

EFFECTS OF A SINGLE HEIGHT (*Dw*) GENE OF SORGHUM  
BICOLOR (L) MOENCH AT THE 1-DWARF  
AND 2-DWARF HEIGHT LEVELS

by

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## REVIEW OF LITERATURE

The inheritance of height in sorghum (Sorghum bicolor [L.] Moench), because of its economic importance and the genetic implications involved, has been studied by a number of investigators (5, 7, 14, 16, and 18). The most complete work was done by Quinby and Karper (14). In 1932, Soiglinger (16) reported that height in broomcorn was determined by two genes which he called A and D. When he crossed 'Standard' (tall) with 'Western Dwarf' or 'Whisk Dwarf broomcorn', the F<sub>1</sub>'s were all the height of Standard. He obtained a 3:1 segregation for height from these crosses in the F<sub>2</sub> generations. When he crossed Western Dwarf broomcorn with Whisk Dwarf broomcorn, he obtained F<sub>1</sub>'s equal in height to Standard, and the F<sub>2</sub> generation segregated 9:3:3:1 indicating that two factors were involved. Considering Standard broomcorn as possessing two height factors, A and D, he concluded that the Western Dwarf lacked the dominant D and the Whisk Dwarf lacked the dominant A. Quinby and Karper (14) reported four genes that influenced elongation of the internodes and identified the height genotypes of numerous varieties. Tallness was found to be partially dominant to dwarfness. They also found that varieties identical genetically for height and having similar times of blooming may differ greatly in height. This difference was attributed to a modifying complex. It appears that 'Spur Feteretia', all of the milos, 'Texas Blackhull kafir', 'Bonita', the hogaris, and 'Plainsman' have a modifying complex that shortens their stature comparable to one recessive gene. In all crosses in which 'Durra', 'Japanese Dwarf broomcorn', or 'Sumac' was one of the parents, there was a tendency for the height classes of the various genotypes to be taller than those in which one of those varieties was not a parent. Lines recessive at one, two, three, and four loci were later designated 1-dwarf, 2-dwarf, 3-dwarf, and 4-dwarf, respectively (15).

Hadley (5) treated height as a quantitative character and found at least four independent genes with unequal effects. His analysis was based upon the cross 'Double Dwarf White Sooner milo' X 'Durra, PI 54484'. The results obtained by Hadley agreed with Quinby and Karper (14) who used Mendelian procedures. Hadley presented a model based upon assumptions compatible with his results, as well as Quinby and Karper's, which showed how an estimate of four genes could be obtained when actually two major and eight minor genes were involved. Watkins (18) also used a quantitative approach to study height of sorghum, and the results obtained were in close agreement with those obtained by conventional methods of analyzing qualitative characters.

Karper (7) reported an unstable height gene in sorghum that reverted frequently to the dominant state. He found the mutation rate of the unstable gene in 'Standard Blackhull kafir' to be one out of 604 on the basis of zygotes, and he concluded that if the mutation of the gene occurred as readily among male gametes as female gametes, the mutation rate in the gametes was one to 1,209 or 327 per million. Quinby and Karper (14) concluded that the unstable allele was  $dw_3$ ; however, they pointed out that 'Early Hegari', which is not recessive for the  $Dw_3$  gene, also possesses an unstable height gene which they failed to identify. In some varieties recessive for the  $dw_3$  gene ('Shantung Dwarf kaoliang', 'Acme broomcorn', and Japanese Dwarf broomcorn) the  $dw_3$  allele appeared stable (10).

Freeman, Hadley, and Seif (3) studied the phenotypic effects of nine height mutations. These results indicate that all reversions within families produce the same phenotype. All mutants expressed the same degree of dominance, suggesting that the unstable gene was the same in all cases and mutated to the same tall allele, or that if different genes were involved, their corresponding mutants expressed equal effects.

A number of people have studied the effects of a single height gene

(1, 2, 4, 6, and 8). Quinby (10) stated that the height genes did not influence number of leaves, days to bloom, width of leaf, number of stalks per plant, peduncle length, head length, or leaf sheath length. He found a significant head weight difference but attributed it to environmental factors. Karper (7) stated that the tall reversions of Standard Blackhull kafir were typical of the parental lines in which they appeared in all characters except internode elongation. He found no difference in number of nodes between tall and short plants.

Hadley, Freeman, and Javier (6) studied the effects of tall mutations on yield and other quantitative characters in grain sorghum. Mutant genes for long internodes and the dwarfing genes from which they arose were compared in both heterozygous and homozygous genetic backgrounds. In three of four hybrids having 'Combine Kafir-60' as a female parent, tall (*Dwdw*) plants produced more tillers and yielded more grain than dwarf (*dwdw*) plants. All of the yield superiority was not accounted for by the larger number of tillers. In one hybrid no significant difference was found in number of tillers between *Dwdw* and *dwdw*. In an experiment comparing *DwDw* with *dwdw* in 'Combino-7078' and *DwDw* with *dwdw* in 'RS 610', superiority of the tall version over the short in grain yield was 16.7% and 18.2% in Combino-7078 and in RS 610, respectively.

Casady (1) compared the effects of *Dw<sub>3</sub> Dw<sub>3</sub>* with *dw<sub>3</sub> dw<sub>3</sub>* in the varieties 'Martin', Plainsman, and 'Redlan'. Under the environmental conditions studied, he found that the *Dw<sub>3</sub>* allele resulted in higher yield, more heads per plant, higher kernel weight, and higher test weights in all three varieties. A significant environment X height interaction with these characters was indicated. The *Dw<sub>3</sub>* allele resulted in fewer kernels per head in Redlan but not in the other two varieties. No environment X height interaction was found for this character under the environments studied. The study indicated that the *Dw<sub>3</sub>*

allele did not have the same effect in all three varieties. All lines were shown to be isogenic, and testcross evidence was presented to show that the gene involved was  $Dw_3$ .

In a similar study with the same material, Casady (2) examined the effects of the  $Dw_3$  gene on culm and leaf blade characteristics. This study indicated that the  $Dw_3$  gene influenced culm diameter of the third, fourth, and fifth internodes from the top of the plant; peduncle length; blade width, blade length, and blade area of the third, fourth, and fifth leaves from the top, as well as culm height. The effect of the  $Dw_3$  allele on blade length and area was influenced by variety and environment. In both studies there was no evidence that the  $Dw_3$  genes influenced maturity.

Graham and Lessman (4) made reciprocal crosses between 'SA 368' ( $dw_1 Dw_2 Dw_3 dw_4$ ), and 'Calif. 38' ( $dw_1 dw_2 Dw_3 dw_4$ ), a short mutation of the former. They found total yield to be equal in the homozygous 2-dwarf line (SA 368) and the heterozygous 2-dwarf hybrids, but lesser in the 3-dwarf (Calif. 38). They also found the same relationship existing with seed weight; however, they found main head yield to be greater in the 2-dwarf than in the hybrids, and both hybrids and 2-dwarf to be greater than the 3-dwarf line. Panicle length was found to be equal in the hybrids and 3-dwarf and longer in the 2-dwarf line. The relative performance of the  $F_1$ 's showed the incomplete dominance of the  $Dw_2$  gene. No evidence was presented to show the lines to be isogenic, but it was stated that they appeared to be.

All of the previous mentioned studies have compared 2-dwarf and 3-dwarf lines or hybrids. Maunder and Woddlige (8) compared 3-dwarf and 4-dwarf hybrids which differed only in alleles at the  $Dw_2$  locus. Preliminary results indicated a progressive reduction in yield, height, and head exertion from the homozygous 3-dwarf ( $Dw_2 Dw_2$ ) to the heterozygous 3-dwarf ( $Dw_2 dw_2$ ) and, finally, to the

recessive 4-dwarf ( $dw_2 dw_2$ ) condition. Yield reductions of 8% and 5% were reported for 4-dwarf hybrids when compared with 3-dwarf hybrids. A height reduction of 25.4 cm was observed in the hybrids heterozygous for  $Dw_2$  when compared with the 3-dwarf.

In addition to the  $Dw$  genes which influence internode elongation, another group of genes that influence the duration of growth can also influence height (11, 12, 13, and 15). Quinby and Karper (13) have reported on three of these. They found that time of floral initiation controlled the number of leaves, duration of growth and the ultimate size of the plant. A fourth maturity gene has been reported by Quinby (11).

#### METHODS AND MATERIALS

The source of the material used in this study was the variety Japanese Dwarf broomcorn, with a known height genotype of  $dw_1 Dw_2 dw_3 Dw_4$  (14). In the summer of 1964, a tall mutant appeared in a row of Japanese Dwarf broomcorn in the sorghum nursery at Kansas State University. This plant was transplanted in the greenhouse, and during the winter of 1964-65, the plant was selfed by bagging the heads produced. The selfed seed, when planted in the field in 1965, segregated for height. Both tall and short plants were bagged for pure seed. In the summer of 1966, individual rows were planted from each head selfed in 1965. A number of heads from rows not segregating for height were bagged and seed from the tall and short rows combined into separate seed lots. The tall material obtained in this manner will hereafter be referred to as tall revertant, and the short as short recovered. The term short original will be used to refer to material derived from the original seed source.

$F_1$  progenies of testcrosses were grown in the field in 1967, to determine the height genotype of the tall revertant. The varieties used in the testcrosses

were Texas Blackhull kafir and 'Soonor milo, SA 5043. The height genotypes of these varieties are  $Dw_1 Dw_2 dw_3 dw_4$  and  $dw_1 Dw_2 Dw_3 dw_4$ , respectively (14). Care was taken to select varieties of the same maturity (12), since maturity can influence height by regulating the number of nodes. Both testcrosses were made with tall revertant Japanese Dwarf broomcorn as the female parent, and plants resulting from selfed seed were identified on the basis of head type.

The material was planted at Manhattan and Powhattan, Kansas, in 1967. The experimental design was a randomized complete block design with ten replications. Individual plots were four rows wide and 6.1 m long. Row spacing was 91.4 cm. All rows were planted thick and thinned to give a distance of 15.25 cm between plants. All data were collected from the center two rows to minimize any border effect. Measurements were taken on the short original, the short recovered, and the tall revertant. Total yield, primary and secondary culm yield, test weight, kernel weight, heads per plant, and number of kernels per head were determined for both locations. Leaf blade characteristics, culm characteristics, head length, length of the sheath of the flag leaf, and days to 90% bloom were determined at Manhattan only.

Harvesting was done by hand with primary and secondary heads being kept separate. The heads were threshed with a nursery thresher. The grain was dried for one week at approximately 40C before weights were taken. Total yields were computed by adding the yield from primary and secondary culms. Test weights were made in the usual manner with official test weight apparatus. Grain used to determine kernel weights was run through a scourer to remove any glumes that remained attached to the kernels. Kernel weights were taken after drying the samples at 68C for four days. Number of kernels per head was computed from main head yield, number of main heads per plot, and kernel weight. The kernel weight used for this calculation was obtained from samples which had



not been cleaned and dried as described above. Number of heads per plant was computed by adding the primary and secondary heads and dividing by the number of plants per plot. Test weight, kernel weight, and number of kernels per head were determined for main heads only.

Fifteen plants were selected for determination of leaf blade characteristics, culm characteristics, head length and sheath length of the flag leaf. These plants were selected by use of a table of random numbers with the first three plants on the ends of the rows being excluded to minimize possible border effect. The same 15 plants were used for all measurements and values for each plot were averaged before being analyzed.

Leaf blade width was the maximum measurement obtained regardless of the location on the blade. Blade length was the length from the collar to the leaf tip. Leaf blade area was calculated as maximum width X length X 0.747 (17). The leaf used for all measurements was the fourth leaf from the top. Culm diameter was determined for the fourth internode from the top of the plant -- considering the peduncle as the first internode. Culm diameter was the maximum measurement obtained at the midpoint of the internode, rotated between the jaws of a pair of calipers. Head length was the measurement from lowest branch of the head to the tip of the head. The length of the sheath of the flag leaf was obtained by measuring the distance from the collar of the flag leaf to the point of attachment at the first node. Peduncle length was the measurement from the lowest branch of the head to the uppermost node. Number of nodes was determined after the plants had been taken from the soil and the soil removed. Plant height was the measurement from the base of the culm to the base of the peduncle. Days to 90% bloom was the number of days from emergence to the day nearest the time when 90% of the main heads were in some stage of bloom.

## RESULTS

## Testercross Results

Table 1 gives the mean heights of the  $F_1$  progenies of the testcrosses of tall revertant Japanese Dwarf broomcorn with Texas Blackhull kafir and Sooner milo, SA 5043. The mean heights of the parents are also given. These  $F_1$  data failed to show which gene had reverted to cause the tall phenotype. Since only two height classes were observed in the segregating material in 1965 and 1966, apparently only one gene was involved.

## Comparison of Short Types

For this study to be meaningful, it is essential that the short and tall lines were isogenic. To establish this, the short recovered material was compared with the short original. If the original tall plant found in Japanese Dwarf broomcorn resulted from a reversion of a single *Dw* gene, there should have been no evidence of segregation for characters other than height, and the short recovered should have been identical to the short original, insofar as the variety used was a pure line.

In the field, the short recovered and short original were indistinguishable by visual observation. There was no evidence of segregation for any character other than height in any of the progenies of the original tall plant. Comparisons of main head yield, tiller yield, total yield, test weight, kernels per head, heads per plant, and grams per 1,000 kernels are given in Table 2. Height; leaf blade length, width, and area of the fourth leaf; culm diameter of the fourth internode; peduncle length; head length; sheath length of the flag leaf; node number; and days to 90% bloom are given in Table 3. Those comparisons indicated that the short recovered line was essentially the same as the

Table 1. Mean heights of  $F_1$  progenies of tall revertant Japanese Dwarf broomcorn crossed with varieties of known height genotype and the parent varieties grown at Manhattan, Kansas, in 1967.

$F_1$ progenies and parent varieties	No. of plants	Mean ht. (cm)
Sooner milo, SA 5043, $dw_1 Dw_2 Dw_3 dw_4$	34	86.0
Texas Blackhull kafir, $Dw_1 Dw_2 dw_3 dw_4$	34	76.2
Japanese Dwarf broomcorn (tall revertant)	36	163.7
Japanese Dwarf broomcorn (tall revertant) X Sooner milo, SA 5043, $F_1$	261	179.0 <sup>1</sup>
Japanese Dwarf broomcorn (tall revertant) X Texas Blackhull kafir, $F_1$	163	186.9 <sup>1</sup>

<sup>1</sup>The difference between these values is nonsignificant at the .05 level of probability ( $t = .662$ ).

Table 2. Main head, tiller, and total yield; test weight; kernels per head; heads per plant; and grams per 1,000 kernels for the short original and short recovered lines of Japanese Dwarf broomcorn at Manhattan and Powhattan, Kansas, 1967.

	Manhattan	Powhattan	Grand mean
Grain yield (g/plot):			
Main head yield:			
short original	1732	2877	2304
short recovered	1827	2950	2388
Tiller yield:			
short original	1386	1067	1227
short recovered	1453	804*	1128
Total yield:			
short original	3118	3946	3532
short recovered	3281	3753	3517
Test weight (lb/bu):			
short original	43.1	44.9	44.0
short recovered	43.4	45.6	44.5
Kernels per head:			
short original	1648	2562	2105
short recovered	1724	2617	2170
Heads per plant:			
short original	2.33	1.82	2.08
short recovered	2.24	1.70*	1.97
Grams per 1,000 kernels:			
short original	11.20	14.59	12.90
short recovered	11.47	14.84	13.16

\* indicates difference is significant at the .05 level of probability.

Table 3. Culm height; leaf length, width, and area of the fourth leaf blade; maximum culm diameter of the fourth internode; peduncle length; head length; flag leaf sheath length; number of nodes; and days to 90% bloom for the short original and short recovered lines of Japanese Dwarf broomcorn at Manhattan, Kansas, 1967.

	Short original		Short recovered
Culm Height (cm):	64.3		60.0
Fourth leaf blade:			
Length (cm)	58.1	*	56.4
Width (cm)	8.0		8.1
Area (cm <sup>2</sup> )	348	*	339
Maximum culm diameter (cm):	1.61	*	1.65
Peduncle length (cm):	9.8		9.7
Head length (cm):	43.6		44.1
Flag leaf sheath length (cm):	34.6		33.7
Number of nodes:	14.0		14.1
Days to 90% bloom:	75		75

\* indicates difference is significant at the .05 level of probability.

variety from which it arose. Therefore, it was assumed that the tall revertant was the result of a reversion, and that it was identical to the short recovered line except for a single height (*Dw*) gene.

#### Comparison of Short Recovered and Tall Revertant Lines

Except for height, the short recovered (2-dwarf) and tall revertant (1-dwarf) lines appeared to be identical in most respects. A greater number of secondary heads and a lesser degree of head exertion were observed in the short recovered.

Table 4 gives the means for main head yield, tiller yield, total yield, test weight, kernels per head, heads per plant, and grams per 1,000 kernels. The F values obtained from the analyses of variance of those characters is given in Table 6. The means for height; leaf blade length, width, and area of the fourth leaf; culm diameter of the fourth internode; peduncle length; head length; head plus peduncle length; flag leaf sheath length; node number; and days to 90% bloom are reported in Table 5 and the corresponding F values in Table 7.

All characters measured except leaf width and node number showed significant differences. Main head yield, test weight, kernels per head and grams per 1,000 kernels were all larger in the tall revertant than in the short recovered. The short recovered line produced a larger tiller yield, and more heads per plant. Total yield was greater in the short line at Manhattan, greater in the tall at Powhattan, and nonsignificant when both locations were averaged. The nonsignificant difference in number of nodes indicated that both lines were of the same maturity; however, this was not substantiated by days to 90% bloom which showed a difference. The tall revertant had a greater height, leaf length, leaf area, peduncle length, head length, head plus peduncle length, and sheath length of the flag leaf, but was exceeded in culm diameter and days to 90% bloom by the short recovered at Manhattan.

Significant environment X height interactions for main head yield, tiller yield, total yield, test weight, heads per plant, and grams per 1,000 kernels indicated that environment had a differential effect on the relative performance of the tall and short lines. No such interaction was found for kernels per head.

Table 4. Main head, tiller, and total yield; test weight; kernels per head; heads per plant; and grams per 1,000 kernels for the short recovered and tall revertant lines of Japanese Dwarf broomcorn at Manhattan and Powhattan, Kansas, 1967.

	Manhattan	Powhattan	Grand mean
Grain yield (g/plot):			
Main head yield:			
short recovered	1827 ***	2950 ***	2388 ***
tall revertant	2496	4037	3267
Tiller yield:			
short recovered	1153 ***	804 **	1128 ***
tall revertant	328	442	385
Total yield:			
short recovered	3281 *	3753 ***	3517
tall revertant	2824	4478	3651
Test weight (lb/bu):			
short recovered	43.4 *	45.6 ***	44.5 ***
tall revertant	45.0	51.5	48.3
Kernels per head:			
short recovered	1724 ***	2617 ***	2170 ***
tall revertant	2136	3015	2576
Heads per plant:			
short recovered	2.24 ***	1.70 ***	1.97 ***
tall revertant	1.31	1.35	1.33
Grams per 1,000 kernels:			
short recovered	11.47 **	14.81 ***	13.16 ***
tall revertant	12.18	17.95	15.06

\*, \*\*, and \*\*\* indicate difference is significant at the .05, .01, and .001 levels of probability, respectively.

Table 5. Culm height; leaf length, width, and area of the fourth leaf blade; maximum culm diameter of the fourth internode; peduncle length; head length; head plus peduncle length; flag leaf sheath length; number of nodes; and days to 90% bloom for the short recovered and the tall revertant lines of Japanese Dwarf broomcorn at Manhattan, Kansas, 1967.

	Short recovered		Tall revertant
Culm height (cm):	60.0	***	201.6
Fourth leaf blade:			
Length (cm)	56.4	***	67.8
Width (cm)	8.1		8.1
Area (cm <sup>2</sup> )	339	***	412
Maximum culm diameter (cm):	1.65	***	1.55
Peduncle length (cm):	9.7	***	18.3
Head length (cm):	44.1	***	49.5
Head plus peduncle length (cm) <sup>1</sup> :	53.8	***	67.8
Flag leaf sheath length (cm):	33.7	***	40.6
Number of nodes:	14.1		14.2
Days to 90% bloom:	75	***	72

<sup>1</sup>Significance is based upon t test and is not reported in Table 7 (t = 10.48).

\*\*\* indicates difference is significant at the .001 level of probability.



Table 6. Analyses of variance of main head yield, tiller yield, total yield, test weight, kernels per head, heads per plant, and grams per 1,000 kernels for the short original, short recovered, and tall revertant lines of Japanese Dwarf broomcorn at Manhattan and Pothattan, Kansas, 1967.

Source	df	F						
		Main head yield	Tiller yield	Total yield	Test weight	Kernels/head	Heads/plant	g/1,000 kernels
Environments	1	226.18***	8.84**	41.14***	64.47***	383.11***	56.67***	1476.52***
Error A	18							
Heights	2	93.18***	61.71***	.68	57.14***	52.18***	163.00***	87.48***
Env. X Ht.	2	4.53*	10.68***	11.51***	18.29***	.06	27.00***	29.81***
Error B	36							

\*, \*\*, and \*\*\* indicate difference is significant at the .01 and .001 levels of probability, respectively.

Table 7. Analyses of variance of height; leaf length, width, and area of the fourth leaf blade; culm diameter of the fourth internode; peduncle length; head length; flag leaf sheath length; number of nodes; and days to 90% bloom for the short original, short rocovered, and tall revertant lines of Japanese Dwarf broomcorn at Manhattan, Kansas, 1967.

Source df	Height	4th leaf blade		Culm diameter	Peduncle length	Head length	F. Leaf sheath length		No. of Days to nodos 90% bloom	
		Length	Width				Area	length		length
Reps. 9	.42	.83	1.71	1.46	1.38	1.56	2.23	3.68*	1.58	
Heights 2	3003.11***	177.67***	.98	211.49***	15.84***	78.46***	27.76***	109.55***	1.11	17.73***
Error 18										

\* and \*\*\* indicate difference is significant at the .05 and .001 levels of probability, respectively.

## DISCUSSION AND CONCLUSIONS

While the testcross results failed to show which *Dw* gene was involved, only two height classes were observed in the segregating material, indicating that only one gene had reverted. The partial dominance of the height genes and differences in specific combining ability may have caused the difference in height of the  $F_1$  progenies to be nonsignificant. While Texas Blackhull kafir was the shorter of the two varieties used as a testcross parent, it produced the taller  $F_1$  progeny. This may be an indication that the revertant gene was  $Dw_3$ ; however, a comparison of the  $F_2$  ratios is needed before a final conclusion can be made.

Since the number of nodes and days to 90% bloom, which are both measures of maturity, appear to be in conflict, there is some question as to which should be used. The heads seemed to emerge from the boot a day or so earlier in the tall than in the short line. Head plus peduncle length and flag leaf sheath length provide a possible explanation of this. Both measurements were longer in the tall revertant; however, a comparison with the short recovered shows that the heads exerted further in the tall than in the short (Table 5). If the same amount of time was required for maximum head and peduncle elongation in both lines, the heads would have emerged sooner in the tall line. The effect of emergence on time of blooming is not known, but possibly it accounts for part of the difference in days to 90% bloom. Unusually low night temperatures after a large portion of the tall plants had bloomed and at the time the short had just begun to bloom may have delayed blooming in the short, making the difference in days to 90% bloom greater than would have occurred with warmer nights. Because of these circumstances, node number seemed to be the better measure of maturity, and it was assumed that the dominant or recessive state of

the Dw gene involved had no effect on maturity.

The comparison of the short recovered and the short original line showed the two lines to be essentially equal. Differences were found for tiller yield, leaf blade length and area, and culm diameter at Manhattan and for heads per plant at Manhattan and over both locations. It should be noted that tiller yield is a function of heads per plant and leaf blade area a function of leaf blade length, and as a consequence, there were not as many differences between the two lines as it would appear from the data presented in Tables 2 and 3. The differences found between the two short lines could be due to chance or to the fact that the short recovered represents the progeny of a single plant selected from a variety and may, therefore, be expected to vary from the average of the variety slightly.

The data indicate that the Dw gene involved influences main head yield, tiller yield, total yield, test weight, kernels per head, heads per plant, grams per 1,000 kernels, leaf length and area of the fourth leaf, culm diameter of the fourth internode, head length, peduncle length, and flag leaf sheath length, as well as culm height. This study further supports the conclusion of Casady (2) that some or all of the Dw genes are pleiotropic. Node number and leaf width were not influenced under the environments studied. Total yield showed no differences between the two lines when both locations were averaged; however, it was significant under each environment considered separately. Total yield was higher in the short at Manhattan and higher in the tall at Powhattan. This was primarily due to the large tiller yield of the short line at Manhattan.

The environment X height interactions were significant for total yield, main head yield, tiller yield, test weight, heads per plant, and grams per 1,000 kernels, indicating that environment effects the relative expression of

the alleles of this *Dw* gene on these characters. No such interaction was found for kernels per head under the environments studied.

It is not known to what extent the results reported here would be applicable under other environments or with other varieties. Other *Dw* genes would not necessarily have the same effects as the gene studied. In work with corn, Phinney (9) has shown that the reasons for dwarfism can vary depending upon the particular gene controlling the expression of the dwarf character. The gene, being a complex structure with innumerable sites at which a mutation can occur, would not duplicate any previous mutation at the same locus. This being true, it would be unwise to assume that any mutation which occurred at the locus studied would be identical to the mutation involved in this study.

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EFFECTS OF A SINGLE HEIGHT (Dw) GENE OF SORGHUM  
BICOLOR (L) MOENCH AT THE 1-DWARF  
AND 2-DWARF HEIGHT LEVELS

by

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AN ABSTRACT OF A MASTERS THESIS

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A comparative study was made of isogenic lines of Japanese Dwarf broomcorn differing only in the dominant or recessive allele of a single height (*Dw*) gene.  $F_1$  data from testcrosses failed to show which *Dw* gene was involved; however, the observation of only two height classes in the segregating material indicated that only one *Dw* gene was involved.

The material for the study was obtained from a single tall revertant plant discovered in the sorghum nursery at Kansas State University in 1964. The reversion was dominant and affected only one allele of the original plant. A homozygous dominant 1-dwarf (tall) line and a homozygous recessive 2-dwarf (short) line were recovered from the original plant.

By comparing the short recovered line with the variety from which it arose, it was shown that the two lines were essentially the same. This indicated that the original tall plant was the result of a reversion and not an outcross.

The results showed that the dominant or recessive state of the height gene involved influenced main head yield, tiller yield, total yield, test weight, kernels per head, heads per plant, grams per 1,000 kernels, leaf blade length and area of the fourth leaf, culm diameter of the fourth internode, peduncle length, head length, flag leaf sheath length, and days to 90% bloom, as well as height. Under the environments studied node number and leaf width were not affected. Significant environment X height interactions were found for main head yield, tiller yield, total yield, test weight, heads per plant, and grams per 1,000 kernels. This indicated that the relative effect of the alleles of the *Dw* gene on these characters was influenced by environment. No such interaction was found for kernels per head.

Node number and days to 90% bloom, both being measures of maturity, appeared to be in conflict. It seemed that node number was the better measure

of maturity in this study, and it was assumed that the dominant or recessive state of the D<sub>w</sub> gene involved had no effect on maturity.