THE INFLUENCE OF THE SOURCE OF SEED UPON THE GROWTH AND YIELD OF WHEAT

by

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INTRODUCTION

Wheat produced at different geographical locations does not always produce the same results in growth and yield when seeded in the same locality under comparable environmental conditions. Considerable interest has been aroused to this problem as the variations may not be due to genetic differences but to modifications in the seed resulting from the particular environmental conditions under which the seed was produced.

A limited amount of data pertaining to this problem was obtained at the Kansas Agricultural Experiment Station in 1942, 1943, and 1944. It was decided at a recent regional agronomy meeting to make a further study of the influence of seed-source on the growth and yield of wheat. The test was organized on a uniform basis at Chillicothe, Texas; Lincoln, Nebraska; and Manhattan, Kansas. Dr. T. A. Kiesselbach of Nebraska was responsible for supplying the seed and the necessary details to maintain as much uniformity as possible in the tests at these three stations.

The data obtained at this station are presented in this paper.

REVIEW OF LITERATURE

Cummings (1914) compared the production of garden crops from seedings of larger seed with that from seedings of small seed. His results showed that the weights and sizes of the plants when compared at different stages of growth indicate that a continuous and permanent advantage exists in favor of the larger seed. Plants grown from large seed possess more leaves of greater surface area and hence have greater assimulative powers.

Kiesselbach and Helm (1917) conducted yield tests comparing large and small seeds planted both in equal numbers and equal weights at rates normal for the large seed. The small seed of winter wheat yielded about four percent less than the large seed when planted in equal numbers; however, the yields were comparable when planted at equal weights. Lill (1910) found that the heavier, better developed kernels of wheat germinate better than the lighter ones. Extensive tests resulted in a little more than one percent variation in germination.

Koehler, Dungan and Burlison (1934) reported that mature seed corn was more vigorous than immature seed corn. Laboratory germination tests showed that seedling vigor was much better in seed harvested at the more mature stages than in the milk and late milk stages. Field stands varied directly with

the vigor of the seed planted. Seed inoculation at planting time with several fungi capable of causing seedling disease in all cases had the greatest effect on immature seed.

Suneson and Peltier (1936) conducted an extensive seed-source comparison of winter wheat varieties as to the resistance to cold. The most conspicuous variable in the condition of the seed was the difference in size. The plants produced from small kernels were less hardy as shown by 32 comparisons. The winter wheat seedlings gave highly significant hardiness differences within the same varieties when different sources of seed were compared.

Kiesselbach (1937) reported as much as 31 days difference in the time of maturity, 29 inches variation in plant height, and 38 percent variation in yield of open pollinated corn in which the seed was produced at different localities. He explained this as a variation between unadapted regional strains.

Dungan and Koehler (1944) found a marked decrease in yield from old seed corn which was primarily caused by a reduction in field stand and also to a less extent by a lowered yield per plant.

Tervet (1944) studied the problem from a pathological viewpoint. He found the variation in the amount of smut on oats from seed lots within one variety as great as may be found between certain varieties. It was shown that variation in the amount of smut occurred with plants from seed lots of

one variety grown in different years in the same locality, and between plants from seed lots of the same variety grown in one year in widely different localities. It was concluded that the more vigorous seedlings of oats were less frequently attacked by smut than the weaker seedlings. It was also apparent that plants from large seed were more vigorous than plants from the smaller seeds as indicated by rapidity of germination, percentage of germination, and weight and height of the seedlings.

MATERIALS AND METHODS

Two varieties of winter wheat from eight different geographical sources were used for this study. The two varieties were Pawnee and Wichita produced at Denton and Chillicothe, Texas; Stillwater, Oklahoma; Hays and Manhattan, Kansas; Lincoln and North Platte, Nebraska; and Akron, Colorado. All the seed was grown in 1946 with the exception of the Wichita from Manhattan which was a year older. All the stations cooperating in this study sent the seed to Lincoln, Nebraska where it was stored under uniform conditions. Just before the time for seeding, the seed was sent to this station.

The tests were conducted at the Agronomy Farm of the Kansas State College on soil that had been used for test plots the previous year. The seed was planted in a nursery with a

Planter Jr. drill and the seed was dropped by hand. Each source of seed within the variety was planted in a 4-row plot 12 feet long. Only 10 feet of the two middle rows were harvested for yield. Each source was replicated 10 times and statistically randomized within each variety. The sources were planted across the test plots of the previous year while the replications were parallel to the previous plots. In this manner much of the soil heterogeneity was absorbed by the replications while the sources were affected very little. The location of the two varieties was definitely systematized for each replication. This system does not permit a statistical comparison to be made between the varieties. General observations, however, were easily made. It is the writer's opinion that a complete randomization of the sources and the varieties would have been practical. Although it was not the main purpose of the study, it always seems desirable to compare different varieties whenever possible.

The seed was planted at a uniform rate, slightly higher than that of ordinary field seeding. The size of the seed was determined in the laboratory and in that manner the number of seeds planted on each plot was determined. Two weeks after the seedlings had emerged actual counts of the emerged seedlings were made. This made it possible to calculate the percentage of seed that germinated in each plot. Dry weight and tillering data were based upon 10-plant samples taken at two different periods of growth. The first sample was taken

at the completion of the fall growing season and the second sample a few weeks after growth had started in the spring. The samples were dug in the field and brought to the laboratory to be washed and have the roots removed. The tillers were counted and then left to dry in the air. The air dry plants were weighed.

The two center rows of each plot were cut back to a length of 10 feet and harvested by hand. The heads were sacked in order to prevent any loss in yield by shattering. Before threshing, the straws in each bundle were counted to determine the number of heads per plot. The bundles were threshed with a small plot separator. The yield of each plot was weighed separately. The test weight was determined and the size of the heads was calculated.

The experiment was statistically designed to determine more accurately any variation between the different seed sources. The analysis of variance was calculated whenever it seemed practicable. Snedecor (1946), Paterson (1939), and Leonard and Clark (1939) have explained excellent statistical analysis procedures. Their methods and interpretations were utilized in analyzing the data for this study. One plot of Wichita wheat from the Denton, Texas source was missing and had to be substituted for by the method outlined by Snedecor (1946). Because of this substitution, one extra degree of freedom was lost in the analysis of variance for the Wichita variety.

An accurate germination study was conducted in the seed laboratory. Observations were taken every 12 hours. Counts were made at four arbitrary stages of germination three of which were suggested by Robbins (1931). The first stage was determined just as the germ split and the coleoptile became visible. The second stage was at the time the coleoptile was plainly distinguishable. The third stage was determined just after the seminal roots had emerged from their coleorhiza. The last stage of germination was at the appearance of the first foliage leaf. This portion of the study gave a comparison of the rapidity and vigor of germination between each source as well as a comparison of the germination in the laboratory with that in the field.

DATA AND RESULTS

Influence of Seed Source Upon Germination of Wheat

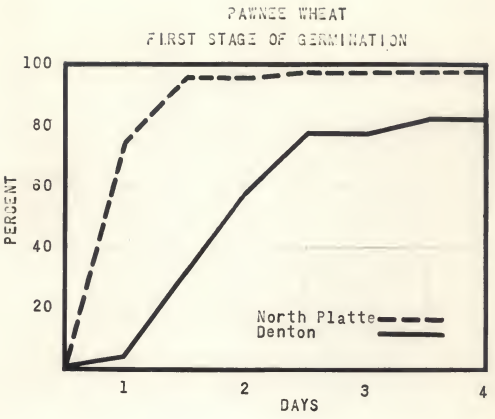
Laboratory germination tests were conducted in order to determine if differences existed in the germination of seed produced at different localities. Two varieties from eight different sources were placed in a cold germinator at the same time and comparisons were made every 12 hours. Comparatively high germinations were obtained from the seed of all sources. A test of above 90 percent was obtained in all cases except the Pawnee variety from Denton and Chillicothe, Texas and the

Wichita from Manhattan, Kansas, Lincoln, Nebraska, and Denton, Texas. These lots of seed, however, germinated above 80 percent.

The most striking variation among the different sources of seed shown by this test was in the rapidity of germination and seedling growth as well as in the vigor of the seedlings. All the seed of the Pawnee wheat except that from Denton, Texas reacted similarly in germination and seedling development. The seed from these seven sources had reached the first stage of germination within 36 hours after the test was started. The seed from the Denton source reached the same stage after 60 hours in the germinator. It took the Denton seed approximately 24 hours longer than the seed of the other sources to reach the second stage of germination. Likewise, the third stage was 36 hours later for the wheat from Denton and the fourth stage was reached some 30 hours after the other sources.

Table 1. Germination percentages of Pawnee wheat from seed differing in source.

Days	Seed source: Denton	Chilli-cotho	Still-water	Hays	Manhattan	North Platte	Lincoln	Akron
First stage of germination								
1	4	40	18	28	0	74	20	54
1-1/2	32	82	78	90	56	96	74	86
2	58	88	94	94	90	96	94	92
2-1/2	78	90	98	98	92	98	98	92
3	78	90	98	100	96	98	98	96
3-1/2	82	92	100	100	96	98	100	100
4	82	92	100	100	96	98	100	100
4-1/2	84	94	100	100	96	98	100	100
Second stage of germination								
1-1/2	0	16	12	18	0	24	6	16
2	16	70	62	80	40	90	60	70
2-1/2	42	80	94	92	84	94	90	88
3	68	84	96	96	94	94	96	90
3-1/2	80	84	98	98	96	94	98	92
4	80	86	98	100	96	94	98	98
4-1/2	80	86	98	100	96	96	100	98
5	80	86	98	100	96	96	100	98
Third stage of germination								
2-1/2	0	34	12	10	0	24	10	22
3	8	66	56	46	26	72	42	62
3-1/2	24	74	86	86	84	86	86	84
4	54	76	90	92	92	90	88	86
4-1/2	70	80	96	94	96	92	98	92
5	72	80	98	94	96	92	98	92
5-1/2	76	84	98	94	96	92	98	94
6	76	84	98	94	96	92	98	96
6-1/2	78	84	98	96	96	92	98	96
Fourth stage of germination								
5-1/2	0	12	10	0	0	12	4	8
6	0	32	32	24	2	62	18	52
6-1/2	16	50	60	52	26	86	54	78
7	26	70	80	76	54	92	76	88
7-1/2	50	76	98	90	84	92	90	90
8	62	76	98	92	92	92	96	94
8-1/2	70	78	98	94	96	92	98	94



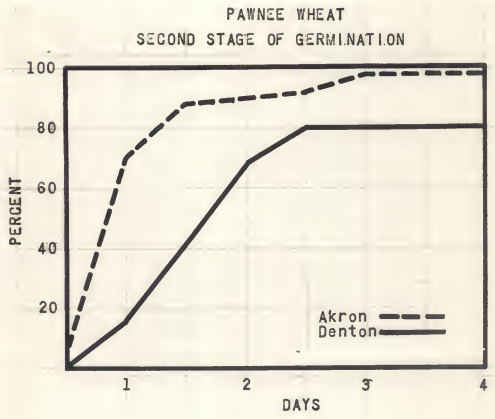
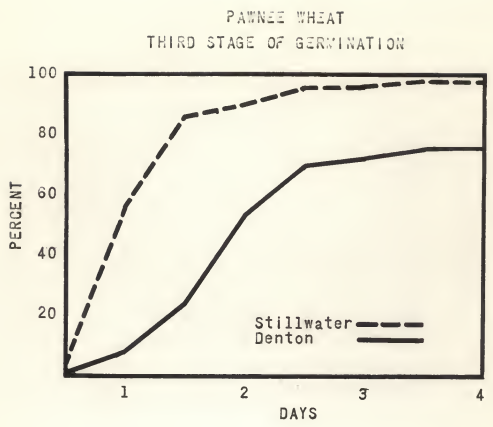


Fig. 1. First and second stage of germination of Pawnee wheat.



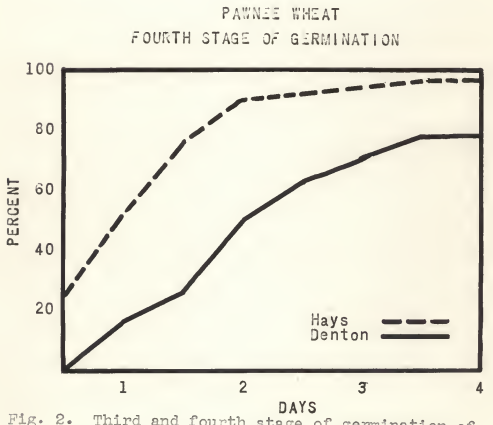


Fig. 2. Third and fourth stage of germination of Pawnee wheat.

EXPLANATION OF PLATE I

Comparison of seedling development of wheat from seed differing in source (side view).

Left - Pawnee from North Platte, Nebr.

Right - Pawnee from Denton, Texas.

PLATE I

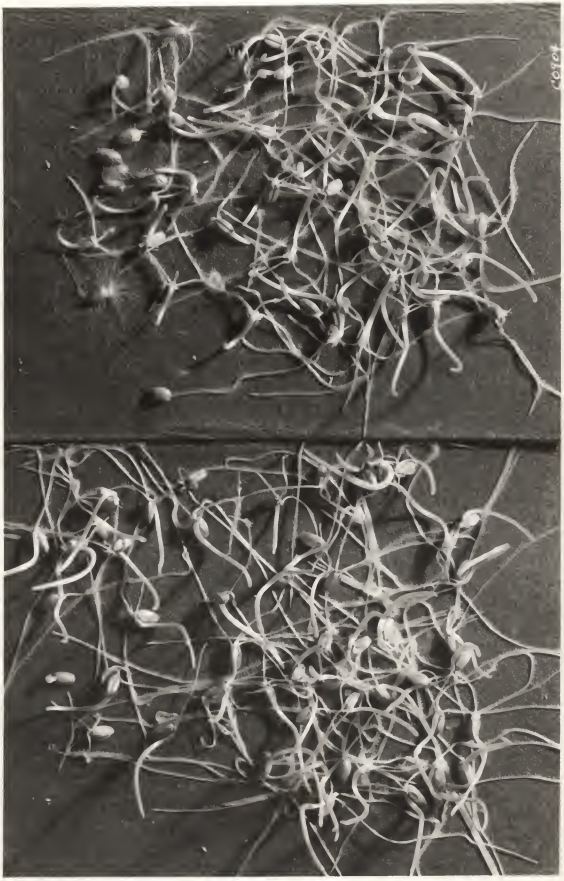
EXPLANATION OF PLATE II

Comparison of seedling development of wheat from seed differing in source (top view).

Upper - Pawnee from Denton, Texas.

Lower - Pawnee from North Platte, Nebr.

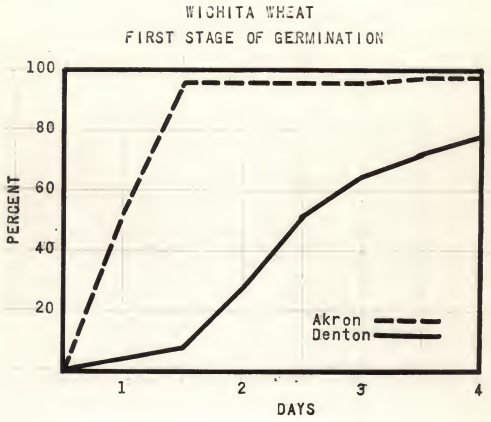
PLATE II



The rapidity of germination of the Wichita wheat varied among the different sources to an even greater extent than did that of Pawnee wheat. The seed from Manhattan, Lincoln, and Denton was slower than that from the other five seed sources in reaching all four of the stages of germination. Although the slower germinating seed finally reached a relatively high percentage of germination, the seedling vigor was observed to be reduced. It is doubtful that many of the seeds that germinated would have survived under field conditions.

Table 2. Germination percentages of Wichita wheat from seed differing in source.

Days	Seed source: Denton	Lincoln	Man-hattan	Colby	Hays	North Platte	Still-water	Akron
First stage of germination								
1	4	0	0	40	34	26	14	52
1-1/2	8	18	16	86	92	88	86	96
2	28	56	50	88	98	92	90	96
2-1/2	52	68	76	92	98	98	94	96
3	64	68	78	92	98	98	96	96
3-1/2	72	76	78	92	98	98	98	96
4	78	78	82	92	98	100	98	98
4-1/2	82	78	88	94	98	100	98	98
5	84	80	88	94	98	100	98	98
7	88	88	88	94	98	100	98	98
Second stage of germination								
1-1/2	0	0	0	24	22	10	10	22
2	6	0	4	60	66	72	72	80
2-1/2	14	30	40	82	98	92	88	88
3	42	54	58	88	98	94	92	88
3-1/2	56	64	76	88	98	96	96	88
4	68	68	78	88	98	96	96	90
4-1/2	76	76	80	88	98	96	98	90
5	78	76	80	88	98	98	98	90
5-1/2	80	78	82	88	98	98	98	90
6-1/2	82	80	82	88	98	100	98	90
7-1/2	84	80	82	90	98	100	98	90
Third stage of germination								
2-1/2	0	0	0	20	30	12	20	30
3	6	0	0	64	62	46	38	68
3-1/2	16	14	10	82	96	90	90	84
4	32	58	52	84	98	92	94	84
4-1/2	56	64	76	84	98	92	94	86
5	64	66	76	84	98	92	94	86
5-1/2	76	72	78	84	98	94	94	86
6	76	74	78	86	98	94	96	86
6-1/2	76	76	78	86	98	94	96	86
7	78	76	78	86	98	96	98	86
7-1/2	80	76	78	86	98	96	98	88
Fourth stage of germination								
5-1/2	0	0	0	0	4	2	0	4
6	0	0	0	2	16	8	2	10
6-1/2	2	2	0	24	36	24	20	24
7	8	12	0	50	62	62	68	56
7-1/2	22	54	10	80	92	82	90	74
8	46	64	20	80	98	96	94	88
8-1/2	60	68	40	86	98	96	96	88



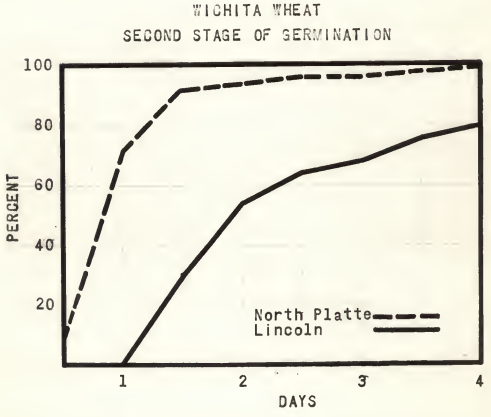
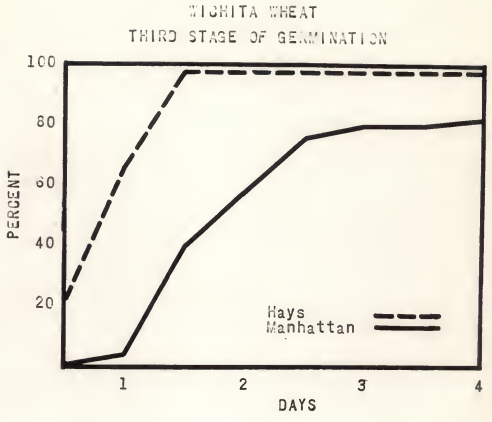


Fig. 3. First and second stage of germination of Wichita wheat.



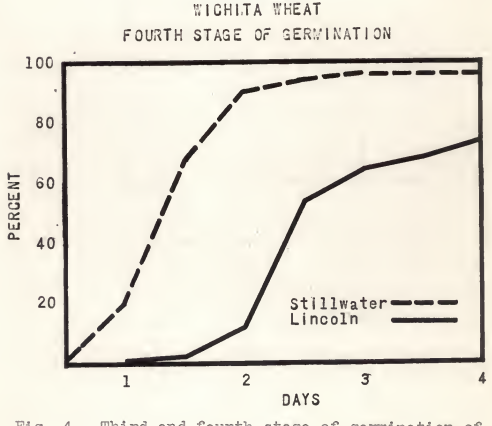


Fig. 4. Third and fourth stage of germination of Wichita wheat.

Influence of Seed Source Upon Field Emergence of Wheat

The plots were observed very closely after the seed was planted to determine as nearly as possible the exact time of emergence. The Pawnee wheat from North Platte emerged six days after planting, a full day ahead of any of the other sources. The Pawnee from Akron, Hays, Manhattan and Stillwater and the Wichita from Akron, Hays, Stillwater, North Platte and Chillicothe emerged the following day. The next day the Pawnee from Chillicothe was plainly visible and two days later the Wichita from Manhattan and the Pawnee from Denton had emerged. Five full days after the first Pawnee from North Platte had emerged came the two slowest plots which were Wichita from Lincoln and Denton. These observations indicated a variation in the field germination among the different seed sources and the results agreed closely with those obtained by the laboratory germination tests.

In order to picture the variation of field germination more clearly, the seedlings were counted and the percentage of emergence determined. The variation in percent of emergence was readily observed as the average from the seed sources of Pawnee varied from 36 percent to 83 percent and the variation in the seed sources of Wichita from 18 percent to 76 percent. The data were statistically analyzed by the analysis of variance and the variation between seed source was highly sig-

nificant at the one percent probability level in both the Pawnee and Wichita varieties. The analysis of variance for this variable is shown in Table 3.

Table 3. Variation in percent of emergence of seed differing in source.

Factors	D/F	S. S.	Variance	F	5%	1%
		Pawnee				
Total	79	22,311.707				
Sources	7	18,256.990	2,608.14	124*	2.17	2.95
Replications	9	2,729.757	303.31	14*	2.04	2.72
Error	63	1,324.960	21.03			
		Wichita				
Total	78	42,757.367				
Sources	7	41,909.118	5,987.02	537*	2.17	2.95
Replications	9	157.700	17.52	1.57	2.04	2.72
Error	62	690.549	11.14			

* High significance at the one percent probability level.

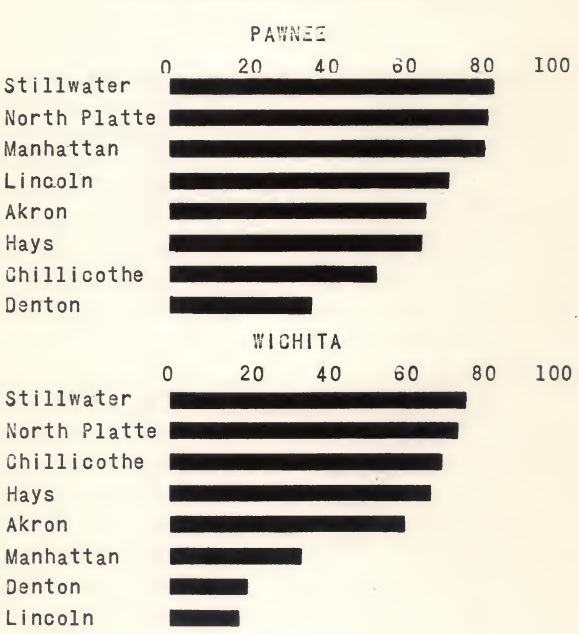


Fig. 5. Field emergence in percent of Pawnee and Wichita wheat.

Influence of Seed Source Upon Growth of Wheat

The amount of tillering and the dry weight taken at two different stages of growth were used to measure the possible variability in the growth of the wheat plants. The dry weight of the plants taken at the end of the fall growing season indicated a significant difference in both the Pawnee and Wichita varieties. As shown in the other tests, the Pawnee wheat acted similarly in all cases except the wheat from Denton which was decidedly lower in dry weight. The Wichita from Manhattan and Denton was significantly lower in dry weight than that from the other six sources. The plots were sampled again in the early spring and dry weights of the plants were obtained. The Pawnee variety showed no significant variability among the seed sources. The between source variation of the Wichita wheat was highly significant at the one percent probability level. It was also interesting to note that the Wichita wheat was somewhat higher in dry weight than the Pawnee wheat. The Pawnee variety, however, was thicker in stand, which increased the competition between the plants of this variety. The statistical analysis for the dry weight variable is presented in Table 4.

Table 4. Variation in dry weight of wheat plants from seed differing in source.

Factors	D/F	S. S.	Variance	F	5%	1%
		Pawnee				
Total	79	17.4900				
Sources	7	2.9439	.42056	2.39*	2.17	2.95
Replications	9	3.4776	.38640	2.20*	2.04	2.72
Error	62	11.0685	.17569			
		Wichita				
Total	78	33.9880				
Sources	7	13.0283	1.8612	8.07**	2.17	2.95
Replications	9	6.6541	.7393	3.21**	2.04	2.72
Error	62	14.3056	.2307			

* Significance at the five percent probability level.
** Significance at the one percent probability level.

The variability in the amount of tillering was found to be significant at the five percent probability level for both varieties when the samples were taken at the end of the fall growth period. The sources with the thinnest stands had the highest tiller counts per plant except for the Manhattan and Stillwater sources. The wheat from Manhattan produced the thinnest stand and also the lowest number of tillers per plant. That from Stillwater produced the thickest stand and yet produced the most tillers per plant. The lack of competition was the probable factor allowing for the excessive tillering.

The failure of the Manhattan source to tiller abundantly may have been due to the old seed that was used. The erratic action of the Stillwater source was probably due to sampling error as the amount of tillering was not significantly higher than the tillering of the Denton, Lincoln, Hays, Akron, or North Platte sources. The Stillwater source showed no excessive amount of tillering in the second sample that was taken in the spring. At this stage of growth both varieties indicated high significance in the variability of the amount of tillering. Again the plots with the thin stands produced more tillers with the exception of the Wichita from Manhattan which produced the lowest number of tillers per plant. The analysis of variance is shown in Table 5.

Table 5. Variation in amount of tillering of wheat plants from seed differing in source.

Factors	D/F	S. S.	Variance	F	5%	1%
		Pawnee				
Total	79	418.95				
Sources	7	82.49	11.784	3.65*	2.17	2.95
Replications	9	133.08	14.786	4.58*	2.04	2.72
Error	63	203.38	3.228			
		Wichita				
Total	78	303.03				
Sources	7	61.29	8.756	3.64*	2.17	2.95
Replications	9	92.51	10.279	4.27*	2.04	2.72
Error	62	149.23	2.407			

* Significance at the one percent probability level.

The height of the plants was measured in order to test further the variability of the vegetative growth. The seed sources of the Pawnee variety showed no significant variation for this factor. The Wichita wheat, however, showed a high significance in height of plant variability between the sources. The shortest plot was from Manhattan seed with a height of 40.8 inches and the tallest plot was from Hays seed which was a full three inches taller. The Lincoln source ranked next to Manhattan, but there was a height difference of only 1.3 inches between the plots from Lincoln and Hays.

As shown by the various tables, the F-ratio of the variance between the replications is exceedingly high in nearly every case. This indicates a highly significant variation between the replications. A portion of this variability may be assigned to the previous history of the soil.

Influence of Seed Source Upon Yield of Wheat

Although the importance of the growth and performance of the plants during the growing season should not be underestimated, the most important factor is the ultimate yield. In this study, it was necessary to measure the yields in grams per plot because of the small nursery plots. These yields were converted into bushels per acre in order that the results may be more easily understood.

The variability of yield between the seed sources was significant at the one percent probability level in both the Pawnee and Wichita varieties. The Wichita, however, exhibited a great deal more variability in yield than the Pawnee. The analysis of variance for yield is presented in Table 6.

Table 6. Variation in the yield of wheat from seed differing in source.

Factors	D/F	S. S.	Variance	F	5%	1%
		Pawnee				
Total	79	126,675				
Sources	7	25,818	3,688.3	3.65*	2.17	2.95
Replications	9	37,214	4,134.9	4.09*	2.04	2.72
Error	63	63,643	1,010.2			
		Wichita				
Total	78	515,277				
Sources	7	353,471	50,495.9	35.6*	2.17	2.95
Replications	9	69,702	7,633.6	5.1*	2.04	2.72
Error	62	93,104	1,501.6			

* High significance at the one percent probability level.

The only great difference in the yields of the Pawnee wheat was in that from Denton. Although there were small differences in yield between the other seed sources, these differences were non-significant. The Denton source had showed inferior performance in the previous tests and finally resulted in a significantly lower yield. The yields of the Pawnee wheat are shown in Table 7.

Table 7. Yields of Pawnee and Wichita wheat from seed differing in source.

Pawnee	:Bushels/acre:	Wichita	:Bushels/acre
Hays	50.6	Akron	52.9
North Platte	50.1	North Platte	52.0
Lincoln	49.9	Hays	51.2
Manhattan	49.9	Stillwater	50.1
Akron	48.8	Chillicothe	49.1
Chillicothe	48.8	Denton	40.4
Stillwater	48.7	Lincoln	37.9
Denton	44.5	Manhattan	35.1

The seed sources of the Wichita wheat fell into the same two groups for yield that they did for the germination and other tests. There was no significant difference in the yield of the seed sources from Akron, North Platte, Hays, Stillwater, and Chillicothe while the seed sources from Denton, Lincoln, and Manhattan were significantly lower in yield. The yields of the Wichita are also shown in Table 7.

The seed sources of the Wichita variety produced higher yields than the corresponding seed sources of Pawnee except for the cases of the Denton, Lincoln, and Manhattan seed. Test weights were determined but in no case was the variabil-

ity between the different seed sources found significant.

In addition to the yield, studies were made of the number and size of heads. Actual counts were made to determine the number of heads that were responsible for the yield. In both the varieties a highly significant variability between the seed sources was shown. The grouping of the sources of the Wichita wheat was exactly the same as that for yield. The Chillicothe and Denton sources of the Pawnee variety were significantly lower in the number of heads than the other sources. A comparison of the two varieties showed that Pawnee produced many more heads per plot than did Wichita. This comparison is shown in Table 8.

Table 8. Number of heads of Pawnee and Wichita wheat from seed differing in source.

Source	Number of heads per plot	
	Pawnee	Wichita
North Platte	1337	964
Lincoln	1304	544
Stillwater	1275	912
Hays	1257	890
Akron	1229	962
Manhattan	1206	537
Chillicothe	1110	851
Denton	985	601

It has already been noted that Wichita produced a greater yield than Pawnee in every case but three. Since the Wichita variety produced a higher yield with fewer heads, a study of the size of head seemed important. After calculating the weight for each head an analysis of variance was applied to determine the variability between the seed sources. The results obtained were highly significant at the one percent probability level for both the varieties. The sources with the least number of heads consistently produced the largest heads. This was somewhat as expected, however, based on the competition of growth viewpoint. The results showed that the increased size of heads was not sufficient to overcome the decrease in the number of heads, thus the yields were reduced by thin stands. This was only true between the seed sources within each variety. When the varieties were compared, it was found that the increased size of the heads of the Wichita variety was sufficient to overcome the greater number of heads of the Pawnee, hence a higher yield resulted in the Wichita wheat. The comparison of head size is shown in Table 9.

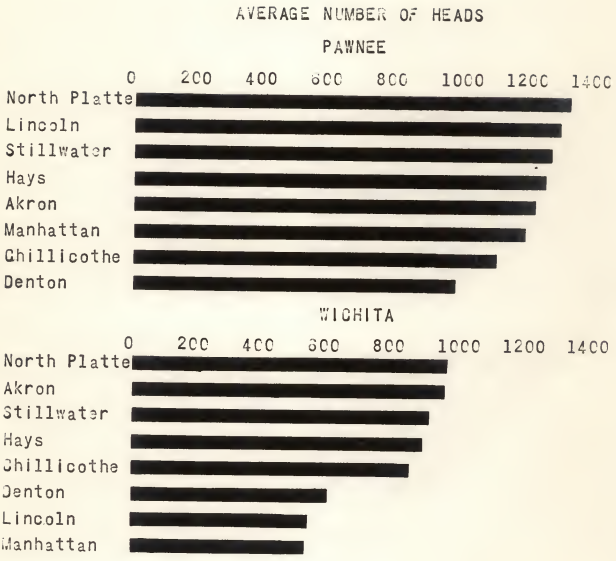


Fig. 6. Average number of heads of Pawnee and Wichita wheat.

Table 9. Size of heads of Pawnee and Wichita wheat from seed differing in source.

Pawnee	: Milligrams:	Wichita	: Milligrams
Denton	467	Lincoln	701
Chillicothe	447	Denton	680
Manhattan	418	Manhattan	664
Hays	406	Hays	589
Akron	401	Chillicothe	586
Lincoln	389	Akron	557
North Platte	386	Stillwater	553
Stillwater	383	North Platte	548

Influence of Size of Seed Upon Yield of Wheat

The size of seed seemed to have little if any effect upon the yield in this test. Although the smallest seeds of the Wichita variety were from Manhattan which produced the lowest yield, the next to the smallest seeds were from Akron which produced the highest yield. Likewise, in the case of the Pawnee variety, the seeds from Akron and Denton were nearly the same size yet the Akron source produced a significantly higher yield than the Denton source. However, in every case in which the Wichita wheat produced higher yields than the

Pawnee wheat, the Wichita had the larger seeds.

Influence of Growth and Development Upon Yield of Wheat

Although this experiment was not designed for the determination of growth and developmental factors that might predict yield, studies were made of some of these factors as to their possible influence on yield. The data have shown that the yields varied as did the measurements of the growth factors. It was important to determine if there was any relationship between yield and these factors that may have caused the variation or resulted from the variation.

The only factor in Pawnee wheat that was highly correlated with yield was the number of heads produced. A simple linear correlation coefficient of .851 was determined which exceeds the one percent probability level for six degrees of freedom. The field emergence was significantly correlated with yield at the five percent probability level. A correlation coefficient of .739 was determined for these factors but may be somewhat useless as the square of the correlation coefficient is only .546 which leaves nearly 50 percent of the relationship unexplained. The dry weight of the plants taken in the spring was correlated with yield at the five percent level with a correlation coefficient of .704. A negative correlation was found in the case of the size of head factor.

All other factors that were studied exhibited no linear correlation with yield.

Several factors were correlated with yield in the Wichita variety. The highest of these was the number of heads with a correlation coefficient of .988. The correlation coefficient of the field emergence on yield was .886 and the size of head was negatively correlated with yield with a correlation coefficient of -.928. Each of these factors was significantly correlated with yield at the one percent probability level. The dry weight of the plants taken at both stages of growth exceeded the correlation coefficient of .707 at the five percent probability level for six degrees of freedom. These were also of little value. The other factors were not linearly correlated with yield.

SUMMARY AND CONCLUSIONS

The variation between the seed sources of the wheat varieties studied seemed to fall into two fairly distinct groups. One group produced high yields and normal growth with little variability between the sources of this group. The other group was decidedly slower in growth and development and the yields were smaller. The Wichita variety showed more variability than Pawnee. Wichita sources from Akron, North Platte, Hays, Stillwater and Chillicothe were in the group of high yielders while Denton, Lincoln and Manhattan were included in the inferior group. The grouping of Pawnee was not as distinct, although the six sources of North Platte, Akron, Hays, Manhattan, Lincoln, and Stillwater were consistently superior in growth and yield to the wheat produced from the seed sources of Denton. The Chillicothe seed was inferior in growth but was average in yield.

The laboratory germination tests indicated possible variation in the seed from different sources. Although there was some difference in total germination, all of the seed gave a comparatively high germination test. The variability was determined to be mainly that of rapidity of germination and vigor of seedling growth.

The germination in the field agreed closely with results obtained in the laboratory. The variability between sources

was highly significant in both the Pawnee and Wichita varieties. Field emergence showed a linear correlation with yield.

The variability between sources in the amount of tillering and dry weight was significant in both varieties studied. The dry weight of Wichita was correlated with yield. The thinner stands consistently produced a greater number of tillers per plant except in the Wichita from Manhattan. The Wichita wheat showed a significant variation in the height of plants, but Pawnee did not.

The sources differed significantly in yield in both varieties. The differences in the yield of Wichita, however, were more pronounced than Pawnee. The number of heads per plot was positively correlated with yield, whereas the size of heads exhibited a negative correlation. This would seem to indicate that it is undesirable to produce wheat with large heads, however, that is not the case. In this experiment, the larger heads were produced where the stands were thin. This was to be expected in view of the lack of competition in growth. The larger heads per plant could not compensate for the fewer plants per plot and a lower yield resulted.

The size of the seed had little influence on the yield of wheat in this test. There was no significant correlation between size of seed and yield of either variety.

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