 ^{ns}	0.009 ^{ns}	10.154*	0.040 ^{ns}	0.017 ^{ns}
LOCxPOP	2	79.70	0.058	0.103	0.002	0.001	0.475	0.031 ^{ns}	0.019 ^{ns}
FERxPOP	2	100.41 ^{ns}	0.155 ^{ns}	0.410 ^{ns}	0.003 ^{ns}	0.020 ^{ns}	0.348 ^{ns}	0.124*	0.016 ^{ns}
LOCxFERxPOP	2								
E(C) PxR, RxPxP	24	210.74	0.087	0.294	0.003	0.016	0.570	0.014	0.034
RxLxP, RxLxFxP	13	1590.62*	6.890*	5.808*	0.011*	0.208*	1.251 ^{ns}	0.205*	5.175*
ENT									
TYPE	2	92392.26*	8.363*	5.333*	0.014*	0.048*	4.082*	0.508*	5.845*
HYB	5	824.74*	2.464*	1.942*	0.011*	0.224*	0.410 ^{ns}	0.165*	2.106*
OP	4	2331.96*	10.100*	3.180*	0.010*	0.211*	1.050 ^{ns}	0.080*	0.725*
EXO	2	4281.50*	10.625*	21.204*	0.010*	0.322*	0.925 ^{ns}	0.505*	21.078*
LOCxENT	13	843.11*	1.900*	1.764*	0.011*	0.055*	7.335*	0.034*	0.110
LOCxTYPE	2	3037.79*	3.235*	0.737*	0.016*	0.030*	31.477*	0.091*	0.402*
LOCxHYB	5	464.88 ^{ns}	0.370*	0.886*	0.011*	0.109*	0.018*	0.018*	0.030 ^{ns}
LOCxOP	4	408.25*	2.440*	2.700*	0.010*	0.016*	0.033*	0.033*	0.060*
LOCxEXO	2	463.73*	3.308*	3.114*	0.009*	0.023 ^{ns}	16.090*	0.019 ^{ns}	0.118 ^{ns}
FERxENT	13	110.80 ^{ns}	0.060 ^{ns}	0.238 ^{ns}	0.001 ^{ns}	0.027*	0.248 ^{ns}	0.009 ^{ns}	0.029 ^{ns}
FERxTYPE	2	184.75 ^{ns}	0.007 ^{ns}	0.664*	0.001 ^{ns}	0.004 ^{ns}	0.232 ^{ns}	0.025 ^{ns}	0.021 ^{ns}
FERxHYB	5	141.50 ^{ns}	0.072 ^{ns}	0.144 ^{ns}	0.002*	0.022 ^{ns}	0.322 ^{ns}	0.001 ^{ns}	0.025 ^{ns}
FERxOP	4	77.08 ^{ns}	0.080 ^{ns}	0.110 ^{ns}	0.000 ^{ns}	0.030*	0.180 ^{ns}	0.007 ^{ns}	0.028 ^{ns}

Table A-6 (continued)

Source	df	QUPHA	MEANEH	MEANPH	ERECTR	ERECT	FILL	TILLPLT	ENOPLT
----- Mean Squares -----									
FERxEXO	2	27.54 ^{ns}	0.043 ^{ns}	0.303 ^{ns}	0.001 ^{ns}	0.057*	0.215 ^{ns}	0.017 ^{ns}	0.049 ^{ns}
POPxENT	26	111.47 ^{ns}	0.314*	0.447*	0.001 ^{ns}	0.024*	0.271 ^{ns}	0.323*	0.305*
POPxTYPE	4	82.56 ^{ns}	0.079 ^{ns}	0.301 ^{ns}	0.003*	0.053*	1.575*	1.705*	0.279*
POPxHYB	10	144.20 ^{ns}	0.108 ^{ns}	0.213 ^{ns}	0.000 ^{ns}	0.030*	0.155	0.069*	0.181*
POPxOP	8	72.29 ^{ns}	0.460*	0.500	0.000 ^{ns}	0.009*	0.230 ^{ns}	0.021*	0.022 ^{ns}
POPxEXO	4	130.69*	0.772*	1.072*	0.003 ^{ns}	0.010 ^{ns}	0.127 ^{ns}	0.180*	1.206*
LOCxFERxENT	13	338.71 ^{ns}	0.335 ^{ns}	0.335 ^{ns}	0.002 ^{ns}	0.015 ^{ns}	0.525*	0.010 ^{ns}	0.032 ^{ns}
LOCxPOPxENT	26	310.72 ^{ns}	0.413*	0.413*	0.001 ^{ns}	0.019*	0.215 ^{ns}	0.007 ^{ns}	0.046 ^{ns}
FERxPOPxENT	26	105.24 ^{ns}	0.121 ^{ns}	0.121 ^{ns}	0.001 ^{ns}	0.007 ^{ns}	0.249 ^{ns}	0.018 ^{ns}	0.019 ^{ns}
LOCxPOPxFERxENT	26	228.32 ^{ns}	0.215 ^{ns}	0.232 ^{ns}	0.001 ^{ns}	0.008 ^{ns}	0.255 ^{ns}	0.005 ^{ns}	0.027 ^{ns}
ERROR	468	98.18	0.169	0.211	0.001	0.008	0.230	0.013	0.029
TOTAL	671								
C.V. (%)		27.04	11.39	7.07	3.83	10.80	17.88	132.40	21.32

*Significant at the 5% level.

^{ns} Nonsignificant.

Table A-7. Mean ear height for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	P ₂	Mean	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃		
----- cm -----																	
Hybrids																	
NCJR10xNCIR10	101	102	100	103	88	92	104	95	116	109	102	109	116	109	102	109	
Pioneer 3147	99	103	100	94	104	93	89	95	101	107	98	102	101	107	98	102	
T111xT115	113	105	117	118	108	114	114	112	102	120	122	115	102	120	122	115	
T7100	99	101	99	97	96	104	88	96	106	94	106	102	106	94	106	102	
75:1683x75:1684	108	105	105	113	93	113	106	104	116	98	120	111	104	98	120	111	
T5009	105	107	106	103	104	105	100	103	111	107	106	108	111	107	106	108	
DeKalb XL390B	99	101	98	99	97	91	93	94	105	105	104	105	105	105	104	105	
Open-pollinated varieties																	
Jelllicorse	110	107	113	110	106	105	106	106	107	121	113	114	107	121	113	114	
SGP	105	100	110	110	84	111	111	102	116	109	108	111	116	109	108	111	
Neal Paymaster	105	94	116	105	79	112	105	99	109	120	104	112	109	120	104	112	
TLLE-9	89	107	78	84	105	79	73	86	108	77	95	93	108	77	95	93	
Jarvis	108	112	108	103	115	101	95	104	109	115	112	112	109	115	112	112	
Exotic varieties																	
Cow Corn	105	102	108	107	91	100	105	99	112	117	110	113	112	117	110	113	
Huffman	117	107	120	125	109	119	128	119	104	121	121	115	104	121	121	115	
Zapalote Chico	102	117	90	100	115	85	90	97	119	95	109	108	119	95	109	108	
Mean	105	105	105	105	100	102	101	101	110	108	109	109	110	108	109	109	

Table A-8. Mean ear height for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂		
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃
----- cm -----																
<u>Hybrids</u>																
T505	104	106	106	100	105	105	105	97	102	106	107	103	105	105	105	105
Pioneer 3147	92	92	94	91	89	89	89	91	90	95	99	90	95	95	95	95
T111xT115	110	107	112	112	107	107	107	112	109	106	116	111	112	112	112	112
T7100	100	102	98	98	104	96	96	97	99	100	101	100	100	100	100	100
75:1683x75:1684	89	86	90	89	84	89	89	85	86	88	91	93	91	91	91	91
T5009	113	112	112	115	109	110	110	111	110	114	113	119	116	116	116	116
DeKalb XL390B	100	99	99	103	98	94	94	98	97	99	104	107	103	103	103	103
<u>Open-pollinated varieties</u>																
Jelllicorse	96	95	98	94	94	96	96	93	94	96	101	95	97	97	97	97
SGP	105	108	103	105	108	103	103	101	104	108	103	110	107	107	107	107
Neal Paymaster	112	114	112	110	112	108	108	107	109	116	116	112	115	115	115	115
TLL-9	60	63	58	58	58	57	57	57	57	67	59	60	62	62	62	62
Jarvis	98	97	100	96	94	96	96	94	95	99	104	98	101	101	101	101
<u>Exotic varieties</u>																
Cow Corn	124	129	127	116	132	126	126	115	124	128	128	117	124	124	124	124
Huffman	130	129	130	130	123	128	128	120	124	134	131	141	136	136	136	136
Zapalote Chico	90	91	88	92	90	89	89	87	89	92	87	97	92	92	92	92
Mean	101	101	102	101	100	99	99	98	99	103	104	104	103	103	103	103

Table A-9. Mean percent of plants not stalk lodged for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean	
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃		
----- % -----																		
<u>Hybrids</u>																		
NCJR10xNCIR10	87	89		88	84	86	91	89	89	93	85	79	85					
Pioneer 3147	83	96		84	69	100	86	69	85	91	81	68	80					
T111xT115	83	94		84	73	100	85	81	89	88	83	64	78					
T7100	95	96		94	96	93	96	96	95	98	93	96	96					
75:1683x75:1684	95	96		94	93	96	95	96	96	96	94	90	94					
T5009	80	88		80	71	91	81	76	83	86	79	67	77					
DeKalb XL390B	85	97		89	69	100	94	81	92	95	85	56	79					
<u>Open-pollinated varieties</u>																		
Jellicorse	80	86		76	79	91	80	86	86	82	72	71	75					
SGP	87	86		87	87	91	87	88	88	82	87	87	85					
Neal Paymaster	83	86		78	85	89	85	86	87	84	71	85	80					
TLLE-9	96	95		96	98	95	95	97	95	96	98	98	97					
Jarvis	90	92		88	91	93	94	93	93	91	82	89	88					
<u>Exotic varieties</u>																		
Cow Corn	80	80		76	83	89	78	87	84	71	74	80	75					
Huffman	90	95		92	83	93	92	86	91	98	92	79	90					
Zapalote Chico	90	95		89	86	96	85	90	90	95	94	82	90					
Mean	87	92		86	83	93	88	87	89	90	85	80	85					

Table A-10. Mean percent of plants not stalk lodged for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- % -----																	
<u>Hybrids</u>																	
T505	81	82	81	79	82	89	77	83	82	73	82	82	80				
Pioneer 3147	93	96	91	92	96	93	89	93	95	89	95	95	93				
T111xT115	69	80	71	56	73	64	50	62	88	78	62	62	76				
T7100	91	91	88	93	93	96	95	94	89	80	92	92	87				
75:1683x75:1684	83	90	80	78	89	80	74	81	91	80	82	82	84				
T5009	74	80	71	71	88	71	66	75	73	71	76	76	73				
DeKalb XL390B	90	97	81	92	100	92	91	94	95	71	93	93	86				
<u>Open-pollinated varieties</u>																	
Jellicorse	71	76	65	72	79	70	76	75	74	60	68	68	67				
SGP	82	87	84	77	84	80	79	81	89	87	75	75	84				
Neal Paymaster	85	87	84	83	86	80	79	82	88	89	86	86	87				
TLL-9	92	95	93	88	95	89	83	89	95	97	92	92	94				
Jarvis	85	83	86	84	88	90	84	87	79	83	85	85	82				
<u>Exotic varieties</u>																	
Cow Corn	66	68	66	63	70	71	70	70	67	61	57	57	62				
Huffman	83	83	84	83	79	81	79	80	88	86	86	86	87				
Zapalote Chico	85	89	83	82	84	80	81	82	95	85	83	83	88				
Mean	82	86	80	80	86	82	78	82	86	79	81	81	82				

Table A-11. Mean grain fill rating* for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	P ₂	Mean	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃		
----- Scale 1-5 -----																	
<u>Hybrids</u>																	
NCJR10xNCIR10	2.3	2.1	2.6	2.2	2.1	2.8	2.4	2.4	2.4	2.2	2.5	2.0	2.2	2.5	2.0	2.2	2.2
Pioneer 3147	2.5	2.4	2.7	2.4	2.6	2.8	2.4	2.6	2.3	2.7	2.5	2.6	2.3	2.7	2.5	2.5	2.5
T111xT115	2.1	2.1	2.1	2.1	2.3	2.3	2.0	2.2	1.9	2.0	2.3	2.2	1.9	2.0	2.3	2.1	2.1
T7100	2.5	2.4	2.5	2.6	2.4	2.4	2.6	2.5	2.5	2.7	2.5	2.5	2.5	2.7	2.5	2.5	2.5
75:1683x75:1684	2.3	2.0	2.3	2.4	2.3	2.6	2.6	2.5	1.8	2.0	2.3	2.2	1.6	2.5	2.4	2.0	2.0
T5009	2.2	1.8	2.4	2.3	1.9	2.4	2.3	2.2	1.6	2.5	2.4	2.2	1.6	2.5	2.4	2.2	2.2
DeKalb XL390B	2.8	2.8	2.9	2.7	2.9	3.0	3.0	3.0	2.6	2.8	2.5	3.0	2.6	2.8	2.5	2.6	2.6
<u>Open-pollinated varieties</u>																	
Jellicorse	3.1	2.9	3.1	3.4	3.3	2.9	3.5	3.2	2.6	3.4	3.3	3.2	2.6	3.4	3.3	3.1	3.1
SGP	2.9	2.8	2.9	3.1	2.9	2.9	3.0	2.9	2.6	3.0	3.3	2.9	2.6	3.0	3.3	3.0	3.0
Neal Paymaster	3.2	3.2	3.1	3.3	3.1	3.1	3.4	3.2	3.3	3.1	3.3	3.2	3.3	3.1	3.3	3.2	3.2
TLLE-9	3.7	3.6	3.7	3.9	3.5	3.8	3.9	3.7	3.6	3.6	4.0	3.7	3.6	3.6	4.0	3.7	3.7
Jarvis	2.9	2.5	2.7	3.6	2.6	2.4	3.8	2.9	2.4	3.0	3.4	2.9	2.4	3.0	3.4	2.9	2.9
<u>Exotic varieties</u>																	
Cow Corn	2.2	1.9	2.2	2.4	1.9	2.3	2.3	2.1	1.9	2.1	2.6	2.1	1.9	2.1	2.6	2.2	2.2
Huffman	3.2	2.9	3.1	3.5	3.0	2.9	3.3	3.0	2.9	3.3	3.8	3.0	2.9	3.3	3.8	3.3	3.3
Zapalote Chico	3.3	3.0	3.4	3.3	3.1	3.4	3.4	3.3	2.9	3.5	3.3	3.3	2.9	3.5	3.3	3.2	3.2
Mean	2.7	2.6	2.8	2.9	2.7	2.8	2.9	2.8	2.5	2.8	2.9	2.8	2.5	2.8	2.9	2.7	2.7

*Scale = 1 to 5, where 1 = most complete grain fill.

Table A-12. Mean grain fill rating* for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- Scale 1-5 -----																	
<u>Hybrids</u>																	
T505	2.6	2.8	2.6	2.4	2.9	2.6	2.4	2.6	2.6	2.4	2.6	2.6	2.4	2.6	2.4	2.5	
Pioneer 3147	2.8	3.2	2.6	2.5	3.0	2.8	2.5	2.8	3.4	2.5	2.5	2.5	2.5	2.5	2.5	2.8	
T111xT115	2.7	3.1	2.4	2.5	3.1	2.4	2.5	2.7	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.7	
T7100	2.4	2.7	2.4	2.1	2.9	2.4	2.0	2.4	2.5	2.4	2.4	2.1	2.1	2.4	2.1	2.3	
75:1683x75:1684	2.8	3.2	2.6	2.7	3.6	2.5	2.8	3.0	2.8	2.6	2.6	2.6	2.6	2.6	2.6	2.7	
T5009	2.8	3.2	2.6	2.6	3.1	2.9	2.6	2.9	3.3	2.4	2.4	2.5	2.7	3.3	2.4	2.7	
DeKalb XL390B	2.3	2.9	2.1	2.0	2.4	2.0	1.9	2.1	3.4	2.3	2.3	2.1	2.1	3.4	2.3	2.6	
<u>Open-pollinated varieties</u>																	
Jellicorse	2.2	2.6	2.1	1.9	2.4	1.9	1.8	2.0	2.9	2.4	2.1	2.1	2.1	2.9	2.4	2.5	
SGP	2.5	2.7	2.3	2.4	2.9	2.3	2.5	2.5	2.5	2.3	2.4	2.4	2.4	2.5	2.4	2.4	
Neal Paymaster	2.2	2.3	2.2	2.1	2.3	2.3	1.9	2.1	2.3	2.3	2.1	2.1	2.3	2.3	2.3	2.2	
TLE-9	2.3	2.4	2.2	2.3	2.4	2.1	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.3	
Jarvis	2.4	2.5	2.3	2.4	2.3	2.4	2.3	2.3	2.8	2.3	2.4	2.3	2.3	2.8	2.3	2.5	
<u>Exotic varieties</u>																	
Cow Corn	2.9	3.1	2.9	2.7	3.3	3.1	2.9	3.1	2.9	2.8	2.8	2.5	2.5	2.9	2.8	2.7	
Huffman	1.7	2.1	1.8	1.3	3.0	1.6	1.5	2.0	1.1	2.0	2.0	1.1	1.1	1.1	2.0	1.4	
Zapalote Chico	2.2	2.3	2.3	1.9	2.1	2.3	1.9	2.1	2.5	2.4	2.4	2.0	2.0	2.5	2.4	2.3	
Mean	2.4	2.7	2.4	2.2	2.8	2.4	2.2	2.5	2.7	2.4	2.4	2.3	2.3	2.7	2.4	2.4	

*Scale = 1 to 5, where 1 = most complete grain fill.

Table A-13. Mean number of tillers per plant for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- no. -----																	
Hybrids																	
NCJR10xNCIR10	.21	.55	.09	.03	.55	.14	.05	.24	.55	.04	.02	.17	.55	.04	.02	.17	
Pioneer 3147	.00	.01	.00	.00	.00	.00	.01	.00	.02	.00	.00	.01	.00	.00	.00	.01	
T111xT115	.02	.04	.02	.01	.02	.03	.01	.02	.05	.01	.01	.03	.02	.01	.01	.03	
T7100	.03	.04	.03	.03	.04	.02	.02	.03	.04	.03	.03	.03	.04	.03	.03	.03	
75:1683x75:1684	.12	.29	.04	.03	.29	.06	.04	.13	.30	.02	.02	.12	.30	.02	.02	.12	
T5009	.05	.10	.02	.03	.14	.04	.06	.08	.05	.00	.00	.02	.05	.00	.00	.02	
DeKalb XL390B	.04	.11	.02	.00	.07	.03	.00	.03	.14	.01	.01	.05	.14	.01	.01	.05	
Open-pollinated varieties																	
Jellicorse	.11	.26	.05	.02	.31	.08	.03	.14	.21	.01	.01	.08	.21	.01	.01	.08	
SGP	.21	.44	.09	.08	.53	.14	.11	.26	.36	.04	.05	.15	.36	.04	.05	.15	
Neal Paymaster	.07	.16	.04	.03	.24	.05	.02	.10	.07	.02	.03	.04	.07	.02	.03	.04	
TLLE-9	.21	.40	.14	.04	.54	.21	.07	.27	.30	.07	.02	.14	.30	.07	.02	.14	
Jarvis	.09	.22	.04	.01	.29	.05	.02	.12	.16	.03	.00	.06	.16	.03	.00	.06	
Exotic varieties																	
Cow Corn	.02	.03	.01	.02	.05	.00	.01	.02	.00	.01	.03	.01	.00	.01	.03	.01	
Huffman	.22	.46	.12	.07	.52	.17	.09	.26	.40	.07	.05	.17	.40	.07	.05	.17	
Zapalote Chico	.02	.03	.01	.02	.02	.00	.00	.01	.04	.02	.04	.03	.04	.02	.04	.03	
Mean	.09	.21	.05	.03	.24	.07	.04	.11	.18	.03	.02	.07	.18	.03	.02	.07	

Table A-14. Mean number of tillers per plant for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	Mean	P ₂	Mean	P ₃	Mean	P ₁	P ₂	P ₃					
----- no. -----																	
<u>Hybrids</u>																	
T505	.22	.58	.06	.02	.21	.05	.00	.09	.95	.06	.04	.35					
Pioneer 3147	.03	.02	.06	.00	.00	.06	.00	.02	.04	.06	.01	.04					
T111xT115	.03	.04	.04	.00	.00	.00	.00	.00	.09	.08	.01	.06					
T7100	.05	.10	.04	.00	.02	.04	.01	.02	.18	.03	.00	.07					
75:1683x75:1684	.23	.46	.18	.04	.43	.19	.00	.20	.49	.17	.08	.25					
T5009	.07	.15	.03	.01	.04	.01	.00	.02	.27	.05	.03	.12					
DeKalb XL390B	.04	.04	.06	.00	.04	.07	.00	.04	.05	.05	.00	.04					
<u>Open-pollinated varieties</u>																	
Jelllicorse	.06	.09	.07	.01	.05	.02	.01	.03	.13	.13	.01	.09					
SGP	.10	.20	.08	.03	.13	.02	.00	.05	.28	.14	.06	.16					
Neal Paymaster	.01	.17	.02	.03	.18	.00	.01	.06	.16	.04	.05	.08					
TLLE-9	.12	.24	.09	.02	.04	.07	.03	.05	.45	.11	.01	.19					
Jarvis	.11	.26	.05	.02	.05	.06	.00	.04	.46	.04	.05	.18					
<u>Exotic varieties</u>																	
Cow Corn	.08	.11	.14	.00	.11	.00	.00	.04	.12	.28	.00	.13					
Huffman	.21	.41	.17	.07	.13	.09	.01	.08	.70	.24	.12	.35					
Zapalote Chico	.01	.01	.16	.01	.00	.00	.02	.01	.02	.03	.01	.02					
Mean	.10	.19	.07	.02	.09	.05	.01	.05	.29	.10	.03	.14					

Table A-15. Mean ear number per plant for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- no. -----																	
Hybrids																	
NCJR10xNCIR10	1.3	1.7	1.2	1.0	1.7	1.1	1.0	1.3	1.7	1.3	1.0	1.3	1.7	1.3	1.0	1.3	
Pioneer 3147	1.1	1.3	1.0	0.9	1.3	1.0	0.9	1.1	1.2	1.0	0.9	1.1	1.2	1.0	0.9	1.1	
T111xT115	1.5	1.9	1.4	1.1	1.9	1.5	1.0	1.5	1.8	1.4	1.1	1.5	1.8	1.4	1.1	1.4	
T7100	1.0	1.0	1.0	0.8	1.1	1.0	0.8	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.9	0.9	
75:1683x75:1684	1.4	2.0	1.3	1.0	1.9	1.3	1.0	1.4	2.0	1.3	1.0	1.4	2.0	1.3	1.0	1.5	
T5009	1.2	1.6	1.1	1.0	1.6	1.1	0.9	1.2	1.6	1.1	0.9	1.2	1.6	1.1	1.0	1.3	
DeKalb XL390B	1.1	1.3	1.0	0.9	1.2	1.1	0.9	1.0	1.4	1.0	0.9	1.0	1.4	1.0	0.9	1.1	
Open-pollinated varieties																	
Jellicorse	1.0	1.2	1.0	0.8	1.1	1.0	0.7	0.9	1.3	1.1	0.9	0.9	1.3	1.1	0.9	1.1	
SGP	0.9	1.0	0.9	0.7	1.0	0.9	0.6	0.8	1.1	1.0	0.7	0.8	1.1	1.0	0.7	0.9	
Neal Paymaster	1.0	1.2	0.9	0.7	1.2	0.9	0.7	0.9	1.2	1.0	0.8	0.9	1.2	1.0	0.8	1.0	
TLLE-9	0.7	0.9	0.7	0.5	0.8	0.7	0.4	0.6	0.9	0.8	0.6	0.6	0.9	0.8	0.6	0.8	
Jarvis	0.7	0.8	0.7	0.6	0.8	0.6	0.5	0.7	0.8	0.8	0.5	0.7	0.8	0.8	0.6	0.7	
Exotic varieties																	
Cow Corn	1.9	2.6	1.8	1.2	2.8	1.7	1.3	1.9	2.5	1.8	1.1	1.9	2.5	1.8	1.1	1.8	
Huffman	0.5	0.6	0.6	0.4	0.5	0.6	0.4	0.5	0.8	0.6	0.4	0.5	0.8	0.6	0.4	0.6	
Zapalote Chico	0.9	1.1	0.9	0.7	1.0	0.9	0.6	0.8	1.1	0.9	0.7	0.8	1.1	0.9	0.7	0.9	
Mean	1.1	1.3	1.0	0.8	1.3	1.0	0.8	1.1	1.3	1.1	0.9	1.1	1.3	1.1	0.9	1.1	

Table A-16. Mean ear number per plant for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- no. -----																	
<u>Hybrids</u>																	
T505	0.9	1.2	1.0	0.7	1.2	0.9	0.6	0.9	1.1	1.0	0.7	1.0	0.7	1.0	0.7	1.0	
Pioneer 3147	0.8	1.1	0.8	0.6	1.1	0.7	0.5	0.8	1.1	0.8	0.6	0.9	0.6	0.9	0.6	0.9	
T111xT115	1.1	1.6	1.0	0.9	1.6	1.0	0.8	1.1	1.5	0.9	1.0	1.0	0.9	1.0	1.0	1.1	
T7100	0.7	1.0	0.7	0.4	0.9	0.7	0.3	0.7	1.0	0.7	0.5	0.7	0.5	0.7	0.5	0.7	
75:1683x75:1684	1.2	1.6	1.1	0.8	1.5	1.1	0.7	1.1	1.7	1.1	0.9	1.1	0.9	1.2	0.9	1.2	
T5009	0.9	1.3	0.8	0.6	1.3	0.9	0.7	1.0	1.3	0.7	0.6	1.0	0.6	0.9	0.6	0.9	
DeKalb XL390B	0.7	1.0	0.6	0.5	1.0	0.5	0.5	0.7	1.0	0.7	0.5	0.7	0.5	0.7	0.5	0.7	
<u>Open-pollinated varieties</u>																	
Jelllicorse	0.8	1.0	0.8	0.6	1.0	0.8	0.6	0.8	1.1	0.7	0.5	0.8	0.5	0.8	0.5	0.8	
SGP	0.6	0.9	0.6	0.4	0.9	0.5	0.4	0.6	0.9	0.6	0.4	0.6	0.4	0.7	0.4	0.7	
Neal Paymaster	0.7	0.9	0.6	0.4	0.9	0.8	0.4	0.7	0.9	0.5	0.4	0.7	0.4	0.6	0.4	0.6	
TLL-9	0.6	0.9	0.6	0.3	0.9	0.5	0.3	0.6	0.8	0.6	0.3	0.6	0.3	0.6	0.3	0.6	
Jarvis	0.5	0.7	0.5	0.3	0.7	0.5	0.3	0.5	0.7	0.6	0.3	0.5	0.3	0.5	0.3	0.5	
<u>Exotic varieties</u>																	
Cow Corn	1.4	1.9	1.4	0.8	1.8	1.5	0.8	1.4	2.0	1.3	0.8	1.4	0.8	1.4	0.8	1.4	
Huffman	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.0	0.1	0.0	0.1	0.0	0.1	
Zapalote Chico	0.6	0.8	0.5	0.4	0.8	0.5	0.4	0.6	0.9	0.5	0.4	0.6	0.5	0.6	0.4	0.6	
Mean	0.8	1.1	0.7	0.5	1.1	0.7	0.5	0.8	1.1	0.7	0.5	0.8	0.7	0.5	0.5	0.8	

Table A-17. Mean number of days to 50% silking for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	
----- no. -----																	
Hybrids																	
NCJR10xNCIR10	81	79	82	82	79	82	82	81	82	82	80	82	82	80	82	82	81
Pioneer 3147	79	78	79	80	78	80	80	79	78	80	80	79	79	78	79	80	79
T111xT115	78	78	78	79	77	77	79	78	77	77	79	78	79	78	79	78	78
T7100	79	77	79	80	77	79	79	78	77	79	79	78	80	78	80	80	79
75:1683x75:1684	80	80	80	81	80	81	81	80	80	81	81	80	79	80	79	81	80
T5009	78	78	78	79	77	78	78	78	77	78	78	78	78	78	78	79	78
DeKalb XL390B	78	77	79	79	76	79	78	78	76	79	78	78	79	78	79	80	79
Open-pollinated varieties																	
Jelllicorse	79	78	79	81	79	78	80	79	79	78	80	79	79	78	79	81	79
SGP	79	77	79	80	76	79	80	78	76	79	80	78	79	78	79	81	79
Neal Paymaster	81	79	81	83	78	81	83	81	78	81	83	81	81	80	81	83	81
TLL-9	81	79	81	83	79	82	85	82	79	82	85	82	81	79	81	81	80
Jarvis	82	80	81	84	81	82	84	82	81	82	84	82	81	80	81	83	81
Exotic varieties																	
Cow Corn	80	79	80	82	79	80	82	80	82	80	82	80	80	80	80	82	81
Huffman	94	93	94	95	93	93	95	94	93	93	95	94	95	93	95	96	94
Zapalote Chico	74	73	74	75	74	74	75	74	74	74	75	74	74	73	74	75	74
Mean	80	79	80	81	79	80	81	80	79	80	81	80	80	79	80	81	80

Table A-18. Mean number of days to 50% pollen shed for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	Mean	P ₂	Mean	Mean	P ₃	Mean	P ₁	P ₂	P ₃				
----- no. -----																	
<u>Hybrids</u>																	
NCJR10xNCIR10	77	76	78	78	76	78	78	78	76	78	77	76	79	77	77	77	77
Pioneer 3147	76	76	76	76	75	77	77	76	75	77	76	76	76	77	77	76	76
T111xT115	75	75	75	76	75	74	74	76	75	74	76	75	76	76	76	76	76
T7100	76	75	76	76	75	75	75	76	75	75	76	75	76	76	76	76	76
75:1683x75:1684	78	77	78	79	77	78	80	78	77	78	80	78	78	79	79	78	78
T5009	76	75	76	77	75	76	76	76	75	76	76	76	76	77	77	76	76
DeKalb XL390B	77	76	77	77	76	76	76	77	76	76	77	76	77	78	77	77	77
<u>Open-pollinated varieties</u>																	
Jellicorse	74	74	74	75	75	73	75	75	74	73	75	74	74	75	75	75	75
SGP	75	74	75	76	76	75	76	76	74	75	76	75	76	76	76	76	75
Neal Paymaster	76	75	76	77	77	74	76	76	74	76	76	75	76	77	77	76	76
TLLF-9	75	75	76	76	76	75	76	76	75	75	76	75	76	76	76	76	76
Jarvis	77	76	76	78	78	76	78	78	76	76	78	76	76	78	78	77	77
<u>Exotic varieties</u>																	
Cow Corn	77	76	77	78	76	76	77	77	76	76	77	76	77	78	77	77	77
Huffman	87	86	87	89	85	87	89	87	85	87	89	86	88	89	88	88	88
Zapalote Chico	72	71	73	72	71	73	72	72	71	73	72	71	73	72	72	72	72
Mean	77	75	76	77	77	76	77	76	76	76	77	76	77	77	76	77	77

Table A-19. Mean percent of plants not root lodged for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean
----- % -----																	
<u>Hybrids</u>																	
NCJR10xNCIR10	95	96	95	96	93	96	97	95	100	94	94	96					
Pioneer 3147	100	100	100	100	100	100	100	100	100	100	100	100					
T111xT115	96	95	96	96	91	94	93	93	98	98	99	98					
T7100	93	91	92	95	87	91	91	90	95	93	99	95					
75:1683x75:1684	100	99	100	100	100	100	99	100	98	100	100	99					
T5009	99	98	100	99	98	100	99	99	98	100	99	99					
DeKalb XL390B	100	100	100	99	100	100	99	100	100	100	100	100					
<u>Open-pollinated varieties</u>																	
Jelllicorse	91	91	90	91	87	87	91	88	95	93	91	93					
SGP	95	95	96	96	95	95	95	95	95	97	97	96					
Neal Paymaster	95	95	96	94	91	98	94	94	98	94	94	95					
TLLE-9	100	100	100	100	100	100	100	100	100	100	100	100					
Jarvis	95	96	95	95	91	94	93	93	100	96	97	97					
<u>Exotic varieties</u>																	
Cow Corn	93	88	93	96	84	92	97	91	93	95	95	94					
Huffman	97	98	96	97	98	97	95	97	98	95	98	97					
Zapalote Chico	98	95	99	99	92	99	98	96	98	100	99	99					
Mean	96	96	96	97	94	96	96	95	98	97	97	97					

Table A-20. Mean number of days for the silking interval for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean
----- no. -----																	
<u>Hybrids</u>																	
NCJR10xNCIR10	5	4	5	5	4	6	5	5	5	5	4	6	5	5	4	5	5
Pioneer 3147	4	3	4	4	3	4	4	4	3	3	3	4	4	4	4	4	4
T111xT115	3	3	3	5	2	3	3	3	2	3	3	3	3	3	3	3	3
T7100	4	3	4	3	3	4	4	4	3	3	3	4	4	4	4	4	4
75:1683x75:1684	3	3	4	3	3	4	3	3	3	3	2	4	4	2	3	4	3
T5009	3	3	3	4	2	3	3	3	3	3	3	3	3	3	3	3	3
DeKalb XL390B	4	3	5	4	3	5	4	4	3	3	3	5	4	3	5	4	4
<u>Open-pollinated varieties</u>																	
Jellicorse	5	4	5	7	4	5	5	5	4	5	4	5	4	5	5	7	5
SGP	6	5	5	8	5	5	6	6	5	5	5	6	6	5	6	7	6
Neal Paymaster	5	4	5	6	4	5	7	5	4	5	5	5	5	5	5	7	6
TLLE-9	6	4	6	4	5	7	10	7	5	4	4	5	6	4	5	6	5
Jarvis	5	5	5	6	5	6	7	6	5	5	4	6	6	4	5	5	5
<u>Exotic varieties</u>																	
Cow Corn	5	4	5	7	5	6	6	6	5	3	3	6	6	4	4	5	4
Huffman	7	7	8	6	6	7	6	6	6	8	8	7	6	9	7	8	8
Zapalote Chico	4	3	4	4	4	4	4	4	4	3	3	4	4	4	4	4	4
Mean	5	4	5	5	4	5	5	5	4	4	4	5	5	4	4	5	4

Table A-21. Mean number of days for the pollen shed interval for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	Mean	P ₂	Mean	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃		
----- no. -----																	
<u>Hybrids</u>																	
NCJR10xNCIR10	6	5	6	7	5	7	7	6	6	8	6	6	6	6	8	6	6
Pioneer 3147	5	4	5	6	4	6	6	5	3	5	6	5	3	5	6	5	5
T111xT115	5	6	5	5	6	6	6	6	5	4	5	6	5	4	5	5	5
T7100	5	5	5	5	5	5	4	5	4	5	5	5	4	5	6	5	5
75:1683x75:1684	5	4	5	6	4	6	6	6	4	5	5	5	4	5	5	4	4
T5009	5	4	6	6	4	6	6	6	4	5	5	5	4	5	6	5	5
DeKalb XL390B	6	6	6	7	6	7	8	7	6	6	7	7	6	6	6	6	6
<u>Open-pollinated varieties</u>																	
Jellicorse	8	8	8	9	8	8	10	8	8	8	10	8	8	8	9	8	8
SGP	9	10	8	11	10	9	10	10	9	8	10	10	9	8	11	9	9
TLLE-9	9	8	8	9	7	9	8	8	8	7	8	8	8	7	9	8	8
Jarvis	8	8	9	9	9	10	10	10	9	10	10	9	7	8	8	8	8
<u>Exotic varieties</u>																	
Cow Corn	7	6	6	9	7	7	9	7	7	5	9	8	5	5	9	6	6
Huffman	11	11	11	10	10	10	11	10	10	12	10	10	12	11	10	11	11
Zapalote Chico	10	10	10	10	9	10	10	10	9	10	10	10	10	10	10	10	10
Mean	7	7	7	8	7	8	8	7	7	7	8	7	7	7	8	7	7

Table A-22. Mean percent bird damage for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			F ₁			F ₂			Mean
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃					
----- no. -----																	
Hybrids																	
NCJR10xNCIR10	4.5	3.0	4.5	5.9	3.8	4.5	5.5	4.6	2.0	4.5	6.3	4.5	6.3	2.0	4.5	6.3	4.5
Pioneer 3147	5.0	4.9	4.0	6.1	5.8	4.8	5.5	5.3	4.0	3.3	6.8	4.7	6.8	4.0	3.3	6.8	4.7
T111xT115	4.6	3.8	4.8	5.3	3.8	5.0	5.0	4.6	3.8	4.5	5.5	4.6	5.5	3.8	4.5	5.5	4.6
T7100	3.9	4.4	3.0	4.4	4.3	2.0	4.5	3.6	4.5	4.0	4.3	4.3	4.3	4.5	4.0	4.3	4.3
75:1683x75:1684	3.4	2.1	3.5	4.6	3.0	4.5	4.3	3.0	1.3	2.5	5.0	2.9	5.0	1.3	2.5	5.0	2.9
T5009	4.2	3.4	4.4	4.8	5.3	4.5	6.5	5.4	1.5	4.3	3.0	2.9	3.0	1.5	4.3	3.0	2.9
DeKalb XL390B	4.8	3.8	4.8	5.9	4.3	2.8	6.8	4.6	3.3	6.8	5.0	5.0	5.0	3.3	6.8	5.0	5.0
Open-pollinated varieties																	
Jellicorse	4.5	3.9	5.3	4.3	2.5	5.8	3.3	3.8	5.3	4.8	5.3	5.1	5.3	5.3	4.8	5.3	5.1
SGP	4.4	3.9	4.0	5.4	3.5	5.0	5.5	4.7	4.3	3.0	5.3	4.2	5.3	4.3	3.0	5.3	4.2
Neal Paymaster	3.6	2.9	3.3	4.6	2.0	3.0	5.0	3.3	3.8	3.5	4.3	3.8	4.3	3.8	3.5	4.3	3.8
TLLE-9	3.7	3.4	4.6	3.1	4.5	5.0	3.3	4.3	2.6	4.3	3.0	3.2	3.0	2.6	4.3	3.0	3.2
Jarvis	3.1	3.6	3.0	1.9	5.0	2.8	1.8	3.2	2.3	5.0	2.0	3.1	2.0	2.3	5.0	2.0	3.1
Exotic varieties																	
Cow Corn	1.5	1.0	1.6	1.9	1.5	1.5	1.8	1.6	0.5	1.8	2.0	1.4	2.0	0.5	1.8	2.0	1.4
Huffman	0.8	1.3	1.3	0.0	2.5	1.3	0.0	1.3	0.0	1.3	0.0	0.4	0.0	0.0	1.3	0.0	0.4
Zapalote Chico	0.8	0.8	0.5	1.1	0.5	0.5	0.5	0.5	1.0	0.5	1.8	1.1	1.8	1.0	0.5	1.8	1.1
Mean	3.5	3.1	3.6	3.9	3.5	3.5	3.9	3.6	2.7	3.6	4.0	3.4	4.0	2.7	3.6	4.0	3.4

Table A-24. Mean plant height for corn entries grown at two fertility and three plant population levels at Crossville in 1980.

Entry	Grand Mean	P ₁			P ₂			P ₃			Mean			F ₁			F ₂			Mean			
		Mean	P ₁	P ₂	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃							
----- cm. -----																							
<u>Hybrids</u>																							
T505	230	232	232	232	225	233	229	215	226	231	236	234	234	234	235	233	229	215	226	231	236	234	234
Pioneer 3147	215	216	219	219	211	209	207	212	210	223	231	210	221	221	223	207	212	210	231	231	210	210	221
T111xT115	248	247	249	249	249	244	237	244	242	252	261	253	255	255	252	261	237	244	242	261	261	253	255
T7100	237	240	236	236	235	239	223	231	231	240	250	239	243	243	240	250	223	231	231	250	250	239	243
75:1683x75:1684	211	209	213	213	213	201	205	204	203	217	221	221	220	220	217	221	205	204	203	235	233	234	234
T5009	227	228	224	224	228	222	214	222	219	235	233	234	234	234	235	233	214	222	219	235	233	234	234
DeKalb XL390B	227	227	226	226	227	221	216	216	218	233	235	237	235	235	233	235	216	216	218	233	235	237	235
<u>Open-pollinated varieties</u>																							
Jefficorse	222	223	229	229	216	215	220	209	214	232	238	222	231	231	232	238	220	209	214	232	238	222	231
SSGP	229	233	233	233	221	227	222	209	219	240	244	236	239	239	240	244	222	209	219	240	244	236	239
Neal Paymaster	237	243	241	241	228	242	232	219	231	245	250	236	244	244	245	250	232	219	231	245	250	236	244
TLLE-9	198	195	202	202	197	185	201	191	192	204	204	202	203	203	204	204	185	191	192	204	204	202	203
Jarvis	219	217	227	227	212	212	223	205	213	223	230	219	224	224	223	230	223	205	213	223	230	219	224
<u>Exotic varieties</u>																							
Cow Corn	211	220	216	216	197	221	215	191	209	219	216	204	213	213	219	216	221	191	209	219	216	204	213
Huffman	241	245	242	242	238	239	239	224	234	251	245	251	249	249	251	245	239	224	234	251	245	251	249
Zapalote Chico	186	190	184	184	184	188	178	179	182	191	190	189	190	190	191	190	188	179	182	191	190	189	190
Mean	222	224	225	225	219	220	217	212	216	228	232	226	229	229	228	232	220	217	212	216	232	226	229

Table A-25. Mean plant height for corn entries grown at two fertility and three plant population levels at Knoxville in 1980.

Entry	Grand Mean	P ₁		P ₂		P ₃		F ₁			F ₂			Mean
		Mean	P ₁	Mean	P ₂	Mean	P ₃	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃	
----- cm. -----														
<u>Hybrids</u>														
NCJR10xNCIR10	206	216	200	202	207	194	197	199	224	207	207	207	212	
Pioneer 3147	206	215	203	201	207	190	190	196	223	216	211	217		
T111xT115	211	205	214	212	197	211	205	204	214	218	219	217		
T7100	212	218	214	205	217	217	195	210	219	211	214	215		
75:1683x75:1684	211	208	217	207	190	218	201	203	226	216	213	219		
T5009	212	215	220	201	210	218	199	209	220	223	204	216		
DeKalb XL390B	200	208	198	195	200	189	185	191	217	206	206	210		
<u>Open-pollinated varieties</u>														
Jellicorse	212	221	208	207	220	201	201	207	222	215	214	217		
SGP	207	204	213	2-4	194	217	200	203	214	209	208	210		
Neal Paymaster	211	211	216	207	203	216	209	209	220	216	205	214		
TLLE-9	208	221	202	201	222	204	191	206	221	200	211	211		
Jarvis	213	213	221	205	215	217	194	208	211	225	216	218		
<u>Exotic varieties</u>														
Cow Corn	196	203	194	191	197	184	185	188	210	204	197	204		
Huffman	215	216	217	211	216	224	223	221	216	211	199	209		
Zapalote Chico	190	224	172	174	220	164	169	184	229	180	178	196		
Mean	207	213	207	202	208	204	196	203	219	210	207	212		

VITA

Daniel Bruce Smith was born in Cincinnati, Ohio, on August 16, 1951. He moved to Plainfield, Indiana, in 1953 and attended elementary and high school in that city. He received his Bachelor of Science degree in August 1979 from The University of Tennessee, Knoxville. In the Fall of 1979 he accepted an assistantship in Plant Breeding at The University of Tennessee, Knoxville, and began study toward a Master's degree. This degree was received in March 1982.

Mr. Smith currently owns and operates a farm in Hawkins County, Tennessee.

He is married to the former Patricia Gale Williams of Oldenburg, Indiana.