COTTONSEED PROTEIN AND OIL WITH REPEATED HARVESTS

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STUDIES aimed at improvement of economically important attributes of cottonseed in the Indian context appear to be limited in number and scope[1-3]. Seed processing quality changes following time of boll setting in cotton are now regarded as significant sources of variation[4-6]. Analysis of intraseasonal differences in protein and oil in each year is therefore likely to yield information useful in the selection for improved levels of both, along with the fibre. In the present investigation, changes in oil and protein content in mature seeds of 22 diverse cultivars belonging to *Gossypium hirsutum* L and 10 of *G. arboreum* L were determined. Character associations were examined at the various stages of harvest within the crop season.

The set in *G. hirsutum* consisted of Bikaneri Narma, F 414, 320F, H777, Buri 1007, DHY 286, G cot 100, SRT 1, L 147, Khandwa 2, Narmada, MCU6, DS56, Hampi and Mysore Vijaya; local selections T-3-11 and T-3-46, as also 5 exotic entries viz Bobshaw, Tide water, IC 934, IC 794 and IC 814. *G. arboreum* group consisted of LD135, Lohit, G27, AK277, AKH4, H 508, H511, K-5, LS1, and 30799. Entries were grown as single row plots of 15 plants and replicated four times. The crop was sown on 4 July 1981 and was harvested at maturity on 23 November, 23 December and 6 February 1982. Nitrogen in seed was estimated following the method of Jackson[7], and was converted into protein content. Composite samples of 25 seeds per variety per replication at each harvest were used to determine the kernel percentage. The percentage of kernel-oil in these samples was measured on a wide-

Table 1 *Range, mean and analysis of variance of four attributes in two groups of cotton*

Character	Stage of picking	Range	Grand mean ± SE	Variety mean square
	Group a: 22 cultivars of *Gossypium hirsutum*			
Seed protein (%)	I	(15.50–26.58)	20.34 ± 1.58	4.94
	II	(14.67–28.09)	21.00 ± 1.88	11.77**
	III	(11.41–25.70)	18.79 ± 1.53	12.95**
Protein/seed (mg/seed)	I	(9.6–25.2)	17.2 ± 1.9	0.288**
	II	(9.4–30.5)	17.3 ± 2.0	0.43**
	III	(6.0–21.9)	13.6 ± 1.6	0.20**
Kernel percentage	I	(44.98–65.17)	60.09 ± 2.63	15.05
	II	(48.70–67.91)	61.53 ± 3.98	12.26
	III	(50.77–68.58)	59.21 ± 2.19	7.88
Kernel oil percentage	I	(30.0–37.1)	33.75 ± 0.93	4.20**
	II	(30.9–38.0)	34.83 ± 1.32	4.10*
	III	(22.7–37.7)	33.74 ± 1.64	13.86**
	Group b: 10 cultivars of *G. arboreum*			
Seed protein (%)	I	(14.95–23.07)	18.70 ± 1.20	3.60
	II	(11.91–22.09)	17.24 ± 1.68	5.03
	III	(10.76–25.79)	16.28 ± 1.97	5.37
Protein/seed (mg/seed)	I	(7.8–14.9)	10.8 ± 1.4	0.30
	II	(4.9–12.5)	9.4 ± 1.5	0.30
	III	(4.8–11.4)	7.8 ± 1.1	0.20
Kernel percentage	I	(45.54–64.30)	54.96 ± 3.37	17.08
	II	(44.04–61.60)	54.74 ± 3.14	62.52**
	III	(43.85 61.15)	53.76 ± 2.75	29.46***
Kernel oil percentage	I	(27.6–36.4)	32.9 ± 1.05	7.49**
	II	(28.5–36.6)	33.3 ± 1.08	19.31**
	III	(23.7–36.6)	33.78 ± 1.38	10.10*

* $P = 0.05$; ** $P = 0.01$; *** $P = 0.10$.

line nuclear magnetic resonance instrument. The weight of protein per seed in mg was derived from the seed index and the per cent protein of each sample.

The highest mean percentage of protein per seed, kernel percentage and kernel-oil percentage in *G. hirsutum* cultivars were obtained at first and second harvest (table 1). Varietal differences for seed protein percentage and protein per seed were highly significant at second harvest. Estimates of heritability in the broad sense for protein per seed and kernel-oil percentage were also highest at second harvest. A sharp decline in values was noticed at the third harvest. In *G. arboreum* cultivars, the highest values in three of the four attributes were noticeable at first and the lowest at third harvest. Such pattern of variation seemed to correspond with that reported earlier in this material, for seed-oil percentage and seed-oil index[5]. In spite of highly significant differences due to stages of harvest, the cultivar x stage interactions were not significant for percentage protein in both species.

Correlation in *G. hirsutum* between oil and protein percentages over three stages of harvest was negative and significant ($r = -0.71^{**}$), similar to that observed earlier in cotton[1]. Such correlation, nevertheless, was non-significant at each one of the three stages, when considered individually. Seed protein and oil indexes were associated favourably, as also noticed by Kohel and Benedict[6]. Higher levels of oil, protein and fibre traits, similar to those in 'Acala SJ' series of cotton in California, may be present in bolls set at early stages in development[8,9], the lack of significant negative mutual associations at stages may be advantageous in selection. Oil and protein percentages were not negatively correlated to lint yield per plant at stages and also over stages.

Environment generally has a much greater impact in the second half of boll development period[10,11]. The mean daily minimum and the average temperatures during a period of four weeks were determined prior to each harvest date, in an attempt to correlate them with oil and protein. Seed-oil per cent averages[5] could be positively and significantly correlated with temperatures, in both species. Seed-protein percentage was favourably associated with temperatures in *G. hirsutum* in the present study.

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SELECTION CRITERIA FOR GENETIC IMPROVEMENT OF WHEAT GRAIN YIELD IN ALKALI SOILS

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ALKALI soils, characterized by pH greater than 9.0 and exchangeable sodium percentage exceeding 30, with consequent highly deteriorated physical properties, affect wheat production over nearly three million hectares, in otherwise highly productive Indo-gangetic plain. Wheat breeders, engaged in genetic improvement of wheat yields in alkali soils are faced with the choice of selecting directly for grain yield, under edaphic stress conditions or making selections for this purpose indirectly via various parameters and indices, quantifying stress-caused damage or plant's resistance rating. The former criterion has low heritability and suffers from a serious limitation as it does not distinguish between plant's genetic yield potential and its genetic capability to withstand specific stress factors[1]. The latter approach is more promising but requires considerable basic information to prove effective.

With a view to identifying reliable selection criteria, for indirect selection for yielding ability under alkali soil conditions, a study was conducted in specially designed test plots using 20 genetically diverse bread wheat varieties grown in two alkali soil grades (pH 8.9 and 9.3), and also in non-stress productive soil, over