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Grain Production Characteristics of Five WINTER OAT Varieties

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Grain Production Characteristics Of Five Winter Oat Varieties

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The grain yield of an oat variety is the end result of a complex interaction of soil and climatic factors with the genotype of the variety. Wide variations of environment usually result in differing yield responses among varieties, and thus several years of testing at different locations are necessary to determine the area of adaptation for a particular variety. This bulletin reports results of studies made to determine yields and yield components of five oat varieties under different environments.

MATERIALS AND METHODS

The five oat varieties were tested at Woodward and Stillwater, Oklahoma, during 1959 and 1960. Four of these varieties, Cimarron (C. I. 5106), Bronco (C. I. 6571), Forkedeer (C. I. 3170), and Wintok (C. I. 3424), represent commercial types grown in Oklahoma. The other strain, Arkwin Selection (C. I. 7404), is a selection from Arkwin (C. I. 5850); the two resemble each other in many respects.

Cimarron is an extremely early, short-strawed, winter-hardy type with excellent grain yielding ability under Oklahoma conditions.

Bronco is a tall, late-maturing, winterhardy type with extremely high grain yield capacity under favorable conditions.

Forkedeer is medium in maturity and plant height, with moderate to good winterhardiness. Its grain production performance has been slightly lower than Cimarron and Bronco.

Wintok is one of the most winterhardy varieties in existence. Compared to Cimarron, it is medium to early maturing and slightly taller.

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It is noted for profuse tillering ability, but, in spite of this, it is not a high yielding oat compared to Bronco, Cimarron or Forkedeer.

Arkwin Selection is medium early in maturity and less winterhardy than the other varieties. It generally has large plump kernels with high test weight, but is a lower yielding type than the other varieties.

Yield components studied were number of seeds per panicle, number of panicles per unit area, and weight per seed.

The varieties were grown in a randomized complete block experiment with four replications at both locations. Each plot consisted of four 10-foot rows spaced 12 inches apart. At maturity, two 1-foot samples were harvested from each of the outer rows for yield and yield component determinations. The entire 1-foot section was used for yield and panicle number determination. Number of seeds per head and seed weights were obtained from 10 representative panicles from each 1-foot section. Number of seeds per panicle was further subdivided into primary and secondary kernels to establish intra- and inter-varietal relationships for these characters. Large plot yields were obtained from 16 square feet of the center rows.

Maturity (heading date) was recorded when 75 percent of the plot was headed. Height, expressed in inches from ground level to the top of the mass of panicles, was determined by averaging the readings from three or four random samples per plot. Only one test weight reading was recorded per variety per test, since the grain from the replications provided insufficient seed for testing.

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. The seeding rate was two 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 the study. Slight winterkilling was noted in the 1960 Woodward nursery where survival readings ranged from 86 percent for Arkwin Selection to 96 percent for Wintok. Also, lodging occurred in the 1959 Stillwater test when four of the five varieties showed lodging in the early part of the fruiting period. Lodging, measured in percent broken stems, ranged from 0 percent for Arkwin Selection to 10, 23, 33, and 76 percent for Wintok, Forkedeer, Cimarron and Bronco, respectively.

RESULTS

Number of Kernels Per Panicle

The average number of primary and secondary kernels per variety are shown in Table 1. Bronco produced the largest number of both primary and secondary kernels per panicle of the five varieties. Wintok, the heavy tillering variety, had the least number of seeds per panicle. Development of secondary kernels in Wintok was lower in proportion to primary kernels than for the other varieties. Tertiary (third) kernels per spikelet were rare and occurred only in Cimarron in one year.

Number of Panicles Per Square Foot

Table 2 shows the variety averages for number of panicles per square foot for each station and year. Wintok produced a far greater number

Table 1. Average number of primary and secondary kernels per panicle for five winter oat varieties, Stillwater and Woodward, 1959-1960.

Variety	Stillwater			Woodward			4 Station Year Avg.*	Avg. Prim. & Sec.**
	1959	1960	Avg.	1959	1960	Avg.		
	(primary kernels per panicle)							
Bronco	13.3	19.8	16.5	17.1	16.2	16.6	16.6	32
Cimarron	15.7	16.8	16.3	11.9	13.3	12.6	14.4	27
Forkedeer	12.9	15.5	14.2	10.3	12.4	11.4	12.8	23
Arkwin Selection	12.3	13.1	12.7	8.5	12.1	10.3	11.5	22
Wintok	12.8	13.6	13.2	6.8	11.8	9.3	11.2	19
	(secondary kernels per panicle)							
Bronco	13.2	18.7	15.9	15.4	15.8	15.6	15.8	
Cimarron	13.8	14.8	14.3	10.1	12.2	11.1	12.7	
Forkedeer	9.7	14.1	11.9	7.0	11.1	9.0	10.5	
Arkwin Selection	11.2	12.1	11.7	5.6	11.2	8.4	10.0	
Wintok	8.6	10.8	9.7	2.8	9.4	6.1	7.9	

*Variety averages joined by a continuous line are not significantly different at the .05 level of probability.

**L.S.D. = 0.16 kernels

Table 2. Average number of panicles per square foot for five winter oat varieties, Stillwater and Woodward, 1959-60.

Variety	Stillwater			Woodward			4 Station Year Average*
	1959	1960	Avg.	1959	1960	Avg.	
	(panicles per square foot)						
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 Selection	48	56	52	58	53	55	54
Bronco	58	47	53	63	46	55	54

*Variety averages joined by a continuous line are not significantly different at the 0.05 level of probability.

of panicles than the other four varieties. The highest and lowest yielding varieties, Bronco and Arkwin Selection, produced an average of 54 each.

Kernel Weight

Arkwin Selection produced much heavier seed than the other varieties (Table 3). Wintok, noted for its small seed, produced an average seed weight of only 22 milligrams. The secondary kernels of Wintok averaged only half the weight of the primary. For each of the other varieties the secondary kernels were proportionately heavier. The least weight difference between primary and secondary kernels was exhibited by Cimarron.

Grain Yields

Grain yields were exceptionally high as a result of the favorable growing conditions in 1959 and 1960. Weather conditions were slightly more favorable for production in 1960. Yield data for the five varieties are presented in Table 4.

With one exception, grain yields were higher from the one square foot sections than from the larger sections even though both determinations were taken from the same plot, but the varietal rank was the same. In relating the yield components with yield, the smaller plot yields should be used since the components were determined from these plots.

Table 3. Average weight of primary and secondary kernels of five winter oat varieties, Stillwater and Woodward, 1959-60.

Variety	Stillwater			Woodward			4 Station Year Avg.*	Avg. Prim. and Sec.**
	1959	1960	Avg.	1959	1960	Avg.		
	Primary Kernels (milligrams)							
Arkwin Selection	36	38	37	32	39	36	37	29
Forkedeer	28	35	32	33	35	34	33	26
Bronco	28	32	30	30	35	33	32	25
Cimarron	28	33	30	29	33	31	31	25
Wintok	23	30	27	27	30	29	28	22
	Secondary Kernels (milligrams)							
Arkwin Selection	21	23	22	18	22	20	22	
Forkedeer	15	19	18	17	19	18	18	
Bronco	16	19	18	18	20	19	18	
Cimarron	18	20	19	18	19	19	19	
Wintok	13	15	14	14	15	15	14	

*L.S.D.'s (.05 level) are 1.16 milligrams for primary and 0.88 milligrams for secondary kernels.
**L.S.D. (.05 level) = .094 milligrams.

Table 4. Average grain yields for five winter oat varieties, Stillwater and Woodward, 1959-60.

Variety	Stillwater			Woodward			4 Station Year Average*
	1959	1960	Avg.	1959	1960	Avg.	
	Center Rows (bushels per acre)**						
Bronco	56.1	122.3	89.1	108.6	98.8	103.7	96.4
Cimarron	87.4	107.1	97.3	91.3	83.5	87.4	92.3
Forkedeer	75.6	110.7	93.2	91.7	81.8	86.8	90.0
Wintok	66.4	104.1	85.2	63.2	79.5	71.3	78.2
Arkwin Selection	92.3	81.8	87.0	57.6	71.1	64.3	75.8
	Outer Rows (bushels per acre)***						
Bronco	68.1	150.9	109.5	117.9	125.4	121.5	115.5
Cimarron	95.1	127.2	111.0	104.7	93.0	99.0	105.0
Forkedeer	72.3	137.7	105.0	95.4	105.0	100.2	102.6
Wintok	78.0	124.5	101.1	67.5	110.7	89.1	95.1
Arkwin Selection	103.8	99.6	101.7	65.1	88.8	77.1	89.4

*Averages joined by a continuous line are not significantly different at 0.05 level of probability.
**Harvested from 16 square feet of the center rows of plot.
***Harvested from one square foot on the outer rows of plot.

Yields from the larger plots show that two yield levels are represented by the five varieties. Bronco, Cimarron and Forkedeer are in the upper level and Wintok and Arkwin Selection are in the lower level. The small plot yields show that three yield levels are represented with the upper group further subdivided into Bronco (highest), Cimarron and Forkedeer.

Height, Maturity and Test Weight

Height, maturity and test weight data are presented in Table 5. With the exception of Forkedeer and Bronco, each of the varieties represent a separate height class. Maturity differences were great between each variety. Statistical analyses were not conducted on bushel weight since replications were bulked for this determination.

Table 5. Height, maturity, and test weight averages for five winter oat varieties.*

Variety	Height	Maturity**	Test weight
	(inches)	(days)	(lbs./bu.)
Forkedeer	34	209	35.6
Bronco	34	212	32.9
Arkwin Selection	33	206	35.9
Wintok	31	207	34.5
Cimarron	29	201	33.7

*L.S.D. (.05 level) for height = 0.91 inches and for maturity = 0.53 days.
**Number of days from emergence to heading.

DISCUSSION

The yield components showed different quantitative levels in the yields of the five varieties. Number of seeds per panicle was more closely associated with yield than the other components. The varietal rank in yield paralleled that of seed number per panicle (see Tables 1 and 4). This component was particularly important in the high yield of Bronco. The high number of seeds, along with medium seed weight, more than counterbalanced the low panicle number of Bronco. Conversely, the low number of seeds per panicle coupled with low seed weight in Wintok more than offset the high panicle number and resulted in low yield.

Although this experiment was not designed to study basic criteria for selection of higher yielding varieties, the data suggest that seed number per panicle may be an important selection criterion for higher yield. Petr (8) found in spring oats that number of spikelets per panicle had a heritability value of 74 percent. Frey (1, 2, 3, and 4) found that this component contributed more to total yield in spring oats than panicle number or seed weight. Number of seeds per panicle failed to show a variety X year interaction, but did show a significant (.05 level) variety X location interaction (Table 6). This means the varieties responded slightly differently between the two locations, but not between the years.

Panicle number per unit area was influenced more by environmental changes than either of the other two components. Table 6 shows highly significant variety X location, variety X year, and year X location interactions. This was expected since changes in soil type, soil nutrient, moisture level, and weather have been observed for many years to greatly affect the amount of tillering among varieties. Petr (8) found tillering to have a heritability value of only 33 percent, which suggests it has only limited usefulness as a selection criterion for higher yielding varieties. It should be noted that the highest and lowest yielders, Bronco and Arkwin Selection, had the same low number (54) of panicles per square foot.

Seed weight showed the least variety X environmental interactions of the three yield components. The variety X year interaction was nonsignificant and the variety X location interaction, although significant at the .05 level of probability, was smaller than for the other components. Although seed weight certainly accounts for a portion of the total yield, high seed weights did not appear to be associated with the higher yielding varieties. The higher yielding varieties had intermediate seed weights. The lowest yielders, Arkwin Selection and Wintok, had the highest and lowest seed weight, respectively. Immer and Stevenson (7) found that yield and plumpness were highly correlated with coefficients ranging from 0.58 to 0.89 at four locations in Minnesota.

The data portray the complex interplay of the yield components in determining yield. Although certain components are apparently less subject to changes from environmental variations, all are affected to some degree. For a particular variety within a given environment, a decrease in one component tends to be counterbalanced by an increase of one or both of the other components. For example, at Stillwater in 1959, Arkwin Selection had extremely high seed weight compared to the

Table 6. The combined analysis of variance for 10 characters studied in five winter oat varieties, Stillwater and Woodward, 1959-1960.

Source of Variation	Number of primary kernels		Weight of primary kernels		Number of secondary kernels		Weight of secondary kernels		Total weight of kernels	
	Mean square	F value	Mean square	F value	Mean square	F value	Mean square	F value	Mean square	F value
Total										
Years	42,090.00	51.39**	137.69	91.19**	85,184.00	124.17**	54.35	86.41**	365.06	92.89**
Location	52,428.00	64.01**	33.73	22.34**	55,731.00	81.24**	17.30	27.50**	99.34	25.27**
Yr. X Loc.	21.00	0.03	1.31	0.88	1,857.00	2.71	0.05	0.08	0.86	0.22
Var. X Yr.	713.00	0.87	0.41	0.27	2,135.25	3.11	0.89	1.41	2.20	0.56
Var. X Loc.	4,216.25	5.15*	5.38	3.56*	2,793.50	4.07*	2.26	3.59*	14.19	3.61*
Var. X Yr. X Loc.	8,013.25	9.78**	7.85	5.20*	6,428.25	9.37**	2.34	3.71*	18.74	4.77*
Reps. (Pooled) (Error for above)	819.08		1.51		686.00		0.63		3.93	
Varieties	31,684.75	60.00**	38.58	52.14**	57,630.25	118.14**	27.85	121.09**	130.54	78.17**
Experimental Error (Effor for Var.)	528.10		0.74		487.81		0.23		1.67	
Sampling Error	424.09		0.49		404.75		0.18		1.19	

Table 6. (Continued)

Source of Variation	Number of panicles		Grain yield (1 sq. ft.)		Grain yield (16 sq. ft.)		Height		Maturity	
	Mean square	F value	Mean[1] square	F value	Mean[1] square	F value	Mean square	F value	Mean square	F value
Total										
Years	5,503.00	47.31**	7,747.03	116.83**	128,882.00	23.23**	12.00	4.65	1,805.00	940.10**
Location	4,568.00	39.27**	620.22	9.35**	33,089.00	5.96*	128.00	49.61**	594.00	309.36**
Yr. X Loc.	4,643.00	39.91**	2,007.51	30.27**	121,290.00	21.86**	1.00	0.39	424.00	220.83**
Var. X Yr.	740.00	6.36**	583.63	8.80**	16,799.75	3.03	14.75	5.72**	14.50	7.55**
Var. X Loc.	874.00	7.51**	323.76	4.88*	21,822.00	3.93*	3.75	1.45	9.75	5.08*
Var. X Yr. X Loc.	227.75	1.96	768.23	11.59**	37,829.00	6.82**	4.50	1.74	3.00	1.56
Reps. (Pooled) (Error for above)	116.33		66.31		5,547.92		2.58		1.92	
Varieties	11,353.50	119.20**	711.86	12.67**	37,435.00	15.55**	87.00	54.37**	268.25	479.02**
Experimental Error (Error for Var.)	95.25		56.18		2,407.46		1.63		0.56	
Sampling Error	83.55		33.52							

[1] Computed on grams per plot rather than bushels per acre (figures are higher than for bushels per acre, but the magnitude of variances and significance values apply directly to bushels per acre.)
*Significant at .05 level. **Significant at .01 level.

other varieties. This advantage was particularly offset by the lowest number of panicles per unit area recorded for this variety for the four tests. The number of seeds per panicle was slightly above average for Arkwin Selection, thus its yield was high.

For the test period and locations studied, the wide height and maturity differences among the varieties seemed to have little effect on yield. Normally, the early and medium maturing varieties are favored, but the near ideal weather conditions occurring in the fruiting period of both years allowed rather normal grain development for all maturity classes. The good test weights also reflect the ideal weather conditions during the grain development period.

SUMMARY

This study was made at Stillwater and Woodward, Oklahoma, during 1959 and 1960 to determine the effects of different environments on five winter oat variety yields and components of yield (number of seeds per panicle, number of panicles per unit area, and weight per seed). Height, maturity and test weight were also included in the trials.

Number of panicles per unit area showed an increase relative to yield and was influenced most by different environments. There were highly significant variety X location, variety X year, and year X location interactions. There was a significant variety X location first order interaction for number of seeds per panicle and weight per seed, with the latter component having the smaller variances.

Varietal rank in number of seeds per panicle closely paralleled the yield ranking, suggesting that this component was most important in determining yield. Varietal rank may also be useful as a selection criterion for higher yielding varieties.

The wide range of maturity of varieties apparently had little effect on yield, since the highest yielding varieties were represented by extremely early, medium, and extremely late varieties.

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OKLAHOMA'S WEALTH IN AGRICULTURE

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,000,000 annually. The value added by manufacture of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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