ASSOCIATIONS OF THE MAJOR PLANT CHARACTERS WHICH CONTRIBUTE TO GRAIN YIELD IN FIVE VARIETIES OF WINTER OATS

by

FLOYD EUGENE BOLTON

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
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Thesis Approved:

Boyd C. Curtis
Thesis Adviser

Billy B. Tucker

Robert D. Morrison

A. M. Schlehuber

Lowell Hardin
Dean of the Graduate School

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INTRODUCTION

The problem of maintaining or increasing the high yield potential of crop varieties is faced by the plant breeder each time a new strain is being developed. Extensive yield testing of large numbers of early generation lines is impractical because of the time and expense involved. The plant breeder can select effectively for characters such as height, earliness and head type, but for yield the genetic differences are often completely obscured by environmental differences. Undoubtedly, much of the early generation material being carried along in plant breeding programs stands little or no chance of passing the final test for yield. There is a great need for new techniques or methods of handling early-generation material and for a better understanding of the components of yield.

One approach to this problem has been the study of the component parts of yield. Yield as measured by pounds of grain produced is made up of the number of heads per unit area of land, the number of kernels per head, and the weight of the seed. An increase in any one of these three characters without loss in the other two results in an increase in yield. A thorough understanding of these components of yield may be the answer to selection for high yield in early generation material.

Studies of the yield components in spring oat varieties and strains have been conducted and some progress in selection for yield has been noted. Little information concerning the application of these findings

to winter oat varieties is presently available. Also the environmental effects on the components of yield in winter oats is not known.

This study was initiated in an attempt to supply the needed information concerning yield components in winter oats.

The objectives of this experiment were as follows:

(1) to study the associations of the plant characters that contribute to grain yield in winter oats.

(2) to study the environmental effects on these characters.

(3) to determine if the results obtained in previous studies of spring oats are applicable to winter oats.

REVIEW OF LITERATURE

Conventional Yield Testing

The need for better methods and techniques for testing variety grain yielding potential is recognized by many investigators. A review of the literature reveals that testing for variety yield potential of oat and small grain crops using conventional methods is an expensive, time-consuming and sometimes inadequate procedure.

Frey and Baten (9)[1/] suggest that the optimum plot size for accurate yield determinations is a minimum of 16 square feet of row. Ross and Miller (23) compared the results of testing for yield in small plots (1-foot rows) and rod-rows (16 square feet of row) and found that the variability in yield of the small plots was always higher than in the large plots. They suggested that small plots should be used only when large numbers of lines are to be screened, seed supply is scarce and land space is limited.

Atkins and Murphy (2) attempted to evaluate the yield potentialities of oat crosses from yield tests of bulk hybrid populations. Bulk populations which gave the highest yields in the early segregating generations did not produce the greatest proportion of high-yielding segregates in subsequent generations. Their results suggest that considerable high-yielding germ plasm may be lost if bulk crosses are discarded on the

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1/ Numbers in parenthesis refer to "Literature Cited", page 36.

basis of early generation yield performance.

According to Horner and Frey (14) considerable difficulty in making oat varietal recommendations is experiences because of the variety x location interactions that occur. They stated that because of these interactions it was even more difficult to evaluate new strains as potential varieties.

Yield Component Studies

In an attempt to find more efficient methods to evaluate the yielding potential of oat varieties and strains, several investigators (4, 12, 27) proposed measuring the component parts of yield rather than yield as a whole.

The value of using yield component analyses rather than the actual grain yield for evaluation of varietal yielding potential was discussed by Frey (6). He stated that it was common for a variety to vary from the highest rank at one test site to the lowest at another not too distant location. This necessitates extensive testing for several years before the superior varieties can be detected. He found that when yield component analyses were used instead of total grain yield to measure the varietal potential, a lower variety x location interaction variance was obtained. He suggests that yield component analyses could also be used in selecting parental combinations and predicting high-yielding segregates.

Most of these yield component studies were conducted using spring-sown varieties of oats. No research papers dealing with fall-sown or winter oat varieties in yield component studies were found in this review. However, Wallace et al. (27) studied the components of yield in a Letoria x Fulwin cross, an intermediate and winterhardy type, respectively.

According to Frey (4, 5, 6, 7), Grafius (12) and others (20, 22, 27), the primary components of yield in oats and other small grain crops are: (a) the number of seeds per head, (b) the number of heads per plant or unit area, and (c) the weight per seed.

Number of seed per panicle

Grafius (12) suggests that the number of seeds per panicle, number of panicles per plant or unit area and weight per seed are all equally important component parts of the total yield. He further states that different environments will cause the increase or decrease of one or more of these components within a given variety, but the varietal yield potential remains the same. However, Frey (4, 5, 6, 7), in a series of studies, found that the number of seeds per panicle contributed more to the total yield than did the number of panicles or weight per seed. His data show that Andrew oats produced relatively higher grain yields because it develops more seed per panicle. For the other two components, panicles per plant and weight per 100 seeds, this variety was either lowest or next to lowest in rank. The relative weight per seed for all varieties in this test was about the same.

Wallace et al. (27) found a highly significant positive correlation of 0.818 between grain yield and seed per panicle while studying the progeny of a Letoria x Fulwin cross in the F_4 generation. Little or no correlation between yield and number of panicles or weight per seed was found. He also found a highly significant negative correlation between the number of panicles per plant and the number of seeds per panicle which is in agreement with similar studies by Frey (4) and Petr (22).

Petr (22) studied 15 diallel crosses of 6 varieties of spring oats

for genotypic and environmental correlations, dominance and heritability. Heritability values for some of the characters studied were as follows: panicles per plant - 33%, grain yield - 53%, number of spikelets per panicle - 74%, and heading date - 87%. Low genotypic and high environmental correlations were found between yield and panicle number indicating that progress from selection for these traits would be slow. The negative genotypic correlations between the yield components, panicles per plant and spikelets per panicle, suggest that optimum combination of these traits may not reflect the maximum potential of either one. He further states that selection for number of spikelets per panicle and heading date would be feasible in early generations.

Number of panicles

The effect of number of panicles per plant or unit area on the yield of oats has been studied by several workers (11, 13, 16, 18, 22). Frey and Wiggans (11) reported that oat varieties have tillering capacities which are relatively constant from year to year and that most winter oat varieties produce many tillers. Kaukis and Reitz (16) studied tillering and yield of oat plants grown at different spacings. Highly significant differences were recorded in the average number of productive tillers among spacings within varieties. Since the relative number of tillers within a variety for each spacing remained constant for the 2 years studied, it appeared that tillering ability was an inherent character. Their data indicated that 77% of the total yield increase in the widely spaced plants resulted from increased tillering, 16% from increased yield per tiller and 7% from the interaction of both factors. That tillering capacity in oats is an inherent character was also substantiated by the findings of Grafius (13).

Wiggans and Frey (28) found that oats grown under various light and temperature conditions produced different numbers of head-bearing tillers, but the varietal rank remained relatively constant. In another study (29), they discovered that the number of head-bearing culms per oat plant decreased as planting rate increased. The test weight of the seed planted in this test had no effect on this character.

Seed weight

Although seed weight certainly accounts for a portion of the total yield in oats, a positive relationship between this character and high yield was not found by Frey (4, 5, 7). Grafius (12) has postulated that weight per seed plays an equal role with the other yield components. He theorized that within a given environment a decrease in one component will be counterbalanced by a corresponding increase in one or both of the other components. According to this theory an oat variety would possess a constant yield potential over several different environments. No data to support this theory were presented. Kiesselbach (17), in a summary of more than 10 years study on this subject, states that in general there will be no material or practical gain in the grain yield of oats or other small grain crops from the grading of seeds which are reasonably free from trash and inert matter. However, Immer and Stevenson (15) found that yield and plumpness were highly correlated with a coefficient of 0.58 to 0.89 at 4 locations in Minnesota. The relationship between plumpness and weight per seed was not discussed.

In a study of yield components in spring wheat, McNeal (20) reported that tillers per plant and kernels per head were more highly correlated with plant yield than kernel weight.

Other Factors Influencing Yield

The effect of certain cultural practices on the components of grain yield in oats was reported by Frey (5, 7). He found that the increases in total grain yield after nitrogen fertilization were due to increased number of seeds per head and number of heads per plant. He also determined that seed weight was an insignificant variable in causing a yield response to nitrogen.

Other factors that have been reported to affect grain yield of oats are maturity, plant height, test weight and lodging resistance. Leininger (19), after studying several successive backcross generations of oats, concluded that selection for lines with heading dates like the recurrent parent would have been effective in causing all quantitative characters except weight-per-volume to regress toward the recurrent parent phenotype more rapidly than if random crosses had been made. Petr (22) suggests that selection for heading date and plant height would be feasible in early generations.

Frey (8), after studying 22 oat crosses in the F_2 to F_6 generations, found that the environmental and genetic variances for heading date were positively associated, whereas for plant height they were independent. Frey and Wiggans (11) also found that there was little relationship between heading date and the tillering capacity of spring oats.

Immer and Stevenson (15), after growing and evaluating more than 280 strains of oats, concluded that the early maturing varieties were the highest yielders.

Wallace et al. (27), reported a highly significant positive correlation between plant height and grain yield in oats, however, they state that no special significance should be placed on this value.

The effect of test weight on the grain yield of oats was reported by several workers (10, 19, 29). In general, they found that test weight, either high or low, had little or no effect on the subsequent yield of oat varieties and strains.

According to Norden and Frey (21) the correlation between yield per panicle and lodging resistance is relatively low and should be of little importance in a plant breeding program.

Schwanitz (26) suggested that if the study of the component parts of yield is unsuccessful in predicting high-yielding crop strains, the next alternative would be to approach the problem from the physiological standpoint.

Summary

From the literature cited above conclusions can be drawn as follows: (a) the conventional method for testing grain yielding potential is an expensive, prolonged and sometimes inadequate procedure; (b) yield component analysis may be an effective tool in determining yielding potential in oat varieties; (c) the number of seeds per panicle appears to be more closely associated with grain yielding capacity than the number of panicles or weight per seed; and (d) other factors such as plant height, maturity, lodging resistance, etc., are merely protective plant characters which may or may not allow a variety to reach its maximum yield potential.

MATERIALS AND METHODS

Experimental Materials

Five winter oat varieties and strains were selected for this study. Four of these, Cimarron (C.I. 5106[2/]), Bronco (C.I. 6571), Forkedeer (C.I. 3170), and Wintok (C.I. 3424) represent the commercial types grown in Oklahoma. The other strain, Arkwin Selection (C.I. 7404), is an advanced selection currently being evaluated in the small grain variety testing program. Since it was desirable to study yield components in different agronomic types these varieties were selected because they represent variable plant types and different levels of yield capacity, test weight, height and maturity. "Pure line varieties" were used to reduce as far as possible the confounding of environmental with genetic variance.

Cimarron originated as a mass selection of early-maturing panicles from Woodward Winter Oat Composite (C.I. 3527) made by A. M. Schlehuber (24) in the spring of 1946. Cimarron is an extremely early, short straw-ed, winterhardy type, with wide, light-green leaves. It has shown excellent grain yielding ability under Oklahoma conditions. It is resistant to Victoria blight and soil-borne mosaic but is susceptible to rusts and smuts. It is also susceptible to a physiological foliar disease, designated as "Cimarron Blight", which may occur under more humid

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2/ Accession number of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.

conditions. Cimarron is a recommended variety for northern and western Oklahoma.

Bronco is a tall, late maturing, winterhardy type with narrow dark-green leaves. It was developed by the Texas Agricultural Experiment Station from a cross of Lee-Victoria x Fulwin (1). This variety has demonstrated its capacity to produce very high grain yields under favorable conditions. In regional trials throughout the southern states, Bronco has produced one of the most outstanding grain yield records of any oat variety yet developed. Because of its very prostrate growth habit and slow development during the winter months, it is not considered a good grazing forage producer. Bronco is listed as a recommended variety in Oklahoma.

Forkedeer is a tall, medium maturing selection from Winter Fulghum (25). It has fair straw strength, moderate winterhardiness and is very uniform in appearance. It is resistant to Victoria blight but susceptible to the rusts and smuts. Forkedeer will produce good yields under favorable conditions but its yield record is not as good as that of Bronco or Cimarron. It is a recommended variety for Oklahoma.

Wintok is the result of a cross between Hairy Culberson and Winter Fulghum (25). It was selected, named and distributed by the Oklahoma Agricultural Experiment Station about 1940. Until recently this variety was generally conceded to be the most winterhardy oat in the United States. Compared to Cimarron it is medium to early maturing and slightly taller. Wintok has a prostrate growth habit and fine dark-green leaves. It is noted for its profuse tillering ability but, in spite of this, it is not a high yielding oat when compared with Bronco,

Cimarron or Forkedeer. It is highly susceptible to crown rust, susceptible to the smuts, but is resistant to Victoria blight. It is a recommended variety for Oklahoma.

Arkwin Selection originated as a single plant selection of Arkwin (C.I. 5850) made by B. C. Curtis[3/] in 1956. It differs from Arkwin in that it is earlier maturing, has stronger straw and higher test weight. It also produces longer, larger and more plump kernels than Arkwin which may account for its higher test weight. When compared to Cimarron it is later maturing (4 to 5 days) and taller (3 to 4 inches). Arkwin Selection has an intermediate to upright growth habit and is less winterhardy than the other 4 varieties. It is about equal to Bronco in tillering ability. Production records show it to be a much lower yielding type than the other varieties.

Experimental Methods

Data for this study were collected for 2 consecutive crop years, 1959-1960, at 2 locations: the Agronomy Farm near Stillwater, Oklahoma and the Southern Great Plains Experiment Station near Woodward, Oklahoma. The Woodward location is approximately 140 miles northwest of the Stillwater location. Because of the differences in the 2 locations and the 2 crop years, the test materials were subjected to 4 separate environments. The varieties were grown as a part of a winter oat variety test which included 16 entries.

The nursery was seeded in a randomized complete block design with 4 replications. Plot size was four 10-foot rows spaced 12 inches apart.

3/ Assistant Professor of Agronomy, Oklahoma State University.

The seeding dates at Stillwater were September 25 and October 12 and at Woodward, October 3 and October 9, respectively, for the years 1959 and 1960. Emergence was completed within a range of 6 to 10 days for the 2 years and locations. The seeding rate was 2 bushels per acre.

Environmental conditions during the testing period were generally conducive to excellent grain yields. Insects and diseases did not adversely affect the varieties during this study. Slight winterkilling was noted in the 1960 Woodward nursery ranging from 86% survival for Arkwin Selection to 96% for Wintok. The most serious environmental hazard occurred in the 1959 Stillwater test when lodging was observed in 4 of the 5 test varieties. Lodging, measured in percent broken culms, ranged from 0% for Arkwin Selection to 10%, 23%, 33% and 76% for Wintok, Forkedeer, Cimarron and Bronco, respectively.

Data were collected on 13 characters for each variety each year as follows:

1. Number of panicles per square foot
2. Total number of primary florets per 10 panicles
3. Number of fertile primary florets per 10 panicles
4. Weight of fertile primary florets per 10 panicles
5. Total number of secondary florets per 10 panicles
6. Number of fertile secondary florets per 10 panicles
7. Weight of fertile secondary florets per 10 panicles
8. Weight of all fertile florets per 10 panicles
9. Grain yield per square foot
10. Grain yield per rod-row (16 sq. ft.)
11. Maturity

12. Height

13. Test weight

Four 1-foot sections were harvested at random from rows 1 and 4 of each plot when ripe. These were placed in paper bags for subsequent laboratory analyses. The number of panicles per square foot was obtained by counting the number of seed-bearing panicles in each bag. Ten panicles from each 1-foot section were then selected at random for hand separation of the spikelets into primary and secondary florets which were counted separately.

It was observed during separation of the spikelets that many florets (both primary and secondary) contained no caryopsis. Since there appeared to be a varietal difference for this, both number of fertile and non-fertile florets were determined. A floret was counted if the lemma and palea were developed to a recognizable extent and was considered fertile if it contained a caryopsis.

Weights (to the nearest .01 gram) were determined for primary and for secondary fertile florets on the 10 panicles. Total weight of fertile florets for 10 panicles was obtained by combining the weights of the 2 classes.

Grain yield per square foot was obtained by threshing the material from the 1-foot sections (after removal of the 10 panicles) with a small head thresher. The weight of the fertile florets on the 10 panicles previously removed was then added in for total yield (nearest .01 gram).

Rows 2 and 3 (16 feet) were harvested from each plot to determine yield of grain per rod-row. The material was threshed with a Vogel threshing machine and the grain was weighed to the nearest gram.

Maturity (heading date), recorded when each plot was at least 75%

headed, was listed as number of days from emergence to heading to facilitate statistical analysis.

Height, expressed in inches from ground level to the top of the mass of panicles, was determined by averaging the readings from 3 or 4 random samples taken in each plot.

Weight per bushel was determined by using standard test-weight equipment. Only one test weight reading was recorded per variety per test since the replications had to be bulked to provide sufficient seed for testing.

Since a large number of samples were taken for the 9 yield component characters, only the station-year averages are presented in the main body of the text. The original data for these 9 characters are presented in tables XIX to XXVII of the appendix.

A combined analysis of variance for each character on the data from each variety over all replications for the 2 years and locations are presented in table XVIII of the appendix. Duncan's (3) multiple range test was used to test for significance among the means of each character. The coefficients of correlation for each variety were computed by pooling the corrected sum of squares and cross products obtained for each year at each location. Each year and location contained 16 observations or a total of 64 observations for both years and locations. Fifty-six degrees of freedom for r were obtained by pooling the 14 degrees of freedom for each year and location. Most of the statistical computations were made on an I.B.M. type 650 Magnetic Drum Data Processing Machine.

EXPERIMENTAL RESULTS

Grain Yield Components

Primary florets

The average number of primary florets (fertile and non-fertile) per 10 panicles for each variety is presented in table I. Varietal rank is consistent for both years and locations. For this character each variety mean is significantly different at the 5% level of confidence. The statistical summary presented in table IV shows a highly significant difference due to location, variety and variety x year interaction effects. These statistics represent the 5 varieties as a whole.

Table II shows the average number of fertile primary florets per 10 panicles for each variety. Varietal rank is still consistent for the top 3 varieties with the exception of Bronco in the 1959 Stillwater test. Severe lodging shortly before the fruiting period of this variety probably accounts for the low number of fertile primary florets produced this test year. The other 4 varieties, being considerable earlier maturing, sustained little damage from lodging. Wintok produced the lowest number of fertile primary florets in the Woodward test and Arkwin Selection was lowest in the Stillwater test. No significant difference between the overall mean of Wintok and Arkwin Selection was found.

In table III is shown the average weight in grams of fertile primary florets per 10 panicles for each variety. Again the effect of lodging on Bronco in the 1959 Stillwater test is shown by the unusually

TABLE I.

AVERAGE TOTAL NUMBER OF PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

Variety	Stillwater 1959 Av.	Stillwater 1960 Av.	Stillwater Sta. Av.	Woodward 1959 Av.	Woodward 1960 Av.	Woodward Sta. Av.	4-Sta. Year Av.	Mult. Range (.05 level)
Bronco	225	204	214	206	172	189	202	|
Cimarron	170	177	173	134	139	136	155	|
Forkedeer	152	162	157	121	129	125	141	|
Wintok	152	144	148	104	123	114	131	|
Arkwin Sel.	130	137	134	102	122	112	123	|

TABLE II.

AVERAGE NUMBER OF FERTILE PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

Variety	Stillwater 1959 Av.	Stillwater 1960 Av.	Stillwater Sta. Av.	Woodward 1959 Av.	Woodward 1960 Av.	Woodward Sta. Av.	4-Sta. Year Av.	Mult. Range (.05 level)
Bronco	133	198	165	171	162	166	166	|
Cimarron	157	168	163	119	133	126	144	|
Forkedeer	129	155	142	103	124	114	128	|
Arkwin Sel.	123	131	127	85	121	103	115	|
Wintok	128	136	132	68	118	93	112	|

TABLE III.

AVERAGE WEIGHT IN GRAMS OF FERTILE PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

Variety	Stillwater 1959 Av.	Stillwater 1960 Av.	Stillwater Sta. Av.	Woodward 1959 Av.	Woodward 1960 Av.	Woodward Sta. Av.	4-Sta. Year Av.	Mult. Range (.05 level)
Bronco	3.80	6.36	5.08	5.26	5.63	5.45	5.26	|
Cimarron	4.35	5.56	4.95	3.50	4.39	3.94	4.45	|
Forkedeer	3.67	5.48	4.58	3.37	4.33	3.85	4.21	|
Arkwin Sel.	4.43	4.98	4.71	2.69	4.71	3.70	4.20	|
Wintok	3.00	4.05	3.53	1.82	3.50	2.66	3.09	|

TABLE IV.

A SUMMARY OF STATISTICAL SIGNIFICANCE FOR CHARACTERS ANALYZED FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

Characters analyzed	Source of Variation						
	Year	Location	Yr. x Loc.	Variety	Var. x Yr.	Var. x Loc.	Var. x Yr. x Loc.
No. of primary florets	--	**	--	**	**	--	--
No. of fertile primary florets	**	**	--	**	--	*	**
Wt. of fertile primary florets	**	**	--	**	--	*	*
No. of secondary florets	**	**	*	**	**	--	--
No. of fertile secondary florets	**	**	--	**	--	*	**
Wt. of fertile secondary florets	**	**	--	**	--	*	*
Total wt. of fertile florets	**	**	--	**	--	*	*
No. of panicles	**	**	**	**	**	**	--
Grain yield (1 sq. ft.)	**	**	**	**	**	*	**
Grain yield (16 sq. ft.)	**	*	**	**	--	*	**
Height	--	**	--	**	**	--	--
Maturity	**	**	**	**	**	*	--

* Significant at the .05 level.
** Significant at the .01 level.
-- No significant difference.

low value recorded. In spite of this low value Bronco was significantly higher in primary seed weight than the other varieties. Significant variety x location and variety x year x location interactions were found for this character (table IV).

Varietal rank in weight per primary floret as shown in table V is considerably different from the relative rank in number and weight for 10 panicles. Arkwin Selection and Wintok consistently produced the heaviest and lightest weight primary florets, respectively, in the 4 station-year tests. The other 3 varieties produced about the same average weight per primary floret.

TABLE V.

AVERAGE WEIGHT IN MILLIGRAMS PER PRIMARY FLORET FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

	Stillwater			Woodward			4-Sta.
	1959	1960	Sta.	1959	1960	Sta.	Year
Variety	Av.	Av.	Av.	Av.	Av.	Av.	Av.
Arkwin Sel.	36	38	37	32	39	36	37
Forkedeer	28	35	32	33	35	34	33
Cimarron	28	33	30	29	33	31	31
Bronco	28	32	30	30	35	33	32
Wintok	23	30	27	27	30	29	28

Secondary florets

The average total number of secondary florets (fertile and non-fertile) per 10 panicles for each variety is presented in table VI. Highly significant varietal differences were found (table IV). The varietal rank was the same as for the primary florets except for the switch in positions of Arkwin Selection and Wintok. Arkwin Selection consistently produced more secondary florets than did Wintok. A highly significant

TABLE VI.

AVERAGE TOTAL NUMBER OF SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward			4-Sta. Mult. Year Range
Variety	1959 Av.	1960 Av.	Sta. Av.	1959 Av.	1960 Av.	Sta. Av.	Av. (.05 level)
Bronco	214	195	204	191	167	179	192 |
Cimarron	154	162	158	120	131	125	142 |
Forkedeer	129	150	139	100	118	109	124 |
Arkwin Sel.	118	129	124	74	115	94	109 |
Wintok	106	117	112	53	102	78	95 |

TABLE VII.

AVERAGE NUMBER OF FERTILE SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward			4-Sta. Mult. Year Range
Variety	1959 Av.	1960 Av.	Sta. Av.	1959 Av.	1960 Av.	Sta. Av.	Av. (.05 level)
Bronco	132	187	159	154	158	156	158 |
Cimarron	138	148	143	101	122	111	127 |
Forkedeer	97	141	119	70	111	90	105 |
Arkwin Sel.	112	121	117	56	112	84	100 |
Wintok	86	108	97	28	94	61	79 |

TABLE VIII.

AVERAGE WEIGHT IN GRAMS OF FERTILE SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward			4-Sta. Mult. Year Range
Variety	1959 Av.	1960 Av.	Sta. Av.	1959 Av.	1960 Av.	Sta. Av.	Av. (.05 level)
Bronco	2.17	3.52	2.84	2.80	3.14	2.97	2.91 |
Cimarron	2.53	2.93	2.73	1.85	2.36	2.10	2.42 |
Arkwin Sel.	2.40	2.83	2.62	1.00	2.44	1.72	2.17 |
Forkedeer	1.47	2.73	2.10	1.17	2.11	1.64	1.87 |
Wintok	1.09	1.65	1.37	0.39	1.41	0.90	1.14 |

variety x year interaction was found in this character.

The results presented in table VII for fertile secondary florets shows the same varietal rank as for total secondary florets; however, no significant difference was found between Forkedeer and Arkwin Selection. The ratio of fertile to non-fertile secondary florets in Arkwin Selection was greater than for Forkedeer. Varietal differences as well as the variety x year x location interaction were highly significant.

Table VIII shows the average weight in grams of fertile secondary florets per 10 panicles for each variety. Approximately the same statistical significance relationships were found for weight as for number of secondary florets.

The average weight in milligrams per secondary floret for each variety is presented in table IX. The varietal rank is almost the same as for weight per primary floret except that Cimarron produced slightly heavier secondary florets than Bronco. Arkwin Selection produced the heaviest weight per secondary floret and Wintok the lightest weight.

TABLE IX.

AVERAGE WEIGHT IN MILLIGRAMS PER SECONDARY FLORET FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

	Stillwater			Woodward			4-Sta.
	1959	1960	Sta.	1959	1960	Sta.	Year
Variety	Av.	Av.	Av.	Av.	Av.	Av.	Av.
Arkwin Sel.	21	23	22	18	22	20	22
Forkedeer	15	19	18	17	19	18	18
Cimarron	18	20	19	18	19	19	19
Bronco	16	19	18	18	20	19	18
Wintok	13	15	14	14	15	15	14

Weight of fertile florets

The average weight in grams of fertile florets (primary and secondary) per 10 panicles for each variety are presented in table X. Apparently the same relationships exist among varieties with respect to total weight of fertile florets as the component parts, i.e., weight of primary or secondary florets. Bronco is again significantly higher in weight and Wintok significantly lower than the other varieties. The summary of statistical significance in table IV shows that with but few exceptions the environmental effects on total weight of fertile florets are the same as for weight of fertile primary or secondary florets.

Number of panicles

Table XI shows the varietal averages for number of panicles per square foot. The varietal rank for this component is considerably different from the other components studied. Wintok is in a class by itself producing 22 more panicles than second ranked Forkedeer. Although varietal rank is rather consistent for year and location, environmental variation for panicle number is greater than for the panicle components (table IV).

Grain Yield

Grams per square foot

The average grain yield in grams per square foot for each variety is presented in table XII. Highly significant varietal differences were found. Also highly significant differences were found between years, locations and the interactions, locations x years, locations x varieties and varieties x years. Bronco, in spite of its low yield in the 1959 Stillwater test, was significantly higher in yield than Cimarron

TABLE X.

AVERAGE WEIGHT IN GRAMS OF FERTILE FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward			4-Sta.	Mult.
	1959	1960	Sta.	1959	1960	Sta.	Year	Range
Variety	Av.	Av.	Av.	Av.	Av.	Av.	Av.	(.05 level)
Bronco	5.97	9.88	7.92	8.06	8.78	8.42	8.17	
Cimarron	6.87	8.49	7.68	5.35	6.75	6.05	6.86	
Arkwin Sel.	6.84	7.81	7.32	3.69	7.15	5.42	6.37	
Forkedeer	5.13	8.21	6.67	4.55	6.44	5.49	6.08	
Wintok	4.09	5.71	4.90	2.21	4.90	3.56	4.23	

TABLE XI.

AVERAGE NUMBER OF PANICLES PER SQUARE FOOT FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward				Mult.
	1959	1960	Sta.	1959	1960	Sta.	Year	Range
Variety	Av.	Av.	Av.	Av.	Av.	Av.	Av.	(.05 level)
Wintok	77	77	77	107	83	95	86	
Forkedeer	55	62	58	77	63	70	64	
Cimarron	63	57	60	73	52	62	61	
Arkwin Sel.	48	56	52	58	53	55	54	
Bronco	58	47	53	63	46	55	54	

TABLE XII.

AVERAGE GRAIN YIELD IN GRAMS PER SQUARE FOOT FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

	Stillwater			Woodward			4-Sta.	Mult.
	1959	1960	Sta.	1959	1960	Sta.	Year	Range
Variety	Av.	Av.	Av.	Av.	Av.	Av.	Av.	(.05 level)
Bronco	22.7	50.3	36.5	39.3	41.8	40.5	38.5	
Cimarron	31.7	42.4	37.0	34.9	31.0	33.0	35.0	
Forkedeer	24.1	45.9	35.0	31.8	35.0	33.4	34.2	
Wintok	26.0	41.5	33.7	22.5	36.9	29.7	31.7	
Arkwin Sel.	34.6	33.2	33.9	21.7	29.6	25.7	29.8	

or Forkedeer. Arkwin Selection, which had the highest yield at Stillwater in 1959, ranked lowest in the overall average yields.

Grams per 16 square feet

The grain yield in grams per plot is given in table XIII. Although no significant differences were found among Bronco, Cimarron and Forkedeer in grain yield, the varietal rank remained the same as in the small plot (1 square foot) measurements. The low yield of Bronco in the 1959 Stillwater test is again indicative of the lodging which occurred in that test year. The environmental variation for rod-row yield was large but not as large as for yields of the smaller plots (table IV).

Height

The average height in inches per plot is shown in table XIV. Highly significant varietal differences were recorded. Although highly significant differences were noted due to location and variety x year interaction effects, the other sources of variation were non-significant, indicating the relative stability of this character.

Maturity

The relative maturity of each variety expressed as the number of days from emergence to heading is shown in table XV. All the varieties were significantly different in date headed. The 5 varieties averaged heading over a period of 12 days. Cimarron was the earliest to head averaging 11 days earlier than Bronco, the latest to head. The environmental influences on this character are shown by the highly significant values recorded for the various interactions in table IV. Even though interactions occurred the varietal rank remained constant for each test year.

TABLE XIII.

GRAIN YIELD IN GRAMS PER ROD-ROW FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

	Stillwater											Woodward											4-Sta. Year Av.	Mult. Range (.05 level)
	1959 Replications					1960 Replications					Sta.	1959 Replications					1960 Replications					Sta.		
Variety	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.		
Bronco	273	214	368	340	298.75	667	635	671	634	651.75	475.25	531	658	570	558	579.25	437	541	575	556	527.25	553.25	514.25	
Cimarron	440	475	492	457	466.00	572	606	549	557	571.00	518.50	429	549	565	404	486.75	429	437	475	438	444.75	465.75	492.13	
Forkedeer	464	378	400	370	403.00	557	600	634	570	590.25	496.63	534	463	441	519	489.25	391	460	470	424	436.25	462.75	479.69	
Wintok	384	298	382	350	353.50	528	566	562	563	554.75	454.13	399	377	321	250	336.75	453	356	524	363	424.00	380.38	417.25	
Arkwin Sel.	520	424	516	508	492.00	417	475	509	344	436.25	464.13	341	457	198	233	307.25	382	370	358	406	379.00	343.13	403.63	

TABLE XIV.

AVERAGE HEIGHT IN INCHES PER PLOT FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

	Stillwater											Woodward											4-Sta. Year Av.	Mult. Range (.05 level)
	1959 Replications					1960 Replications					Sta.	1959 Replications					1960 Replications					Sta.		
Variety	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.		
Forkedeer	37	35	38	37	36.75	35	35	36	36	35.50	36.13	34	32	31	33	32.50	32	33	32	33	32.50	32.50	34.31	
Bronco	35	35	35	35	35.00	33	35	36	35	34.75	34.88	35	34	33	36	34.50	31	32	32	32	31.75	33.13	34.00	
Arkwin Sel.	32	35	33	33	33.25	35	33	36	34	34.50	33.88	32	34	31	27	31.00	32	32	32	31	31.75	31.38	32.63	
Wintok	31	33	33	32	32.25	32	33	34	33	33.00	32.63	29	26	30	27	28.00	30	29	32	31	30.50	29.25	30.94	
Cimarron	26	26	28	28	27.00	31	33	33	30	31.75	29.38	30	25	28	25	27.00	29	28	30	29	29.00	28.00	28.69	

TABLE XV.

NUMBER OF DAYS FROM EMERGENCE TO HEADING FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

	Stillwater											Woodward											4-Sta. Year Av.	Mult. Range (.05 level)
	1959 Replications					1960 Replications					Sta.	1959 Replications					1960 Replications					Sta.		
Variety	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.	I	II	III	IV	Av.	I	II	III	IV	Av.	Av.		
Bronco	216	216	216	216	216.00	203	205	205	204	204.25	210.13	216	217	217	217	216.75	214	212	212	213	212.75	214.75	212.44	
Forkedeer	214	214	215	215	214.50	200	200	203	199	200.50	207.50	212	214	215	213	213.50	209	209	209	208	208.75	211.13	209.31	
Wintok	213	213	213	213	213.00	196	196	197	196	196.25	204.63	212	215	214	212	213.25	209	206	207	206	207.00	210.13	207.38	
Arkwin Sel.	210	210	210	210	210.00	195	195	195	195	195.00	202.50	213	213	216	215	214.25	207	205	207	207	206.50	210.38	206.44	
Cimarron	205	205	205	205	205.00	192	192	192	192	192.00	198.50	205	205	205	205	205.00	205	203	203	202	203.25	204.13	201.31	

Test Weight

Test weights, recorded in pounds per bushel, are presented for each variety in table XVI. Only one test weight was recorded per variety per test since the seed from the 4 replications had to be bulked to provide sufficient seed for weighting, consequently no statistical data are presented. Arkwin Selection and Forkedeer produced test weights generally higher or equal to the other 3 varieties. Bronco produced the lowest test weight in each of the 4 tests.

TABLE XVI.

TEST WEIGHT IN POUNDS PER BUSHEL FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-60.

Varieties	Stillwater			Woodward			4-Sta.
	1959	1960	Av.	1959	1960	Av.	Yr. Av.
Arkwin Sel.	35.5	34.7	35.1	33.8	39.4	36.6	35.9
Forkedeer	32.0	36.0	34.0	34.8	39.5	37.2	35.6
Wintok	32.0	35.0	33.5	32.0	38.8	35.4	34.5
Cimarron	31.4	34.0	32.7	30.8	38.5	34.7	33.7
Bronco	27.0	34.0	30.5	32.2	38.2	35.2	32.9

Correlation Coefficients

Correlation coefficients for 9 characters which may influence grain yield are found in table XVII. The correlation between yield and each of the other eight characters ranged from non-significant to highly significant, however, only positive r values were found. The majority of the eight characters were significantly correlated with yield (5% level of confidence). The component parts of the panicle, i.e., primary and secondary florets and their weights, were positively correlated one with another and all r values were significant at the 1% level of confidence. The correlation between the number of panicles per square foot and the

TABLE XVII.

CORRELATION COEFFICIENTS (r) BETWEEN 9 CHARACTERS IN 5 VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		No. of Primary Florets	No. of Fertile Primary Florets	Wt. of Fertile Primary Florets	No. of Secondary Florets	No. of Fertile Secondary Florets	Wt. of Fertile Secondary Florets	Wt. of Fertile Florets	No. of Panicles (1 sq. ft.)
	Cimarron	.181	.213	.212	.267	.321	.395	.334	.727
	Forkedeer	.231	.297	.367	.239	.288	.352	.367	.487
Yield (1 sq. ft.)	Wintok	.329	.384	.379	.365	.406	.394	.397	.428
	Bronco	.038	.295	.190	.090	.288	.105	.159	.570
	Ark. Sel.	.339	.464	.580	.464	.534	.615	.600	.672
	Cimarron	.949	.775	.943	.878	.639	.822	-.063	
	Forkedeer	.955	.870	.945	.917	.789	.854	-.243	
No. of primary florets	Wintok	.923	.840	.916	.791	.718	.823	-.139	
	Bronco	.817	.802	.879	.749	.798	.812	-.433	
	Ark. Sel.	.938	.817	.937	.828	.711	.786	-.001	
	Cimarron	.859	.896	.882	.604	.859	-.007		
	Forkedeer	.939	.903	.930	.838	.917	-.222		
No. of fertile primary florets	Wintok	.925	.922	.878	.789	.906	-.182		
	Bronco	.913	.769	.883	.802	.883	-.232		
	Ark. Sel.	.931	.962	.927	.839	.906	.026		
	Cimarron	.711	.754	.509	.904	-.115			
	Forkedeer	.845	.893	.938	.992	-.256			
Wt. of fertile primary florets	Wintok	.861	.858	.865	.983	-.237			
	Bronco	.745	.820	.938	.990	-.372			
	Ark. Sel.	.903	.917	.953	.993	.068			
	Cimarron	.935	.763	.841	-.007				
	Forkedeer	.951	.814	.846	-.249				
No. of secondary florets	Wintok	.910	.842	.882	-.225				
	Bronco	.887	.723	.747	-.339				
	Ark. Sel.	.951	.856	.895	.061				
	Cimarron	.865	.920	.026					
	Forkedeer	.888	.904	-.237					
No. of fertile secondary florets	Wintok	.935	.913	-.226					
	Bronco	.767	.811	-.186					
	Ark. Sel.	.925	.930	.098					
	Cimarron	.827	.052						
	Forkedeer	.973	-.269						
Wt. of fertile secondary florets	Wintok	.941	-.255						
	Bronco	.976	-.463						
	Ark. Sel.	.981	.120						
	Cimarron	-.049							
	Forkedeer	-.264							
Wt. of fertile florets	Wintok	-.251							
	Bronco	-.413							
	Ark. Sel.	.088							

Tabulated r with 56 D.F. at .05 level = .259 .01 level = .337

components of the panicle were generally negative or non-significant. The highly significant positive correlation between yield and number of panicles per square foot was as expected since the number and weight of florets per panicle within a given variety are generally relatively constant. If the data from all 5 varieties had been combined and a single correlation coefficient for yield and number of panicles had been computed, an entirely different result would probably have been obtained. The data were not combined because of the highly significant differences recorded for years and locations in the analysis of variance (table IV).

DISCUSSION

This study was conducted to determine the association between the components of yield, height, maturity and test weight and their effects on total grain yield in 5 varieties of winter oats. The associations among these various characters also were studied and the environmental influence on these characters was considered. The results of this experiment agree in general with those of previous investigators (4, 12, 19, 22) who had previously conducted similar studies using spring oat varieties.

Number of Florets

Bronco, Cimarron and Forkedeer, in this order, were the 3 highest yielding varieties and these 3 varieties also produced the greatest number of florets (primary and secondary) per panicle. Bronco had an average of 39 florets per panicle as compared to 30 and 27 for Cimarron and Forkedeer, respectively. Both Arkwin Selection and Wintok averaged 23 florets per panicle. The highly significant positive correlations found between the number of primary florets (fertile and non-fertile) and the number of secondary florets (fertile and non-fertile) indicate that varietal differences for these components are insignificant. Thus, these components, i.e., the number of florets or spikelets per panicle, probably should be considered as one unit. The correlation between yield and the number of florets was generally significant, which indicates that this character is relatively stable under differing

environments. This is in agreement with Petr (22) who found a high heritability value for the number of florets per panicle in spring oats. It appears, based on the data presented, that the number of florets per panicle is closely associated with high grain yield in winter oats.

Weight of Florets

The weight per floret appears to be relatively constant within each variety regardless of environment. However, the floret weight seems to be less associated with grain yield than the number of florets per panicle. Wintok produced the lowest floret weight of 21 milligrams as compared to 30 milligrams for Arkwin Selection, yet the grain yields of these two varieties were not significantly different. Bronco, Cimarron and Forkedeer produced medium floret weights of 25, 25 and 26 milligrams, respectively, and were significantly higher in yield than Arkwin Selection and Wintok. These results are also comparable to the findings of other investigators in spring oats (6, 7, 17). The correlations between the weight of fertile florets and panicle number were either insignificant or negative, indicating that the optimum combination of these two characters might not express the full potential of either one. The low environmental variation effects on seed weight suggest that it may warrant important consideration for use as a selection criterion for high yield. The selection of winter oat strains with high weight per floret among lines that have a high number of florets per panicle should result in higher yield.

Number of Panicles

Although the number of panicles per unit area is certainly an important component of yield, the association of this plant character

with grain yield was highly variable in the 5 varieties of winter oats studied. Bronco, the highest yielding variety, and Arkwin Selection, the lowest yielding variety, produced an average of only 54 panicles per square foot as compared to 86, 64, and 61 for Wintok, Forkedeer and Cimarron, respectively. This component was also found to be highly variable under different environments. Logically, a variety that produces an abundance of panicles should produce more grain than a variety that produces fewer panicles. However, Frey (4, 5, 6, 7) found that generally the reverse of this situation occurs. Petr (22) found low correlations between yield and panicle number indicating that progress from selection for this trait would be slow. Even though a positive relationship between panicle number and yield within each variety was found (table XVII), this does not indicate that the same relationship exists among varieties. The relationship among varieties for these two components of yield (table XI and table XII) is apparently negative, however, no r value for the combined data are presented.

Other Plant Characters

Height and maturity apparently have little effect on the grain yielding potential of winter oats unless adverse environmental conditions occur. Highly significant varietal differences for these 2 characters were found among the 3 highest yielding varieties. Bronco and Forkedeer were the tallest and Cimarron the shortest of the five varieties in this study. Cimarron was 11 and 8 days earlier in maturity than Bronco and Forkedeer, respectively.

Test weight apparently has no positive effect on grain yield since Bronco, the highest yielding variety, had the lowest test weight, while Arkwin Selection, the lowest yielding variety, had the highest test weight.

Methods

This study revealed that the measurement of the components of yield can be limited to the number of florets or spikelets per panicle, weight per floret and number of panicles per unit area. For the amount of information obtained, the separation of the spikelet into primary and secondary florets was too time-consuming and tedious to be of practical value. More information is needed concerning the minimum number of samples and plot size necessary for an accurate estimate of the three main yield components. Frey (5) found that the plot or sample size necessary for determining the yield components with a given degree of accuracy is much smaller than for determining grain yield. He suggested a planting rate of 30 seeds per hill with hills spaced 1 foot apart in 2 directions which approximates 3 bushels per acre. Determinations could be made on a plot basis and these data used to predict high yielding strains. It appears from the results reported in the literature and the data obtained in this study that efficient methods for measuring varietal differences in the components of yield could be developed.

Selection for High Yield

This study indicated that the use of grain yield components in the selection of high grain yielding winter oat varieties would be possible. The environmental variation was less for number of seed per panicle and weight per seed than for panicle number and grain yield. The close association between number of seeds per panicle and grain yield indicates that more emphasis should be given to selection of strains that are high in this component than to strains which exhibit high seed weight or high panicle number. Apparently the components of yield in winter oats as

well as those in spring oats show the same relationships, one with another and with grain yield.

SUMMARY

A study to determine the associations of several major plant characters and their effect on grain yield in 5 varieties of winter oats was conducted during 2 consecutive crop-years, 1959 and 1960, at Stillwater and Woodward, Oklahoma. The 5 varieties, Cimarron, Forkedeer, Wintok, Bronco and Arkwin Selection varied widely in agronomic characteristics.

The main objectives of the research were: (1) to determine the primary component of yield most closely associated with high grain yield in winter oats; (2) to determine the environmental effect on the various plant characters; (3) to determine if the components of yield in spring oats, as reported in the literature, have the same or different relationship to grain yield as those found in this study for winter oats.

The number of seeds per panicle appeared to be more closely associated with grain yield than the other components, weight per seed and number of panicles per unit area. The environmental variation was less for seed per panicle and weight per seed than for panicle number or grain yield. Other factors such as plant height, maturity and test weight do not appear to affect the grain yielding capacity of winter oats under normal environmental conditions. The same characters closely associated with grain yield in spring oats are apparently closely related to grain yield in winter oats.

It was concluded that when selecting for high grain yielding winter oat strains more emphasis should be given to strains which produced the higher numbers of seed per panicle. With this component held at a constantly high level any increase in either of the other two components, weight per seed or number of panicles, through selection in later generations should result in an increased yield.

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A P P E N D I X

LIST OF APPENDIX TABLES

TABLE XVIII.

THE COMBINED ANALYSIS OF VARIANCE FOR 12 CHARACTERS STUDIED IN FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959 AND 1960.

Source of variation	D. F.	No. of primary florets		No. of fertile primary florets		Weight of fertile primary florets	
		Mean square	F value	Mean square	F value	Mean square	F value
Total	319						
Years	1	116.00	0.17	42,090.00	51.39**	137.69	91.19**
Location	1	72,691.00	106.31**	52,428.00	64.01**	33.73	22.34**
Yr. x Loc.	1	426.00	0.62	21.00	0.03	1.31	0.88
Var. x Yr.	4	4,250.00	6.22**	713.00	0.87	0.41	0.27
Var. x Loc.	4	628.00	0.92	4,216.25	5.15*	5.38	3.56*
Var. x Yr. x Loc.	4	1,016.00	1.49	8,013.25	9.78**	7.85	5.20*
Reps. (Pooled) (Error for above)	12	683.75		819.08		1.51	
Varieties	4	62,104.75	129.19	31,684.75	60.00**	38.58	52.14**
Experimental Error (Error for Var.)	48	480.73		528.10		0.74	
Sampling Error	240	462.40		424.09		0.49	

* Significant at .05 level.
** Significant at .01 level.

TABLE XVIII. (Continued)

Source of variation	D. F.	No. of secondary florets		No. of fertile secondary florets		Wt. of fertile secondary florets	
		Mean square	F value	Mean square	F value	Mean square	F value
Total	319						
Years	1	12,689.00	20.86**	85,184.00	124.17**	54.35	86.41**
Location	1	73,842.00	121.38**	55,731.00	81.24**	17.30	27.50**
Yr. x Loc.	1	3,206.00	5.27*	1,857.00	2.71	0.05	0.08
Var. x Yr.	4	6,955.50	11.43**	2,135.25	3.11	0.89	1.41
Var. x Loc.	4	181.75	0.30	2,793.50	4.07*	2.26	3.59*
Var. x Yr. x Loc.	4	1,633.75	2.69	6,428.25	9.37**	2.34	3.71*
Reps. (Pooled) (Error for above)	12	608.33		686.00		0.63	
Varieties	4	90,184.50	187.83**	57,630.25	118.14**	27.85	121.09**
Experimental Error (Error for Var.)	48	480.15		487.81		0.23	
Sampling Error	240	467.41		404.75		0.18	

* Significant at .05 level.
** Significant at .01 level.

TABLE XVIII. (Continued)

Source of variation	D. F.	Total wt. of fertile florets		No. of panicles		Grain yield (1 sq. ft.)	
		Mean square	F value	Mean square	F value	Mean square	F value
Total	319						
Years	1	365.06	92.89**	5,503.00	47.31**	7,747.03	116.83**
Location	1	99.34	25.27**	4,568.00	39.27**	620.22	9.35**
Yr. x Loc.	1	0.86	0.22	4,643.00	39.91**	2,007.51	30.27**
Var. x Yr.	4	2.20	0.56	740.00	6.36**	583.63	8.80**
Var. x Loc.	4	14.19	3.61*	874.00	7.51**	323.76	4.88*
Var. x Yr. x Loc.	4	18.74	4.77*	227.75	1.96	768.23	11.59**
Reps. (Pooled) (Error for above)	12	3.93		116.33		66.31	
Varieties	4	130.54	78.17**	11,353.50	119.20**	711.86	12.67**
Experimental Error (Error for Var.)	48	1.67		95.25		56.18	
Sampling Error	240	1.19		83.55		33.52	

* Significant at .05 level.
** Significant at .01 level.

TABLE XVIII. (Continued)

Source of variation	D. F.	Grain yield (16 sq. ft.) Mean square	Grain yield (16 sq. ft.) F value	Height Mean square	Height F value	Maturity Mean square	Maturity F value
Total	79						
Years	1	128,882.00	23.23**	12.00	4.65	1,805.00	940.10**
Location	1	33,089.00	5.96*	128.00	49.61**	594.00	309.36**
Yr. x Loc.	1	121,290.00	21.86**	1.00	0.39	424.00	220.83**
Var. x Yr.	4	16,799.75	3.03	14.75	5.72**	14.50	7.55**
Var. x Loc.	4	21,822.00	3.93*	3.75	1.45	9.75	5.08*
Var. x Yr. x Loc.	4	37,829.00	6.82**	4.50	1.74	3.00	1.56
Reps. (Pooled) (Error for above)	12	5,547.92		2.58		1.92	
Varieties	4	37,435.00	15.55**	87.00	54.37**	268.25	479.02**
Experimental Error (Error for Var.)	48	2,407.46		1.63		0.56	

* Significant at .05 level.
** Significant at .01 level.

TABLE XIX.

TOTAL NUMBER OF PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960

		Stillwater											Woodward										
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	4-Sta. Yr. Av.
Cimarron	1	153	134	169	171	157	146	177	159	175	124		175	140	143	131	147	158	154	150	129	148		
	2	157	196	164	149	167	164	172	182	166	171		131	116	113	133	123	137	147	129	142	139		
	3	200	201	137	198	184	189	184	161	164	175		154	122	143	134	138	132	121	114	160	132		
	4	159	199	170	162	173	192	195	214	187	197		95	146	114	153	127	124	141	141	139	136		
						170					177	173					134					139	136	155
Forkedeer	1	137	168	108	135	137	167	147	164	136	154		145	155	145	86	133	130	104	101	145	120		
	2	179	166	199	96	160	169	157	219	180	181		101	121	193	114	132	153	149	125	121	137		
	3	205	138	144	142	157	176	178	151	143	162		91	99	91	115	99	150	109	109	193	140		
	4	181	150	127	164	156	150	150	150	157	152		136	105	120	125	122	151	117	087	114	117		
						152					162	157					121					129	125	141
Wintok	1	162	165	160	167	164	87	134	165	136	131		115	92	118	143	117	162	140	131	128	140		
	2	142	150	173	139	151	133	121	140	143	134		80	128	101	97	102	95	141	100	113	112		
	3	142	165	141	152	150	162	164	185	142	163		84	79	95	104	91	110	102	123	106	110		
	4	164	124	132	146	142	125	176	137	146	146		112	105	99	113	107	133	151	115	119	130		
						152					144	148					104					123	114	131
Bronco	1	191	192	258	211	213	207	186	201	210	201		227	195	232	238	223	125	203	241	157	182		
	2	234	207	263	247	238	182	200	204	189	194		194	198	192	212	199	173	180	178	183	179		
	3	229	217	187	246	220	235	222	221	179	214		157	218	189	196	190	161	179	160	136	159		
	4	250	214	193	257	229	198	214	209	210	208		234	187	248	175	211	137	141	160	232	168		
						225					204	214					206					172	189	202
Arkwin Sel.	1	143	137	139	113	133	142	145	153	144	146		120	80	128	89	104	107	138	129	125	125		
	2	127	129	116	113	121	140	106	130	129	126		107	117	87	121	108	124	119	144	109	124		
	3	138	120	109	115	121	129	150	141	139	140		109	98	121	86	104	117	150	120	114	125		
	4	121	109	186	170	147	132	111	146	154	136		62	77	101	122	91	121	96	133	111	115		
						130					137	134					102					122	112	123

TABLE XX.

NUMBER OF FERTILE PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	4-Sta. Year Av.
Cimarron	1	136	121	157	147	140	144	167	152	164	157		159	119	117	116	128	153	152	141	125	143		
	2	148	188	153	141	158	157	163	179	155	164		119	105	104	117	111	130	136	125	133	131		
	3	174	199	135	189	174	177	173	157	154	165		138	105	127	130	125	128	118	112	156	129		
	4	150	164	159	158	158	185	188	199	181	188		87	133	96	135	113	120	139	133	125	129		
						157					168	163					119					133	126	144
Forkedeer	1	112	139	89	90	108	159	133	153	133	145		129	124	135	71	115	126	102	99	135	116		
	2	150	148	142	77	129	165	154	212	176	177		84	109	181	91	116	144	145	122	111	131		
	3	177	116	135	115	136	159	167	149	139	154		71	88	74	90	81	146	105	106	188	136		
	4	163	144	118	155	145	147	137	146	150	145		115	78	101	110	101	151	111	84	114	115		
						129					155	142					103					124	114	128
Wintok	1	141	151	120	139	138	86	131	153	119	122		74	65	83	110	83	157	137	129	118	135		
	2	127	137	132	113	127	124	115	131	138	127		52	103	62	53	68	85	134	98	103	105		
	3	131	135	119	141	132	156	161	177	136	158		50	48	71	57	57	101	98	120	102	105		
	4	125	110	120	111	117	120	165	128	138	138		67	70	53	64	64	126	145	113	115	125		
						128					136	132					68					118	93	112
Bronco	1	113	103	183	70	117	201	181	195	202	195		201	71	119	75	174	107	136	127	124	170		
	2	133	147	141	97	130	175	192	198	181	187		162	137	182	176	173	110	200	222	146	170		
	3	163	136	121	133	138	230	216	215	174	209		137	174	162	192	159	163	174	174	170	149		
	4	161	125	129	166	145	187	208	207	201	201		210	164	163	173	177	150	166	151	128	160		
						133					198	165					171					162	166	166
Arkwin Sel.	1	138	132	132	108	128	134	133	148	135	138		113	160	203	134	95	128	136	154	222	124		
	2	121	121	107	102	113	137	102	125	129	123		104	110	70	108	98	122	118	143	108	123		
	3	127	116	100	108	113	123	149	137	131	135		89	88	89	71	84	114	146	118	114	123		
	4	119	105	176	161	140	129	111	133	139	128		41	57	78	74	63	121	95	131	108	114		
						123					131	127					85					121	103	115

TABLE XXI.

WEIGHT IN GRAMS OF FERTILE PRIMARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959 Sub-plots					1960 Sub-plots					Sta.	1959 Sub-plots					1960 Sub-plots					Sta.	4-Sta. Yr.
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Av.	1	2	3	4	Av.	1	2	3	4	Av.	Av.	Av.
Cimarron	1	3.40	3.02	4.78	2.54	3.44	4.63	5.45	5.31	5.45	5.21		4.51	3.56	3.67	3.43	3.79	5.12	5.20	4.75	4.19	4.82		
	2	4.45	5.74	4.34	4.17	4.68	5.09	5.60	6.26	5.14	5.52		3.88	3.39	3.33	3.92	3.63	4.17	4.47	4.18	4.56	4.35		
	3	4.43	5.38	3.52	5.68	4.75	5.61	5.59	5.06	4.95	5.30		4.29	3.21	3.72	3.25	3.62	4.17	3.85	3.64	4.92	4.15		
	4	4.07	4.60	4.50	4.93	4.53	5.95	6.40	6.60	5.87	6.21		2.60	3.30	2.43	3.50	2.96	3.85	4.70	4.40	4.04	4.25		
						4.35					5.56	4.95					3.50					4.39	3.94	4.45
Forkedeer	1	3.95	4.43	2.14	2.20	3.18	5.90	5.12	5.32	5.00	5.34		4.64	3.82	4.55	2.42	3.86	4.60	3.64	3.86	5.25	4.34		
	2	4.66	3.91	3.40	1.97	3.49	5.72	5.11	7.25	6.34	6.11		2.83	3.29	5.73	2.96	3.70	4.71	4.70	4.36	3.78	4.39		
	3	4.66	2.92	3.88	3.15	3.65	5.27	6.25	5.31	4.69	5.38		2.40	3.15	2.29	2.74	2.65	5.02	3.67	3.61	5.80	4.53		
	4	5.00	4.44	3.60	4.34	4.35	5.33	4.63	4.96	5.55	5.12		3.47	2.87	3.29	3.52	3.29	5.18	3.82	3.15	4.14	4.07		
						3.67					5.48	4.58					3.37					4.33	3.85	4.21
Wintok	1	3.78	3.40	3.00	3.50	3.42	2.70	4.00	3.97	3.36	3.51		2.04	1.90	2.35	3.12	2.35	5.04	3.93	3.76	3.34	4.02		
	2	3.01	3.05	2.53	2.57	2.79	3.82	3.49	3.84	4.28	3.86		1.29	2.60	1.70	1.42	1.75	2.58	3.86	2.84	3.13	3.10		
	3	3.04	3.70	2.69	3.13	3.14	4.20	4.84	5.34	4.11	4.62		1.22	1.14	2.06	1.60	1.51	3.13	2.85	3.75	2.90	3.16		
	4	3.05	2.76	2.80	1.95	2.64	3.66	4.85	4.03	4.37	4.23		1.60	2.00	1.30	1.76	1.67	3.80	4.11	3.35	3.55	3.70		
						3.00					4.05	3.53					1.82					3.50	2.66	3.09
Bronco	1	2.97	1.91	5.07	1.97	2.98	6.82	5.87	6.61	6.59	6.47		6.02	4.46	6.02	5.74	5.56	4.12	7.63	8.31	5.52	6.40		
	2	3.64	4.28	3.84	2.70	3.62	5.55	6.60	6.28	5.81	6.06		4.70	4.44	4.26	6.50	4.98	5.48	5.65	5.98	6.16	5.82		
	3	4.60	3.85	3.78	4.33	4.14	7.44	6.85	7.25	5.37	6.73		4.34	5.44	4.94	5.21	4.98	4.96	5.46	5.32	4.43	5.04		
	4	5.39	4.10	3.66	4.70	4.46	6.25	6.46	6.20	5.81	6.18		6.40	4.62	6.75	4.30	5.52	4.24	4.48	5.43	6.95	5.28		
						3.80					6.36	5.08					5.26					5.63	5.45	5.26
Arkwin Sel.	1	5.56	4.98	4.67	4.11	4.83	5.29	5.37	5.68	5.11	5.36		4.07	2.16	4.21	2.52	3.24	4.11	5.25	5.23	5.09	4.92		
	2	4.04	4.46	3.26	3.28	3.76	5.67	4.01	4.84	5.15	4.92		3.76	3.99	2.35	3.50	3.40	4.90	4.70	5.60	4.34	4.89		
	3	4.65	4.33	3.53	3.69	4.05	4.84	5.70	5.20	4.95	5.17		2.43	2.55	2.52	2.14	2.41	4.48	5.50	4.39	4.28	4.66		
	4	4.40	4.06	6.44	5.46	5.09	4.78	4.07	4.09	5.00	4.49		1.20	1.62	2.01	1.95	1.70	4.52	3.83	5.02	4.10	4.37		
						4.43					4.98	4.71					2.69					4.71	3.70	4.20

TABLE XXII.

TOTAL NUMBER OF SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	4-Sta. Year Av.
Cimsrron	1	138	115	150	179	146	131	158	150	165	151		158	127	128	118	133	152	152	134	118	139		
	2	137	181	142	130	148	157	164	169	150	160		108	114	108	132	116	133	138	120	135	132		
	3	177	188	130	184	170	174	166	142	144	157		149	108	120	118	124	126	112	104	151	123		
	4	152	180	143	145	155	169	185	194	168	179		71	128	93	138	108	117	133	137	129	129		
						154					162	158					120					131	125	142
Forkedeer	1	120	136	86	116	115	152	135	143	130	140		132	130	126	60	112	120	91	99	138	112		
	2	150	148	179	95	143	154	140	207	173	169		73	101	171	75	105	138	139	119	110	127		
	3	178	118	105	112	128	163	169	139	131	151		67	91	48	100	77	142	94	101	155	123		
	4	162	130	98	126	129	139	133	142	147	140		116	90	105	109	105	139	110	84	101	109		
						129					150	139					100					118	109	124
Wintok	1	125	124	111	109	117	67	108	137	116	107		53	40	75	90	65	148	122	113	109	123		
	2	104	111	113	82	103	105	96	106	119	107		34	69	52	26	45	74	110	83	96	91		
	3	102	119	91	115	107	131	140	160	113	136		54	37	53	41	46	91	81	100	86	90		
	4	103	91	96	100	98	101	151	110	116	120		50	59	51	66	57	111	121	91	99	106		
						106					117	112					53					102	78	95
Bronco	1	180	177	250	195	201	200	177	192	199	192		209	181	130	244	191	124	204	237	154	180		
	2	220	192	241	226	220	174	199	194	181	187		181	203	179	204	192	168	175	173	174	173		
	3	218	210	180	242	213	224	217	205	170	204		149	200	180	183	178	157	174	155	132	155		
	4	232	212	193	252	222	192	202	188	202	196		230	184	244	159	204	132	134	154	218	160		
						214					195	204					191					167	179	192
Arkwin Sel.	1	132	129	124	108	123	134	143	138	127	136		101	59	107	64	83	100	123	125	122	118		
	2	109	114	107	96	107	135	97	125	127	121		89	102	62	104	89	116	114	141	104	119		
	3	128	115	103	96	111	120	142	127	131	130		72	67	83	55	69	112	143	113	107	119		
	4	112	102	165	150	132	129	107	141	139	129		29	47	63	73	53	111	89	121	101	106		
						118					129	124					74					115	94	109

TABLE XXIII.

NUMBER OF FERTILE SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	4-Sta. Year Av.
Cimarron	1	117	101	140	167	131	128	140	134	152	139		140	100	109	104	113	143	140	128	106	129		
	2	126	172	131	118	137	141	154	153	142	148		99	91	89	116	99	126	126	119	130	125		
	3	133	168	114	176	148	157	145	131	123	139		130	93	101	103	107	115	106	101	136	115		
	4	125	151	136	139	138	162	170	176	159	167		59	104	72	107	86	110	126	126	111	118		
						138					148	143					101					122	111	127
Forkedeer	1	88	101	63	57	77	143	129	136	124	133		99	91	102	38	83	119	88	92	134	108		
	2	110	116	131	74	108	149	131	195	161	159		55	74	135	40	76	130	123	116	101	118		
	3	127	95	95	82	100	144	159	127	128	140		38	69	27	68	51	140	81	96	148	116		
	4	127	107	67	114	104	135	123	136	137	133		74	56	72	74	69	135	104	82	94	104		
						97					141	119					70					111	90	105
Wintok	1	115	113	66	89	96	63	102	122	102	97		20	15	55	60	38	137	111	103	103	114		
	2	85	93	63	65	77	92	88	95	107	96		15	42	35	15	27	59	99	78	86	81		
	3	94	104	78	103	95	117	129	147	105	125		33	20	25	24	26	90	65	93	81	82		
	4	79	77	80	76	78	93	143	105	110	113		25	23	17	30	24	109	110	83	89	98		
						86					108	97					28					94	61	79
Bronco	1	116	103	174	87	120	194	168	186	188	184		174	125	98	194	148	117	196	214	138	166		
	2	131	141	124	103	125	167	193	188	175	181		144	167	150	171	158	162	175	163	169	167		
	3	143	147	120	136	137	214	205	205	166	198		109	153	142	163	142	149	168	148	119	146		
	4	169	135	129	152	146	178	191	181	193	186		201	157	200	123	170	124	125	148	213	153		
						132					187	159					154					158	156	158
Arkwin Sel.	1	128	127	121	103	120	126	127	127	112	123		89	42	94	56	70	95	120	119	119	113		
	2	97	104	96	88	96	127	93	122	126	117		76	90	47	85	75	112	112	140	103	117		
	3	124	112	98	91	106	115	133	115	122	121		46	56	44	44	48	108	140	111	105	116		
	4	108	101	160	133	126	124	102	133	134	123		18	27	47	37	32	109	87	115	97	102		
						112					121	117					56					112	84	100

TABLE XXIV.

WEIGHT IN GRAMS OF FERTILE SECONDARY FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										4-Sta. Year Av.
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	
Cimarron	1	1.84	1.40	2.67	4.54	2.61	2.40	2.88	2.88	3.07	2.81		2.48	1.92	2.18	1.96	2.14	2.82	2.84	2.55	2.10	2.58		
	2	2.39	3.27	2.23	2.12	2.50	2.56	3.11	3.18	2.84	2.92		2.03	1.90	1.76	2.30	2.00	2.36	2.50	2.33	2.61	2.45		
	3	2.22	2.78	1.80	3.24	2.51	3.05	2.63	2.55	2.33	2.64		2.48	1.80	1.86	1.47	1.90	2.26	2.00	1.87	2.43	2.14		
	4	2.11	2.65	2.49	2.65	2.48	3.21	3.56	3.43	3.26	3.37		1.02	1.42	1.20	1.76	1.35	2.04	2.47	2.49	2.06	2.27		
						2.53					2.93	2.73					1.85					2.36	2.10	2.42
Forkedeer	1	1.70	1.86	0.87	0.73	1.29	2.89	2.78	2.65	2.58	2.73		1.96	1.45	1.74	0.68	1.46	2.38	1.75	1.92	2.93	2.25		
	2	2.05	1.55	1.29	0.91	1.45	2.73	2.22	3.65	3.17	2.94		0.95	1.14	2.09	0.67	1.21	2.17	2.13	2.15	1.82	2.07		
	3	1.80	1.24	1.47	1.11	1.41	2.68	3.38	2.50	2.32	2.72		0.69	1.34	0.43	1.02	0.87	2.66	1.47	1.70	2.90	2.18		
	4	2.12	1.79	1.12	1.84	1.72	2.74	2.22	2.40	2.74	2.53		1.14	1.16	1.08	1.22	1.15	2.50	1.81	1.61	1.81	1.93		
						1.47					2.73	2.10					1.17					2.11	1.64	1.87
Wintok	1	1.67	1.38	0.85	1.30	1.30	0.98	1.70	1.55	1.40	1.41		0.26	0.19	0.88	0.87	0.55	2.40	1.69	1.50	1.52	1.78		
	2	1.04	1.07	0.62	0.62	0.84	1.54	1.42	1.41	1.67	1.51		0.21	0.57	0.53	0.22	0.38	0.86	1.40	1.11	1.32	1.17		
	3	1.13	1.48	0.94	1.22	1.19	1.60	2.01	2.40	1.58	1.90		0.39	0.23	0.34	0.32	0.32	1.44	0.92	1.54	1.12	1.25		
	4	1.00	1.07	1.00	1.11	1.05	1.45	2.17	1.73	1.82	1.79		0.21	0.43	0.19	0.41	0.31	1.69	1.52	1.19	1.30	1.43		
						1.09					1.65	1.37					0.39					1.41	0.90	1.14
Bronco	1	1.64	1.12	2.71	1.45	1.73	3.87	3.20	3.68	3.64	3.60		2.96	2.37	3.68	3.70	3.18	2.60	4.41	5.07	3.26	3.84		
	2	2.16	2.45	1.96	1.64	2.05	3.06	3.83	3.42	3.21	3.38		2.28	2.47	2.10	3.27	2.53	3.05	3.16	3.15	3.33	3.17		
	3	2.26	2.44	2.19	2.60	2.37	4.19	3.76	3.90	2.93	3.70		1.84	3.30	2.35	2.65	2.54	2.75	3.13	3.10	2.30	2.82		
	4	3.16	2.45	2.02	2.50	2.53	3.62	3.50	3.20	3.24	3.39		3.46	2.51	3.68	2.21	2.97	2.26	2.16	2.80	3.77	2.75		
						2.17					3.52	2.84					2.80					3.14	2.97	2.91
Arkwin Sel.	1	3.10	2.88	2.64	2.28	2.73	3.05	3.17	3.00	2.69	2.98		1.90	0.71	1.90	1.05	1.39	2.04	2.70	2.85	2.78	2.59		
	2	2.03	2.20	1.69	1.72	1.91	3.28	2.24	2.90	3.09	2.88		1.55	1.82	0.92	1.58	1.47	2.48	2.51	3.06	2.29	2.59		
	3	2.73	2.45	2.07	1.89	2.29	2.75	3.11	2.64	2.88	2.85		0.60	0.94	0.66	0.66	0.72	2.45	3.00	2.22	2.18	2.46		
	4	2.30	2.26	3.51	2.70	2.69	2.85	2.38	2.24	3.00	2.62		0.32	0.36	0.58	0.47	0.43	2.15	1.95	2.40	1.97	2.12		
						2.40					2.83	2.62					1.00					2.44	1.72	2.17

TABLE XXV.

WEIGHT IN GRAMS OF FERTILE FLORETS PER TEN PANICLES FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										4-Sta. Year Av.
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	
Cimarron	1	5.24	4.42	7.45	7.08	6.05	7.03	8.33	8.19	8.52	8.02		6.99	5.48	5.85	5.39	5.93	7.94	8.04	7.30	6.29	7.39		
	2	6.84	9.01	6.57	6.29	7.18	7.65	8.71	9.44	7.98	8.45		5.91	5.29	5.09	6.22	5.63	6.53	6.97	6.51	7.17	6.80		
	3	6.65	8.16	5.32	8.92	7.26	8.66	8.22	7.61	7.28	7.94		6.77	5.01	5.58	4.72	5.52	6.43	5.85	5.51	7.35	6.29		
	4	6.18	7.25	6.99	7.58	7.00	9.16	9.96	10.03	9.13	9.57		3.62	4.72	3.63	5.26	4.31	5.89	7.17	6.89	6.10	6.51		
						6.87					8.49	7.68					5.35					6.75	6.05	6.86
Forkedeer	1	5.65	6.29	3.01	2.93	4.47	8.79	7.90	7.97	7.58	8.06		6.60	5.27	6.29	3.10	5.32	6.98	5.39	5.78	8.18	6.58		
	2	6.71	5.46	4.69	2.88	4.94	8.45	7.33	10.90	9.51	9.05		3.78	4.43	7.82	3.63	4.92	6.88	6.83	6.51	5.60	6.46		
	3	6.46	4.16	5.35	4.26	5.06	7.95	9.63	7.81	7.01	8.10		3.09	4.49	2.72	3.76	3.52	7.68	5.14	5.31	8.70	6.71		
	4	7.12	6.23	4.72	6.18	6.06	8.07	6.85	7.36	8.29	7.64		4.61	4.03	4.37	4.74	4.44	7.68	5.63	4.76	5.95	6.01		
						5.13					8.21	6.67					4.55					6.44	5.49	6.08
Wintok	1	5.45	4.78	3.85	4.80	4.72	3.68	5.70	5.52	4.76	4.92		2.30	2.09	3.23	3.99	2.90	7.44	5.62	5.26	4.86	5.80		
	2	4.05	4.12	3.15	3.19	3.63	5.36	4.91	5.25	5.95	5.37		1.50	3.17	2.23	1.64	2.14	3.44	5.26	3.95	4.45	4.28		
	3	4.17	5.18	3.63	4.35	4.33	5.80	6.85	7.74	5.69	6.52		1.61	1.37	2.40	1.92	1.83	4.57	3.77	5.29	4.02	4.41		
	4	4.05	3.83	3.80	3.06	3.69	5.11	7.02	5.76	6.19	6.02		1.81	2.43	1.49	2.17	1.98	5.49	5.63	4.54	4.85	5.13		
						4.09					5.71	4.90					2.21					4.90	3.56	4.23
Bronco	1	4.61	3.03	7.78	3.42	4.71	10.69	9.07	10.29	10.23	10.07		8.98	6.83	9.70	9.44	8.74	6.72	12.04	13.38	8.78	10.23		
	2	5.80	6.73	5.80	4.34	5.67	8.61	10.43	9.70	9.02	9.44		6.98	6.91	6.36	9.77	7.51	8.53	8.81	9.13	9.49	8.99		
	3	6.86	6.29	5.97	6.93	6.51	11.63	10.61	11.15	8.30	10.42		6.18	8.74	7.29	7.86	7.52	7.71	8.59	8.42	6.73	7.86		
	4	8.55	6.55	5.68	7.20	7.00	9.87	9.96	9.40	9.05	9.57		9.86	7.13	10.43	6.51	8.48	6.50	6.64	8.23	10.72	8.02		
						5.97					9.88	7.92					8.06					8.78	8.42	8.17
Arkwin Sel.	1	8.66	7.86	7.31	6.39	7.56	8.34	8.54	8.68	7.80	8.34		5.97	2.87	6.11	3.57	4.63	6.15	7.95	8.08	7.87	7.51		
	2	6.07	6.66	4.95	5.00	5.67	8.95	6.25	7.74	8.24	7.80		5.31	5.81	3.27	5.08	4.87	7.38	7.21	8.66	6.63	7.47		
	3	7.38	6.78	5.60	5.58	6.34	7.59	8.81	7.84	7.83	8.02		3.03	3.49	3.18	2.80	3.13	6.93	8.50	6.61	6.46	7.13		
	4	6.70	6.32	9.95	8.16	7.78	7.63	6.45	6.33	8.00	7.10		1.52	1.98	2.59	2.42	2.13	6.67	5.78	7.42	6.07	6.49		
						6.84					7.81	7.32					3.69					7.15	5.42	6.37

TABLE XXVI.

NUMBER OF PANICLES PER SQUARE FOOT FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959					1960						1959					1960					
		Sub-plots					Sub-plots						Sub-plots					Sub-plots					
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4		1	2	3	4	Av.	Sta. Av.	4-Ste. Year Av.
Cimarron	1	49	67	68	80	66	71	54	67	55	62		68	67	77	52	66	55	55	44	58	53		
	2	63	67	84	51	66	60	52	55	69	59		65	78	66	84	73	33	53	48	48	46		
	3	55	78	62	49	61	49	58	42	53	51		78	64	70	90	76	61	54	63	59	59		
	4	60	54	64	64	61	73	66	44	45	57		70	85	75	72	76	49	47	42	65	51		
						63					57	60					73					52	62	61
Forkedeer	1	64	54	77	51	62	60	58	71	56	61		79	65	80	80	76	54	72	55	52	58		
	2	62	69	50	60	60	50	68	65	58	60		78	87	65	80	78	73	71	68	66	70		
	3	41	46	62	48	49	62	69	69	62	66		85	71	79	88	81	60	75	69	55	65		
	4	44	47	51	49	48	57	56	67	65	61		81	66	76	74	74	72	67	55	50	61		
						55					62	58					77					63	70	64
Wintok	1	83	69	77	48	69	65	83	79	70	74		106	108	110	93	104	76	87	69	92	81		
	2	82	81	85	103	88	64	76	77	75	73		110	120	105	109	111	103	69	94	92	90		
	3	66	69	91	60	72	86	85	62	65	75		94	120	114	127	114	69	93	67	85	79		
	4	85	83	62	87	79	83	86	85	86	85		103	103	105	90	100	91	89	89	69	85		
						77					77	77					107					83	95	86
Bronco	1	59	47	58	41	51	55	62	56	50	56		57	64	43	48	53	59	50	37	42	47		
	2	48	57	53	37	49	54	53	46	51	51		68	65	64	60	64	69	57	45	41	53		
	3	48	53	52	43	49	38	54	57	66	54		55	41	59	75	58	51	58	54	64	57		
	4	47	48	41	40	44	60	66	66	57	62		43	69	48	70	58	53	56	53	55	54		
						48					56	52					58					53	55	54
Arkwin Sel.	1	62	56	57	74	62	49	47	51	37	46		64	59	70	66	65	37	49	45	48	45		
	2	54	53	66	57	58	49	56	55	39	50		57	86	52	57	63	61	52	49	33	49		
	3	58	61	63	53	59	51	51	40	56	50		58	72	44	39	53	53	45	54	55	52		
	4	59	55	49	58	55	42	50	37	40	42		50	72	83	72	69	38	41	37	46	41		
						58					47	53					63					46	55	54

TABLE XXVII.

GRAIN YIELD IN GRAMS PER SQUARE FOOT FOR FIVE VARIETIES OF WINTER OATS GROWN AT STILLWATER AND WOODWARD DURING THE YEARS 1959-1960.

		Stillwater											Woodward										
		1959					1960						1959					1960						
		Sub-plots					Sub-plots						Sub-plots					Sub-plots						
Variety	Rep.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	1	2	3	4	Av.	1	2	3	4	Av.	Sta. Av.	4-Sta. Year Av.
Cimarron	1	19.5	27.5	37.3	42.9	31.8	43.6	37.1	52.8	47.8	45.3		33.4	35.4	41.7	32.1	35.7	33.0	34.1	32.5	37.8	34.4		
	2	25.0	37.3	43.4	25.9	32.9	39.6	42.4	41.3	43.3	41.7		37.3	39.8	34.7	46.2	39.5	21.6	37.0	26.9	24.4	27.5		
	3	27.3	42.7	35.0	28.2	33.3	35.5	42.9	30.3	38.4	36.8		37.2	31.8	35.6	35.9	35.1	35.5	31.3	29.3	37.4	33.4		
	4	26.8	26.7	31.9	29.4	28.7	58.4	54.1	38.4	32.0	45.7		26.8	31.9	29.7	28.4	29.2	27.6	27.2	24.9	36.2	29.0		
						31.7					42.4	37.0					34.9					31.0	33.0	35.0
Forkedeer	1	37.5	27.0	32.5	19.7	29.2	49.7	47.2	48.2	37.6	45.7		34.9	33.0	43.2	35.0	36.5	28.5	36.5	34.1	31.8	32.7		
	2	29.5	27.7	14.5	20.4	23.0	43.0	47.9	55.1	49.6	48.9		32.4	30.3	32.1	23.6	29.6	45.7	37.7	34.0	37.7	38.8		
	3	16.8	18.4	32.9	18.8	21.7	43.6	52.8	48.7	41.1	46.6		25.4	30.4	25.5	25.2	26.6	42.8	42.9	33.5	37.4	39.2		
	4	23.6	25.4	20.9	19.3	22.3	36.9	37.5	49.1	45.6	42.3		33.3	26.2	42.0	35.8	34.3	34.9	31.8	25.0	26.0	29.4		
						24.1					45.9	35.0					31.8					35.0	33.4	34.2
Wintok	1	32.6	25.9	24.5	18.8	25.5	32.9	43.4	41.2	41.9	39.9		22.1	29.6	23.2	31.9	26.7	41.6	45.6	33.5	44.3	41.3		
	2	25.4	29.8	23.3	27.5	26.5	40.3	37.8	43.1	45.8	41.8		18.6	23.6	21.1	21.4	21.2	28.4	26.5	40.4	33.9	32.3		
	3	24.0	26.8	28.7	21.9	25.4	40.2	47.0	42.3	37.1	41.7		21.1	27.2	25.5	22.7	24.1	29.7	38.0	34.4	39.6	35.4		
	4	31.7	23.6	22.1	28.6	26.5	41.2	45.8	39.1	45.6	42.9		17.0	20.8	16.4	17.8	18.0	45.5	39.9	38.0	30.5	38.5		
						26.0					41.5	33.7					22.5					36.9	29.7	31.7
Bronco	1	21.9	9.4	27.8	14.3	18.4	50.7	59.5	53.8	41.6	51.4		44.1	30.4	33.9	37.9	36.6	39.3	41.5	40.5	38.1	39.9		
	2	22.9	34.3	18.7	16.6	23.1	42.9	41.9	46.4	49.5	45.2		46.5	49.7	42.3	48.5	46.8	55.0	45.5	36.8	35.6	43.2		
	3	30.4	27.2	30.1	22.7	27.6	39.7	50.6	51.2	62.9	51.1		36.4	28.9	34.8	53.0	38.3	38.0	38.6	44.5	44.5	41.4		
	4	25.5	23.5	22.9	15.5	21.9	58.2	50.1	58.2	48.0	53.6		33.8	41.4	38.6	28.3	35.5	36.2	36.2	39.6	59.1	42.8		
						22.7					50.3	36.5					39.3					41.8	40.5	38.5
Arkwin Sel.	1	39.1	35.7	30.7	44.7	37.6	34.8	35.4	40.9	27.8	34.7		31.8	15.4	28.3	28.8	26.1	21.8	37.2	30.5	37.9	31.9		
	2	32.5	31.5	29.7	27.2	30.2	30.1	36.7	37.7	31.3	34.0		31.7	40.2	16.3	23.6	28.0	37.4	31.9	35.1	20.9	31.3		
	3	35.5	40.6	34.7	32.9	35.9	39.2	41.4	28.1	45.7	38.6		18.4	26.0	13.1	8.3	16.5	34.8	30.3	27.3	31.3	30.9		
	4	32.5	33.1	37.4	36.1	34.8	25.9	26.5	21.6	28.0	25.5		9.7	12.1	27.1	17.0	16.5	21.6	26.2	25.7	23.3	24.2		
						34.6					33.2	33.9					21.7					29.6	25.7	29.8

VITA

Floyd Eugene Bolton

Candidate for the degree of

Master of Science

Thesis: ASSOCIATIONS OF THE MAJOR PLANT CHARACTERS WHICH CONTRIBUTE TO GRAIN YIELD IN FIVE VARIETIES OF WINTER OATS

Major Field: Agronomy (Field Crops)

Biographical:

Personal data: Born June 16, 1932 near Grandfield, Oklahoma, the son of William Albert and Beulah Faye Bolton.

Education: Attended elementary school and graduated from Grandfield High School, Grandfield, Oklahoma, in 1950. Undergraduate study at Cameron State Agricultural College, Lawton, Oklahoma, 1955-1956 and Oklahoma State University, 1956-1959. Received Bachelor of Science degree in Agronomy, May, 1959. Graduate study at Oklahoma State University, 1959-1960.

Experience: U. S. Army 1953-1955; Student laborer at the Small Grains Section of the Agronomy Department, Oklahoma State University 1956-1959; Instructor in Agronomy, Oklahoma State University 1959-1960.

Member: Alpha Zeta, Phi Kappa Phi, Agronomy Club

Date of Final Examination: February, 1961.