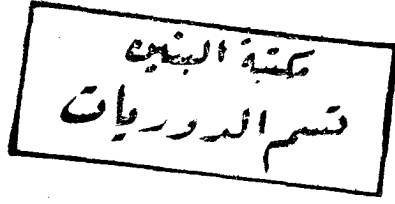




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## INHERRITANCE OF GROWTH AND OTHER AGRONOMIC TRAITS IN TWO OAT (*AVENA SATIVA L.*) CROSSES

By

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*Key words:* Inheritance, oats, growth, dry matter, correlation coefficient, grain yield

### ABSTRACT

Evaluating the inheritance of growth traits should assist plant breeders in determining its usefulness as a selection criterion for grain yield improvement. Three oat cultivars, 'Stout', 'Lodi' and 'Marathon' were chosen as parents on the basis of dry matter accumulation. Stout was early and produced high postheading dry matter. Lodi and Marathon were late and produced high dry before heading, but were not high in post-heading dry matter production. Two oat crosses (Lodi x Stout and Marathon x Stout) were made in 1983 to study heritabilities of growth rate and other agronomic traits. The experimental design was a nested split-split plot. Crosses were considered whole plots, families were sub-plots nested within crosses, and lines (4F<sub>4</sub> progeny lines and an F<sub>3</sub> parent line) were sub-sub plots. Heritability estimates were calculated by the standard-unit and parent-offspring regression methods. Heritability values were adjusted for degree of inbreeding in both methods.

Heritabilities of growth rate at heading and growth rate at maturity were relatively low. Days to heading and maturity had moderate heritability values that are considered sufficient enough to expect good progress from selection in early generations of oat breeding programs. Phenotypic correlations for growth rate at maturity and dry matter at maturity with grain yield were highly significant. After adjusting for degree of inbreeding, the standard-unit method had higher heritability estimates than parent-offspring method. However, both methods showed similar trends in the estimation of heritabilities.

### INTRODUCTION

Grain yield improvement can be achieved by increasing growth rate and harvest index (Helsel and Frey, 1981; Jalani *et al.*, 1981; Takeda *et al.*, 1979; Takeda and Frey, 1985) The relative contribution of growth rate has averaged 1.27 times greater than that of harvest index (Takeda and Frey, 1976). In Iowa, several workers evaluated growth rate as straw yield divided by number of days from sowing to heading (Cox and Frey, 1984; Helsel and Frey, 1983; Jalani *et al.*, 1979, 1981; Takeda and Frey, 1976, 1977; Takeda *et al.*, 1979, 1980). This method accounts for only dry matter production that occurs during vegetative growth, and assumes that the devia-

tion between growth rates calculated by this method and growth rate during the entire period is small or nonexistent.

Heritability values for growth traits were estimated by several researchers in Iowa. A mean heritability value of about 0.40 for growth rate was determined by Takeda and Frey (1976) in interspecific crosses of *A. sativa* x *A. sterilis*. Using 1200 F<sub>9</sub> - derived lines of oats, heritability for growth rate was 19 to 34%, depending on the method of estimation used in estimating heritability (Takeda *et al.*, 1980). Heritability in backcross populations of *A. sativa* x *A. sterilis* averaged 0.40, while the minimum number of effective factor pairs segregating ranged from three to nine (Takeda and Frey, 1977). The type of gene action in the inheritance of vegetative growth rate were varied among matings. In 12 matings involving *Avena sterilis* - derived lines and *A. sativa* cultivars, additive gene action was predominant in seven, while nonadditive gene action was found in the others (Helsel and Frey, 1983). Cultivar differences in accumulation of pre- and postheading dry matter were indicated by Brinkman and Rho (1984). These authors pointed out that the oat cultivars Marathon and Lodi produced more dry matter at heading than the cultivar Stout. Stout subsequently accumulated more dry matter after heading (i.e., post-heading dry matter).

Knowledge of the heritability of growth rate at heading and growth rate at maturity can assist oat breeders in determining their usefulness as selection criteria for grain yield improvement. The objectives of this study were: (1) to evaluate the inheritance of growth rate and dry matter accumulation at heading and at maturity, and (2) to determine associations of growth rate and dry matter accumulation with grain yield and other agronomic traits at both heading and maturity.

## MATERIALS AND METHODS

Three oat cultivars - Stout, Lodi, and Marathon - were chosen as parents on the basis of dry matter accumulation. Stout is relatively short and early, and has low drymatter accumulation before heading but is high in post heading dry matter accumulation. Lodi is tall and late, and has high dry matter accumulation before heading but after heading. Marathon is medium-tall and late, and like Lodi produces high dry matter before heading, but not after. Two crosses were made in 1983, Lodi x Stout and Marathon x Stout. Fifty F<sub>2</sub> seeds cross<sup>-1</sup> were spaced-planted at Madison in 1984 to maximize seed production. Plots were 3.0 m long and 0.33 m apart. In each cross four F<sub>3</sub> seeds from each F<sub>2</sub> plant (family) were sown at Arlington during the spring of 1985 to obtain F<sub>4</sub> seeds.

In the spring of 1986, F<sub>3</sub> and F<sub>4</sub> lines were grown at Arlington and Madison. The soil is a Plano silt loam (Typic Argiudoll, fine-silty, mixed, mesic) at Arlington and a St.

Charles silt loam (Typic Hapludalf, fine silty, mixed, mesic) at Madison. The 1986 planting dates were 9 May at Arlington and 6 May at Madison. The experimental design was a nested split-split plot with two replications. Crosses were considered whole plots, families were sub-plots that were nested within crosses, and lines/family (four F<sub>4</sub> progeny lines and an F<sub>3</sub> parent line) were sub-sub plots. Lines were randomized within families, families were randomized within crosses, and crosses were randomized in the two replications. The experiment in Madison was sown by hand. A plot consisted of a single 1.5 m row, with 0.33 between plots. The experiment at Arlington was mechanically planted in rows that were 3.0 m long and 0.33 m apart. Sufficient fertilizer for high production was broadcasted and incorporated into the soil prior to planting at both locations. There were symptoms of barely yellow dwarf virus infection on the parent Lodi and its progeny in Arlington nurseries during the 1986 growing season.

At both heading and maturity, 0.66 m<sup>2</sup> was harvested from each plot and dried at 40°C for 1 week prior to making dry weight determinations. Heading date was estimated as the day on which approximately 50% of the panicles in a plot had completely emerged from the boot. Plants were considered to be physiologically mature when green color had disappeared from the basal node (whorls) of all panicles in a plot.

Eleven traits were recorded for the parents and the F<sub>3</sub> and F<sub>4</sub> progeny lines:

- 1 . Dry matter (DMAH): above ground dry matter yield at heading.
- 2 . Days to heading (DH): number of days from planting to heading.
- 3 . Growth rate at heading (GRH): DMAH ÷ DH
- 4 . Dry matter at maturity (DMAM): above ground dry matter yield at maturity.
- 5 . Days to maturity (DM): number of days from planting to physiological maturity.
- 6 . Growth rate at maturity (GRM): DMAM ÷ DM
- 7 . Grain yield (GY): dry weight of grain threshed from 0.22 m<sup>2</sup> of a plot.
- 8 . Straw yield (SY): DMAM - GY.
- 9 . Harvest index (HI): GY ÷ DMAM
10. Height at heading (HH): distance between the soil and panicles tips at heading.
11. Height at maturity (HM): distance between the soil and panicle tips at physiological maturity.

Heritability was estimated by two methods. One was parent-offspring regression, by linear regression of the performance of offspring on that of the parents (Lush, 1940). heritability values were adjusted for degree of inbreeding (Smith and kinman, 1965):

$$\begin{aligned}
 h^2_N &= b/2r_{xy} \\
 &= 4/7b(F_4, F_3)
 \end{aligned}$$

where  $b$  is the regression coefficient,  $r_{xy}$  is a measure of the relationship between the parent  $y$  and its offspring  $X$ , and  $r_{xy}$  equal  $7/8$  for the  $F_3 - F_4$  relationship. The second method was regression in standard units, which is correlation of the performance of the parent with its offspring (Frey and Horner, 1957). As above, heritability values were adjusted for degree of inbreeding.

Parent-offspring regression may be biased by genotype X environment interaction (Casler, 1982). Therefore, the regression of the mean of an  $F_4$  line in one environment on the parental  $F_3$  line from the other environment was used to reduce this bias.

## RESULTS AND DISCUSSION

Ranges, means, and standard error for the parents and their progenies for the two crosses are given in Table 1. Differences among parents were reflected in their progenies. The means of the progenies were consistently higher than the mean of one of the parents for almost all traits studied in both crosses at the two environments. Lodi was the high parent in dry matter accumulation and growth rate at heading, while Stout was the lowest parent for these traits. However, Stout had higher dry matter accumulation and growth rate at maturity than did either Lodi or Marathon (Table 1). This agrees with the findings of Brinkman and Rho (1984) who tested these cultivars under several levels of N fertilizer. Stout was the highest parent in grain yield (GY) and the lowest in straw yield (SY), which led to the highest HI in both environments. Marathon x Stout progenies were higher than Lodi x Stout in GRM, DMAM, GY, and HI in the  $F_3$  and  $F_4$  generations. Low HI was observed in the Arlington experiment, due at least in part to the effect of barley yellow dwarf virus (BYDV) on growth during the 1986 season. This disease causes blasting of florets which leads to low HI.

Heritability estimates computed by the standard-unit and parent-offspring regression methods are shown in Tables 2 and 3. The use of parent-offspring regression is based on several assumptions: (a) the trait has diploid Mendelian inheritance, (b) the population is randomly mated, (c) there is no linkage among loci controlling a trait, (d) parents are noninbred, and (e) there is no GXE interaction between the performance of parents and offspring (Vogel *et al.*, 1980). In this study, heritability estimates from the standard-unit method were higher than those from the parent-offspring regression method. The reason for these differences is that the parent-offspring regression method gives a biased estimate of heritability when two generations have different means and variances caused in part by environmental differences (Cahaner and Hillel, 1980). In such cases, the parent-offspring correlation (heritability using the standard unit method) rather than regression is recommended for the measure of heritability (Frey and Horner, 1957).

Table 1

Descriptive statistics for growth and agronomic traits for the F<sub>3</sub> and F<sub>4</sub> populations of two oat crosses grown in two locations in 1986.

Trait	Genotype	Lodi X Stout							
		Madison				Arlington			
		Range	Mean	S.E.	Parental/ Mean	Range	Mean	S.E.	Parental Mean
DMAH	F <sub>3</sub>	40.3-80.1	59.3	1.50	P <sub>1</sub> =68.3	53.2-85.4	76.9	1.80	P <sub>1</sub> =90.1
	F <sub>4</sub>	42.4-69.2	55.4	0.86	P <sub>2</sub> =43.2	50.6-89.0	73.4	1.12	P <sub>2</sub> =81.5
GRHM	F <sub>3</sub>	0.7-1.5	1.1	0.03	P <sub>1</sub> =1.2	0.9-2.0	1.4	0.03	P <sub>1</sub> =1.6
	F <sub>4</sub>	0.7-1.4	1.0	0.02	P <sub>2</sub> =0.8	1.0-1.6	1.3	0.02	P <sub>2</sub> =1.6
DMAM	F <sub>3</sub>	42.3-106.4	76.0	2.00	P <sub>1</sub> =67.9	49.7-148.0	91.7	2.70	P <sub>1</sub> =93.5
	F <sub>4</sub>	42.7-91.7	68.9	1.70	P <sub>2</sub> =86.9	58.8-127.7	87.8	1.90	P <sub>2</sub> =102.6
GRM	F <sub>3</sub>	0.5-1.3	0.9	0.03	P <sub>1</sub> =0.8	0.6-1.8	1.1	0.03	P <sub>1</sub> =1.1
	F <sub>4</sub>	0.5-1.1	0.8	0.02	P <sub>2</sub> =1.1	0.7-1.5	1.1	0.02	P <sub>2</sub> =1.3
GY	F <sub>3</sub>	13.4-44.2	28.4	1.07	P <sub>1</sub> =18.7	4.5-45.1	25.5	1.13	P <sub>1</sub> =16.7
	F <sub>4</sub>	6.7-34.5	24.9	0.79	P <sub>2</sub> =40.0	4.2-36.7	23.0	0.87	P <sub>2</sub> =33.1
SY	F <sub>3</sub>	27.5-66.4	47.6	1.29	P <sub>1</sub> =49.2	42.4-102.9	66.3	1.70	P <sub>1</sub> =76.8
	F <sub>4</sub>	28.8-63.1	44.0	1.19	P <sub>2</sub> =46.9	47.6-94.2	65.0	1.28	P <sub>2</sub> =69.5
HI	F <sub>3</sub>	24.3-49.2	37.1	0.82	P <sub>1</sub> =27.5	8.9-33.9	27.0	0.71	P <sub>1</sub> =17.9
	F <sub>4</sub>	15.7-48.9	36.0	0.76	P <sub>2</sub> =46.0	6.6-33.7	25.8	0.63	P <sub>2</sub> =32.9
DH	F <sub>3</sub>	49.0-64.0	53.1	0.35	P <sub>1</sub> =58.4	52.0-66.5	56.3	0.42	P <sub>1</sub> =56.6
	F <sub>4</sub>	49.8-63.9	53.6	0.37	P <sub>2</sub> =52.5	52.4-67.5	56.6	0.42	P <sub>2</sub> =50.7
DM	F <sub>3</sub>	80.0-89.0	82.3	0.29	P <sub>1</sub> =86.5	78.5-83.5	81.3	0.20	P <sub>1</sub> =85.2
	F <sub>4</sub>	79.5-89.3	81.8	0.29	P <sub>2</sub> =80.5	79.4-86.9	81.5	0.21	P <sub>2</sub> =79.7
HH	F <sub>3</sub>	55.9-74.9	66.0	0.58	P <sub>1</sub> =72.9	58.4-83.8	72.6	0.71	P <sub>1</sub> =90.2
	F <sub>4</sub>	56.4-72.9	66.5	0.53	P <sub>2</sub> =59.4	62.5-79.8	71.6	0.56	P <sub>2</sub> =66.0
HM	F <sub>3</sub>	66.0-95.3	81.0	0.91	P <sub>1</sub> =86.6	71.1-111.8	93.5	1.09	P <sub>1</sub> =110.2
	F <sub>4</sub>	67.1-93.7	78.7	0.79	P <sub>2</sub> =70.1	77.7-116.9	91.9	1.02	P <sub>2</sub> =81.8
DMAH	F <sub>3</sub>	34.6-79.4	56.0	1.60	P <sub>3</sub> =61.0	59.9-111.0	83.7	1.80	P <sub>3</sub> =8.5
	F <sub>4</sub>	35.7-76.8	54.0	1.29	P <sub>2</sub> =43.2	57.9-107.2	78.4	1.27	P <sub>2</sub> =81.5
GRH	F <sub>3</sub>	0.6-1.5	1.1	0.03	P <sub>3</sub> =1.1	1.1-1.9	1.5	0.03	P <sub>3</sub> =1.5
	F <sub>4</sub>	0.7-1.3	1.0	0.02	P <sub>2</sub> =0.8	1.1-1.8	1.4	0.02	P <sub>2</sub> =1.6
DMAM	F <sub>3</sub>	41.5-115.0	77.1	2.20	P <sub>3</sub> =84.1	70.2-141.7	102.9	2.20	P <sub>3</sub> =96.3
	F <sub>4</sub>	54.1-95.1	73.2	1.41	P <sub>2</sub> =86.9	81.9-123.9	98.0	1.50	P <sub>2</sub> =102.6
GRM	F <sub>3</sub>	0.5-1.4	1.0	0.03	P <sub>3</sub> =1.0	0.9-1.8	1.3	0.03	P <sub>3</sub> =1.2
	F <sub>4</sub>	0.7-1.2	0.9	0.02	P <sub>2</sub> =1.1	1.0-1.5	1.2	0.02	P <sub>2</sub> =1.3
GY	F <sub>3</sub>	13.7-49.8	32.7	1.10	P <sub>3</sub> =00432.3	16.0-45.4	30.8	0.95	P <sub>3</sub> =23.8
	F <sub>4</sub>	11.4-42.1	29.9	0.84	P <sub>2</sub> =40.0	12.5-37.7	28.2	0.70	P <sub>2</sub> =33.1
SY	F <sub>3</sub>	27.8-65.2	44.8	1.29	P <sub>3</sub> =51.8	51.6-102.7	72.1	1.50	P <sub>3</sub> =72.5
	F <sub>4</sub>	32.4-62.3	43.3	0.92	P <sub>2</sub> =46.9	55.2-93.0	69.6	1.17	P <sub>2</sub> =69.5
HI	F <sub>3</sub>	29.9-54.6	42.3	0.68	P <sub>3</sub> =38.4	21.5-37.4	29.8	0.53	P <sub>3</sub> =24.7
	F <sub>4</sub>	17.8-48.8	40.7	0.74	P <sub>2</sub> =46.0	14.6-35.5	28.7	0.59	P <sub>2</sub> =32.9
DH	F <sub>3</sub>	48.0-59.5	52.6	0.30	P <sub>3</sub> =56.5	52.0-66.0	56.1	0.40	P <sub>3</sub> =54.7
	F <sub>4</sub>	48.0-60.5	52.9	0.34	P <sub>2</sub> =52.5	52.0-77.0	56.3	0.41	P <sub>2</sub> =50.7
DM	F <sub>3</sub>	77.5-88.0	80.7	0.25	P <sub>3</sub> =84.0	78.5-86.0	80.9	0.23	P <sub>3</sub> =83.6
	F <sub>4</sub>	76.2-88.8	80.9	0.30	P <sub>2</sub> =80.5	78.5-86.9	81.0	0.23	P <sub>2</sub> =79.7
HH	F <sub>3</sub>	53.3-68.0	61.0	0.51	P <sub>3</sub> =67.3	61.0-86.4	69.3	0.89	P <sub>3</sub> =83.3
	F <sub>4</sub>	52.8-72.9	60.2	0.56	P <sub>2</sub> =59.4	61.5-85.6	69.9	0.79	P <sub>2</sub> =66.0
HM	F <sub>3</sub>	62.2-91.4	73.7	0.94	P <sub>3</sub> =77.7	74.9-108.0	87.9	1.07	P <sub>3</sub> =95.3
	F <sub>4</sub>	61.7-89.7	72.1	0.97	P <sub>2</sub> =87.1	72.9-111.8	87.1	1.09	P <sub>2</sub> =81.8

*Inheritance of growth in oats*

Table 2.

Heritability estimates calculated by the standard unit method for growth and agronomic traits in two oat crosses grown at Madison and Arlington in 1986.

Cross	Same environment			Different environment	
	Trait	MADISON F <sub>4</sub> -F <sub>3</sub>	Arlington F <sub>4</sub> -F <sub>3</sub>	Madison F <sub>4</sub> on Arlington F <sub>3</sub>	Arlington F <sub>4</sub> on Madison F <sub>3</sub>
Lodi X Stout	DMAH	0.19	0.25	0.10	0.15
	GRH	0.18	0.19	0.03	0.16
	DMAM	0.39	0.36	0.15	0.21
	GRM	0.41	0.37	0.17	0.24
	GY	0.37	0.34	0.20	0.26
	SY	0.40	0.33	0.17	0.12
	HI	0.36	0.35	0.31	0.18
	DH	0.54	0.35	0.51	0.50
	DM	0.55	0.33	0.38	0.39
	HH	0.41	0.42	0.18	0.14
Marathon X Stout	HM	0.45	0.42	0.34	0.38
	DMAH	0.17	0.33	0.08	0.05
	GRH	0.13	0.21	-0.06	-0.04
	DMAM	0.29	0.20	0.09	0.14
	GRM	0.26	0.19	0.07	0.13
	GY	0.23	0.12	0.10	0.09
	SY	0.28	0.33	0.14	0.16
	HI	0.17	0.30	0.21	0.05
	DH	0.52	0.53	0.46	0.50
	DM	0.49	0.47	0.42	0.45
HH	0.45	0.49	0.14	0.23	
HM	0.45	0.42	0.34	0.44	

**Table 3**

Heritability estimates calculated by the Smith-Kinman method for growth and agronomic traits in two oat crosses grown at Madison and Arlington in 1986.

Cross	Trait	Same environment		Different environment	
		Madison F <sub>4</sub> on F <sub>3</sub>	Arlington F <sub>4</sub> on F <sub>3</sub>	Madison F <sub>4</sub> Arlington <sub>3</sub>	Arlington F <sub>4</sub> Madison F <sub>3</sub>
Lodi X Stout	DMAH	0.11	0.16	0.05	0.11
	GRH	0.10	0.12	0.02	0.10
	DMAM	0.33	0.26	0.10	0.20
	GRM	0.34	0.27	0.11	0.22
	GY	0.27	0.26	0.14	0.21
	SY	0.37	0.25	0.11	0.12
	HI	0.34	0.32	0.34	0.14
	DH	0.58	0.54	0.46	0.62
	DM	0.55	0.33	0.54	0.28
	HH	0.36	0.34	0.13	0.13
	HM	0.39	0.39	0.25	0.42
Marathon X Stout	DMAH	0.14	0.23	0.06	0.03
	GRH	0.09	0.13	0.05	0.03
	DMAM	0.18	0.13	0.05	0.09
	GRM	0.17	0.12	0.05	0.09
	GY	0.18	0.09	0.09	0.05
	SY	0.20	0.25	0.08	0.15
	HI	0.19	0.33	0.29	0.04
	DH	0.59	0.54	0.39	0.68
	DM	0.59	0.45	0.54	0.41
	HH	0.49	0.44	0.09	0.35
	HM	0.46	0.42	0.30	0.51



Heritabilities for GRH and DMAH were similar, however, values were low in the two crosses (Tables 2 and 3). This is in contrast to results observed by Helsel and Frey (1983) who reported that heritability values for GRH averaged 0.54. Heritabilities for GRM and DMAM were higher than GRH and DMAH in the two crosses. This result indicates that gains from selection may be more rapid for GRM than GRH. Heritability for GRM ranged from 0.19 to 0.41 for the same environmental estimate, and 0.07 to 0.24 for a different environment estimate (Table 2). Bias of estimates due to genotype X environment interaction has been indicated by Casler (1982). Heritability of GY ranged from 0.12 to 0.37 for the same environmental estimate and from 0.09 to 0.26 for a different environment estimate (Table 2). A similar trend in the estimate of heritability by parent-offspring regression is shown in Table 3. Low heritability values for GRM, DMAM and GY were observed. A similar result was observed by Osman (1984) who indicated that heritability estimates for DMAM and GY, for barley were low. The results of this study indicate that growth traits had low heritability, so selection in early generations is likely to be ineffective.

The higher estimate of heritabilities for GRM, GY and DMAM in the Lodi X Stout cross than in the marathon X Stout cross indicates that gains from selection in Marathon x Stout mating may be more rapid for these traits. However, selection for these traits should probably be delayed until later generations due to low heritabilities. Since many factors can influence heritability estimates, the estimates should be interpreted with regard to the condition under which they were obtained (Fehr, 1987). Traits DH and DM showed intermediate heritability values in the two crosses (Tables 2 and 3). The results showed that DH and DM were high enough to expect good progress from selection for these traits at the F<sub>3</sub> generation or later. Heritabilities for other agronomic traits, such as SY, HH and HM also were estimated. Straw yield showed a low heritability value while HH and HM showed intermediate values in the two crosses (Tables 2 and 3).

Phenotypic correlation coefficients for GRH, DMAH, GRM and DMAM with GY and other agronomic traits are given in Table 4. A similar trend for dry matter and growth rate was observed in both crosses. The highly significant correlation for GRM and DMAM with GY in the two crosses indicates a reasonably high association between traits, which agrees with findings by Salman and Brinkman (1988) who studied the association of pre- and postheading growth traits with GY in 12 oat cultivars. However, significant correlations for HI with GRM and DMAM were observed only in the Lodi X Stout cross (Table 4).

The results of this study show that the heritability of growth traits is relatively low. Traits DH and DM showed moderate heritability values, which can be considered sufficient to expect good progress from selection in the early generations. Posthead-

Table 4

Phenotypic correlation coefficients for dry matter and growth rate with agronomic traits for two oat crosses in two environments.

		Lodi X Stout		Marathon X Stout	
		F <sub>3</sub>	F <sub>4</sub>	F <sub>3</sub>	F <sub>4</sub>
DMAH With:	GY	0.01	0.07	0.12	0.22
	SY	0.38*	0.43**	0.53**	0.69**
	HI	-0.28	-0.20	-0.31	-0.22
	DH	0.32	0.38*	0.57**	0.72**
	DM	0.27	0.39*	0.52**	0.71**
	HH	0.52**	0.44**	0.47**	0.62**
	HM	0.17	0.19	0.27	0.50**
	DMAM	0.24	0.31	0.41*	0.62**
DMAM with	GY	0.88**	0.85**	0.82**	0.70**
	SY	0.93**	0.91**	0.92**	0.84**
	HI	0.44**	0.41*	0.15	0.12
	DH	-0.37*	-0.36*	0.19	0.31
	DM	-0.26	-0.37*	0.21	0.33
	HH	0.26	0.30	0.36*	0.47**
	HM	0.34*	0.46**	0.47**	0.54**
	DMAH	0.24	0.31	0.41*	0.62**
GRH with	GY	0.20	0.48**	0.23	0.38*
	SY	0.46**	0.47**	0.44**	0.59**
	HI	-0.09	0.25	-0.12	-0.04
	DH	-0.01	-0.21	0.27	0.39*
	DM	-0.03	-0.15	0.25	0.43**
	HH	0.43**	0.28	0.35*	0.49**
	HM	0.28	0.38*	0.23	0.46**
	GRM	0.38*	0.53**	0.37*	0.58**
GRM with:	GY	0.89**	0.88**	0.88**	0.77**
	SY	0.91**	0.87**	0.86**	0.76*☆
	HI	0.48**	0.47**	0.25	0.22
	DH	-0.44**	-0.46**	0.04	0.11
	DM	-0.35*	-0.47**	0.05	0.12
	HH	0.22	0.26	0.29	0.35*
	HM	0.35**	0.47**	0.44**	0.48**
	GRH	0.38*	0.53**	0.37*	0.58**

\* and \*\* Significant at the 5 and 1 error rate, respectively.

ing growth traits should be evaluated in further studies. These traits should be evaluated at least for 2 years in two locations, and probably in larger plots than we used in our study. Ogle, Hazel, and Don cultivars should be considered as possible parents for postheading growth rate and dry matter accumulation studies because of the capacity of these cultivars to accumulate large amounts of dry matter after heading (Salman and Brinkman, 1988).

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## قوة التوارث لصفات النمو وبعض الصفات في اثنين من هجن الشوفان

عبد الجبار عبد الرزاق سلمان ومارشال الين برنكمان

يساعد التعرف على قوة التوارث لصفات النمو والصفات الحقلية مربى النبات عند اجراء الانتخاب لغرض تحسين النبات . وعلى هذا الأساس تم اختيار ثلاثة أصناف من الشوفان وهي Stout و Lodi و Marathon على أساس قابلية هذه الأصناف على تراكم المادة الجافة . ثم الحصول على هجين من الشوفان وهما Lodi X Stat, Marathon X Stout عام ١٩٨٣ وذلك لغرض دراسة قوة التوارث لصفات النمو وبعض الصفات الحقلية . وقد اتبع في هذه التجربة تصميم Nested split-split أعتبرت الهجن قطع رئيسية ، أما العوائل فقد وضعت في القطع الثانوية ( داخل الهجن ) ، ووضعت السلالات ( ٤ من النسل F4 والأب ) في القطع المنشقة - المنشقة . وقد بينت النتائج بأن قوة التوارث لمعدل النمو عند التزهير ومعدل النمو عند النضج قد كان قليلاً نوعاً ما . في حين ان قوة توارث الصفات : عدد الأيام حتى التزهير ، عدد الأيام حتى النضج لها قوة توارث متوسطة وبدرجة كافية لاجراء الانتخاب في الأجيال الأولية من برنامج التربية . وقد وجد بأن هناك ارتباطاً مظهرياً وبدرجة عالية من المعنوية بين معدل النمو عند النضج ، كمية المادة الجافة عند النضج مع كمية الحاصل .