Published March, 1973

Yield Stability in Doubled Haploids of American Pima Cotton[1]

Carl V. Feaster and E. L. Turcotte[2]

ABSTRACT

We compared the yield performances of three American Pima cotton cultivars (*Gossypium barbadense* L.), a doubled haploid from each of the three cultivars, and a composite of the three doubled haploids. The relative yields and yield stabilities of the three doubled haploids were similar to the relative yields and yield stabilities of the cultivars from which the doubled haploids were derived. The probable increased homozygosity and homogeneity of the doubled haploids did not influence yield stability. The greatest yield stability was obtained from a composite of the doubled haploids.

Additional index words: **Regression, Environmental index, *Gossypium barbadense* L., Variety mixtures.**

SEMIGAMY in American Pima cotton (*Gossypium barbadense* L.) makes it possible to produce, at will, haploids of selected parentage (5). These haploids, when doubled, should be as homozygous as cultivars developed over a period of years by the plant-to-row method. The most recently developed, widely grown Pima cultivars were developed from selections taken only a few generations after the cross (3). The potential of these cultivars was established in early generations, making further selection ineffective.

We might speculate that the cultivars selected in early generations were relatively heterozygous and heterogeneous, thus contributing to their satisfactory yield performance over a range of environments. If this supposition is correct, doubled haploids of these cultivars should be less stable for yield due to greater homozygosity and homogeneity. For Upland cotton (*G. hirsutum* L.) Meredith, Bridge, and Chism (4) found that doubled haploids were about as stable in yield as their parent varieties. In this paper we compare the yield performance of three American Pima cultivars, a doubled haploid from each of these three cultivars, and a composite of the three doubled haploids.

MATERIALS AND METHODS

This study included 'Pima S-1,' 'Pima S-2,' experimental strain 22-6, a doubled haploid from each of the above, and a composite of the three doubled haploids. The haploids were doubled with colchicine. Pima S-1 was developed by selection from a complex series of crosses involving 'Sea Island,' Pima, 'Tanguis,' and 'Stoneville' (2). The first three parents were representatives of *G. barbadense*, and the latter was *G. hirsutum*. The final selections were taken when plant variability was evident. A composite of 35 of the most promising selections provided the breeders' seed for this variety. Pima S-2 and experimental strain 22-6 originated as F_3 selections from the cross of Pima S-1 and experimental strain 3-79.

The three cultivars were included in 15 Pima Regional Tests from 1956 through 1959. They were grown in Arizona, New Mexico, and Texas at elevations varying from about 30 to 1,220 m. The three doubled haploids and the composite of them were grown in Arizona at Phoenix (366 m elevation), Marana (609 m elevation), and Safford (884 m elevation) from 1963 through 1966. The environmental influences were mainly temperature differences associated with elevation and were predictable. The cultivar designation followed by DH indicates the doubled haploid from that particular cultivar.

Several methods of evaluating yield stability were employed—yield range for a given entry, coefficient of variability, regression analysis, and deviation from regression. Calculating the regression and deviation from regression involved calculating

[1] Cooperative investigations of the Agricultural Research Service, USDA, and the Arizona Agricultural Experiment Station, Tucson, Ariz. Journal Paper No. 1989 of the Arizona Agr. Exp. Sta. Received Oct. 4, 1972.

[2] Research Agronomist and Research Geneticist, ARS, USDA, University of Arizona Cotton Research Center, Phoenix, Ariz. 85040.

Table 1. Performance of three American Pima cultivars, doubled haploids from each cultivar, and a composite of the doubled haploids.

	Pima S-1	Pima S-2	22-6	Composite
		Cultivar		
X, kg/ha	794 b*	935 a	935 a	
Range, kg/ha	478-1,155	585-1,343	539-1,373	
CV	28.6	24.4	26.3	
Regression	0.97	0.97	1.06	
Σ deviations²	3,051	2,695	1,079	
		Doubled haploid		
S, kg/ha	832 b	894 a	878 a	878 a
Range, kg/ha	506-1,107	498-1,273	512-1,174	504-1,184
CV	24.5	24.8	26.0	24.5
Regression	0.93	1.01	1.05	1.00
Σ deviations²	2,518	2,759	1,306	438

* Values in the same row followed by the same letter are not significantly different at the 5% level.

Table 2. Analyses of regression and deviation from regression of three American Pima cultivars, doubled haploids from each cultivar, and a composite of the doubled haploids.

	Regression		Σ deviation²	
	Cultivar	Doubled haploid	Cultivar	Doubled haploid
S-1 vs. S-2	ns	ns	ns	ns
S-1 vs. 22-6	ns	ns	ns	ns
S-1 vs. composite		ns		*
S-2 vs. 22-6	ns	ns	ns	ns
S-2 vs. composite		ns		**
22-6 vs. composite		ns		ns

* Significant at the 5% level. ** Significant at the 1% level.

an environmental index (1). The environmental index, developed by Eberhart and Russell, is the average yield of all cultivars grown in a given test in a given year, minus the mean yield of all cultivars in all environments. The regression indicates the response of a given cultivar relative to the response of all cultivars. The deviation from regression is a measure of stability.

RESULTS

The yield responses of the three cultivars and their corresponding doubled haploids were similar (Table 1). In the Pima Regional Tests grown under a range of environments from 1956 through 1959, Pima S-2 and 22-6 yielded significantly higher than Pima S-1. Likewise, in the doubled haploid tests grown under a range of environments from 1963 through 1966, Pima S-2 DH and 22-6 DH yielded significantly higher than Pima S-1 DH. These results indicate that the various doubled haploids represent the productive capacity of the cultivar from which they were developed. The three cultivars and their corresponding doubled haploids showed considerable range in yield from test to test and relatively high coefficients of variability. The composite of the three doubled haploids also showed a wide range in yield from test to test and a high coefficient of variability.

The regression analysis showed no significant difference among the three cultivars, nor among the doubled haploids from the three cultivars (Table 2). Although the difference was not significant, 22-6 tended to respond more favorably to higher levels of production than did Pima S-1 and Pima S-2. Similarly, 22-6 DH tended to respond more favorably to high production than did Pima S-1 DH and Pima S-2 DH. The regression for the doubled haploid composite was an average of the regressions of the three doubled haploids.

Deviations from regression were not significantly different among Pima S-1, Pima S-2, and 22-6. Likewise, deviations from regression were not significantly different among Pima S-1 DH, Pima S-2 DH, and 22-6 DH, but the deviations from regression for Pima S-1 DH and Pima S-2 DH were significantly higher than for the doubled-haploid composite. Cultivar 22-6 tended to be more stable than Pima S-1 and Pima S-2, and 22-6 DH more stable than Pima S-1 DH and Pima S-2 DH, suggesting that genotype is involved in stability.

DISCUSSION

The lint yields for doubled haploids derived from three American Pima cultivars were as stable and predictable as were the cultivars from which they were selected. The regression and deviation from regression analyses employed by Eberhart and Russell provided an effective means of estimating yield stability (1).

The three cultivars can be considered as relatively heterogeneous. In contrast, the three doubled haploids should be relatively homogeneous. Apparently, the degree of homogeneity was not an important factor in yield stability.

The least deviation from regression was obtained by compositing the doubled haploids. Presumably, each doubled haploid differed in its response to the environment, and they tended to compensate for one another when grown as a composite. Only yield stability was gained by compositing.

In earlier work, we concluded that the potential of a strain was established in a few generations after a cross, making further selection ineffective (3). We theorized that additional selection would increase homogeneity and decrease yield stability. The data presented in this paper do not support this theory, since the reaction of a doubled haploid from a given cultivar was similar to the reaction of the cultivar from which it was selected. Apparently, doubled haploids of American Pima can be sufficiently stable for yield that they could be grown commercially.

REFERENCES

1. Eberhart, S. A., and W. A. Russell. 1966. Stability parameters for comparing varieties. Crop Sci. 6:36-40.
2. Feaster, Carl V., and E. L. Turcotte. 1962. Genetic bases for varietal improvement of Pima cotton. Crops Res., ARS 34-31.
3. ———, and ———. 1970. Breeding methods for improving Pima cotton and their implications on variety maintenance. Crop Sci. 10:707-709.
4. Meredith, William R., R. R. Bridge, and J. F. Chism. 1970. Relative performance of F_1 and F_2 hybrids from doubled haploids and their parent varieties in Upland cotton, *Gossypium hirsutum* L. Crop Sci. 10:295-298.
5. Turcotte, E. L., and Carl V. Feaster. 1969. Semigametic production of haploids in Pima cotton. Crop Sci. 9:653-655.